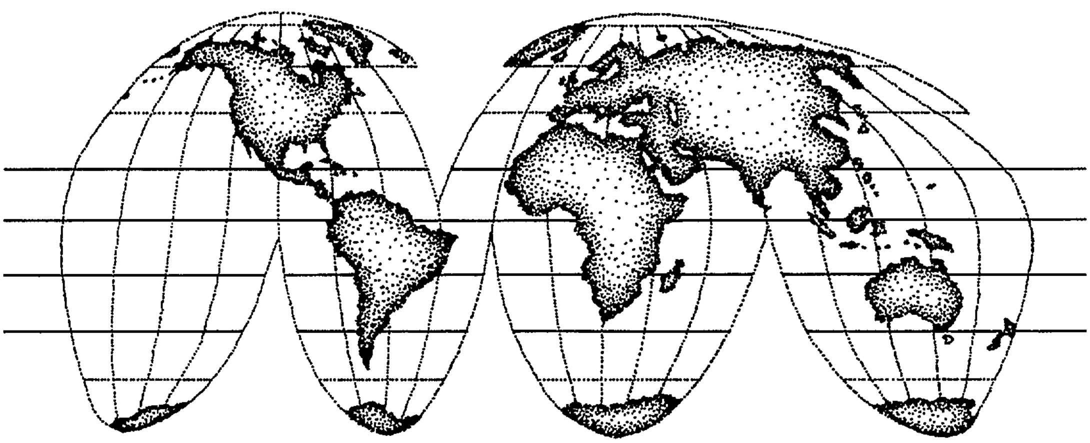
Proceedings of the International Collaborative Effort on Perinatal and Infant Mortality, Volume III

Papers presented at the International Symposium on Perinatal and Infant Mortality, 1990, Bethesda, Maryland, sponsored by the National Center for Health Statistics



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Preface

The International Collaborative Effort on Perinatal and Infant Mortality (ICE) was established by the Director of the National Center for Health Statistics to 1) gain a better understanding of the reasons for the relatively poor international ranking of the United States in perinatal and infant mortality; 2) to improve the quality and comparability of the data and measures utilized in monitoring perinatal and infant mortality in the United States, as well as elsewhere; and 3) to provide guidance to PHS programs relevant to infant health.

ICE activities were developed and carried out by its Planning Group, which includes researchers from NCHS, other components of the Centers for Disease Control, Health Resources and Services Administration, National Institutes of Health, and scientists from Denmark, England and Wales, Federal Republic of Germany, Israel, Japan, Norway, Scotland and Sweden. Subsequent to the 1990 Symposium the ICE has been joined by Czechoslovakia and Hungary.

The first major activity of the ICE was to convene the International Symposium on Perinatal and Infant Mortality in Bethesda, Maryland in August, 1984. The purpose of this symposium was fourfold: to learn about 1) current levels and trends in perinatal and infant mortality in our respective countries, 2) the relevant aspects of our health care systems, 3) current major concerns and priority research in improving infant health, and 4) to establish an agenda for future research activities. Recommendations for future research activities were presented and discussed in the final session of the symposium. The presentations of this symposium were published as the first "Proceedings" of the ICE.

The next major activity of the ICE was to make a series of presentations at two special sessions at the annual meeting of the American Public Health Association in 1985. A compilation of these papers was published as the ICE "Proceedings", Volume II. It was at this time that Denmark joined the ICE.

The Second International Symposium on Perinatal and Infant Mortality was also held in Bethesda, Maryland in May of 1990. This publication is an edited compilation of papers presented at the Second symposium and the Methodology Workshop immediately preceding it. Most of the presentations of this symposium are based on a standardized, birth-weight specific, data set covering birth cohorts around 1980-1985. This data set, which includes length of gestation and plurality, as well as age and cause of death for infant deaths, has provided important insights on the sources of differences in infant and perinatal mortality among the participating countries.

Some of the more interesting findings from the symposium include:

- In the U.S., extremely low birthweight/premature infants contribute disproportionately to infant mortality, due to a greater tendency in the U.S. to treat these very small infants as live births.

- Analysis using normalized scores for birth weight suggest that differences in infant mortality may be due more to differences in birthweight-specific mortality rates, and much less due to differences in birth weight distributions, than previously thought.

- The effects of birth weight on outcome are to a certain extent population-specific, and depend on both the mean and the variance of the distribution. For example, the mean birth weight of Japanese babies, who have the lowest infant mortality in the world have the same mean birth weight as blacks in the United States, the population with the highest infant mortality among the ICE countries. However, the variance of the Japanese distribution is quite small, with births highly concentrated about the mean. The variance of black births, in contrast, is very large, with a relatively high proportion of births falling in the low weight, high risk range.

- The increasing survival of infants under 28 weeks gestation strongly argues that the definition of late fetal deaths and perinatal deaths should be reduced to a minimum gestational age of 20 or 24 weeks.

- Because the minimum age for registering fetal deaths strongly affects completeness of registration of deaths near the minimum, the minimum should be reduced to 16 weeks.

- The feto-infant mortality rate, similar to the perinatal mortality rate but including deaths through the first year of life, is a more appropriate measure of pregnancy outcome for international comparisons.

- European members of ICE rely primarily on midwives for normal deliveries, but this practice is rare in the U.S.

- Socio-economic differentials in infant mortality and other outcome measures, as large as those found in the U.S., exist in several other ICE countries, even in Scandinavia where there is universal access to high quality medical care.

Future activities of the ICE will center on more refined analyses of the major findings from the symposium and will require expanding the ICE data base to include additional variables as well as more detail on existing variables.

Acknowledgements

Overall responsibility for planning and coordinating the content of this report rested with the Office of International Statistics, National Center for Health Statistics. Dr. Francis C. Notzon spent considerable time and effort guiding the editing process and ensuring the high quality of this publication.

Gail Johnson provided publications management and editorial review. Jarmilla Frazier supervised graphics, and Sarah Hinkle designed the cover. Zung Le, Annette Gaidurgis, and Patricia Wilson coordinated production and printing.

The substantial contributions made by the authors of the papers printed in this publication are gratefully acknowledged.

Dedication

The sudden and untimely death of Joel Kleinman, Ph.D., on May 2, 1991, was a profound shock to his colleagues in the International Collaborative Effort on Perinatal and Infant Mortality. As in his other professional associations, Joel was regarded as a brilliant contributor and as a warm and caring friend. One of his major professional concerns was the persisting differential in infant mortality between whites and blacks in this country, a concern that is reflected in his paper, "Implications of differences in birthweight distribution for comparisons of birthweight-specific mortality," published in this volume.

In an obituary, a close associate wrote that "...Joel always approached things with a small dose of healthy skepticism..." (1). But he went on to say that Joel's skepticism was tempered by open-mindedness to new ideas--the same open-mindedness that led him to elaborate on the Wilcox-Russell method for birthweight adjustment, the approach used in his paper. It also led him, after a period of "healthy skepticism," to utilize international comparisons to better understand our own national problems.

We dedicate these *Proceedings of the International Collaborative Effort on Perinatal and Infant Mortality, Volume III*, to the memory of Joel Kleinman. His dedication to professional excellence, his numerous and brilliant research contributions, his caring for those about whom he did research, and his friendship will serve as an inspiration for us all. We sorely miss him.

References

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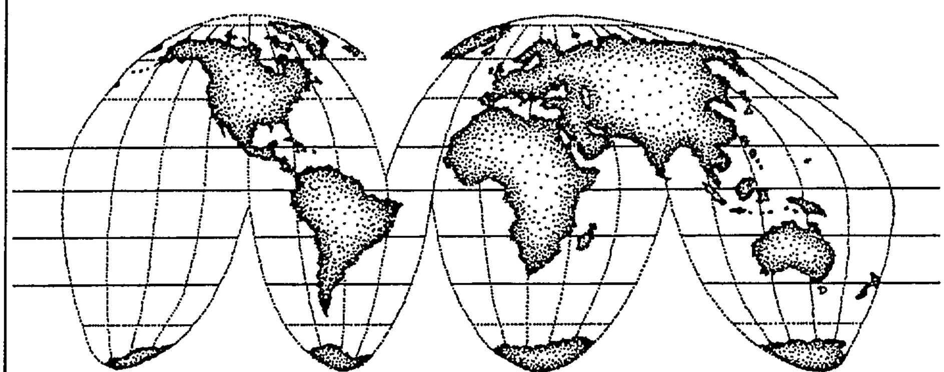


Opening Remarks

Opening Remarks and Introduction

MANNING FEINLEIB, M.D., Dr.P.H.: The theme for this meeting is "Using International Comparisons to Understand National Problems." That theme sets the challenge to use our collective knowledge to address the worldwide public health goal of the prevention of infant mortality.

Infant mortality does not have a single cause, nor does it have a single cure. As I look around the conference center, I see that this audience represents the wide diversity of experience and perspective needed to deal with the very complex problems of infant deaths. We appreciate your joining us for this intensive 3-day program, which we expect will greatly further our understanding of infant mortality in this country, in your countries, and in other countries.

I am particularly pleased to extend a welcome to the ICE members who have traveled far to participate in this symposium. Each member has worked diligently during the past few years to contribute data and information on the factors affecting infant mortality and to develop the foundations upon which we are now building.

The reduction of infant mortality is a major goal of the United States Public Health Service. The Public Health Service has attacked the problem on many fronts. Through surveillance and data analyses, through research, through health education, and through medical care, the Public Health Service has sought to bring about a measurable reduction in infant mortality rates.

Joining us today to open the symposium is Mr. Hal Thompson, Director of the Office of International Health in the Office of the Assistant Secretary of Health of the Department of Health and Human Services. Mr. Thompson, who has been involved with international programs in the Public Health Service for more than 20 years, served as the Deputy Director of the Office of International Health under the previous director, Dr. C. Everett Koop, prior to becoming Director in 1988.

The Office of International Health is the principal coordinating agency in international affairs in the United States Public Health Service, and oversees 67 bilateral agreements in health between the United States and foreign governments. OIH also coordinates activities between the Government and the World Health Organization and the Pan American Health Organization.

It is a pleasure and an honor to have Mr. Thompson address our symposium this morning.

HAROLD P. THOMPSON, M.P.A.: It is a real pleasure for me to be here this morning, and I want to extend a welcome on behalf of Dr. James Mason, our Assistant Secretary for Health, who very much wanted to be here with you this morning. You are talking about a topic that is very close to his heart, but unfortunately, scheduling conflicts made it impossible.

This is a very important symposium. As Dr. Feinleib just said, the reduction of infant mortality, perinatal mortality, under age 5 mortality, and the improvement of child health generally is a major priority for the Public Health Service and has been for quite a few years. It is one of the things that we are in business for. Internationally as well, we are involved in a great deal of activity involving activities that are aimed at child survival. It is one of the major thrusts of what we do in the technical assistance area.

I would like to take a couple of minutes, just the few minutes that I have here this morning, and say a few words about the Global Child Survival Initiative and a little bit about what the Public Health Service does in support of those efforts. The two projects that I want to highlight in particular are the Technical Advisors for Child Survival and the Controlling Childhood Communicable Diseases Project in Africa. Both of these are carried out through our Centers for Disease Control (CDC) in Atlanta, which is the parent agency of our National Center for Health Statistics.

All of the agencies of the Public Health Service are involved in international health activities, and many of them are also involved in technical assistance activities related to child survival. Our National Institutes of Health, by way of example, along with the Food and Drug Administration and CDC are working on some very important and exciting vaccine development projects. But the primary field agency, so to speak, the one that provides on-the-ground advisors and technical assistance, is our Centers for Disease Control.

I might add at this point that the projects that we are talking about here in pure technical assistance, our child survival activities for the most part, are funded by our Agency for International Development, AID. For those of you who may not be completely familiar with our system, I would like to take a minute just to explain how we organize for the provision of technical assistance.

The Public Health Service is primarily a domestic agency. We have no real authority to provide technical assistance in health unless there is a tie-in to our domestic mission--an American benefit, as we call it. The Congress has seen fit to provide all of the authority and all of the appropriations for technical assistance to our Agency for International Development.

On the other hand, the Public Health Service, as the lead technical agency in health for the United States Government, our Ministry of Health so to speak, has the responsibility under a number of Executive orders to provide technical assistance through the Agency for International Development. So we, in effect, serve as a contractor. I think at the present time there are something on the order of 26 separate agreements with the Agency for International Development. Involved is a great deal of money that is primarily for personnel costs, which channels to the Public Health Service for overseas technical assistance in health. We do not do a great deal in the way of provision of equipment and that sort of thing. We are a main source of expertise, and our main value to AID is in the provision of technical experts.

The two projects I talked about, therefore--TACS, Technical Advisors for Child Survival, and CCCD, the Controlling Childhood Communicable Diseases Project--are both funded by AID, but they are our major field activities in the child survival area.

I recently had the opportunity to attend a meeting in Swaziland that focused on child survival. This was organized by the countries participating in the CCCD Project and by our Centers for Disease Control. All of the 15 or so countries that participate in this project were represented, as well as another 5 or 6 African countries. I always come away from meetings like that with really ambivalent feelings. On one hand, you hear an awful lot of good things. There is progress being made, and you are impressed by some of the people that you listen to. They are doing good things. They are good people, and you see an increasing expertise in management, including the use of data in planning, and it is all very encouraging.

This meeting, on the other hand, also made it clear that there are some enormous problems remaining. Of course, we know that before we go to those meetings. We are all familiar with the data in the developing world, and we know that there is a long, long way to go.

On the other hand, it is clear that there are some good things happening, and these local activities generally reflect what is happening internationally. I do not want to diminish or understate the remaining problems in any way; but globally, the United Nations Infant and Children Education Fund (UNICEF) tells us in their figures, for example, that immunization coverages are increasing dramatically, or have so increased in the 1980's. According to their figures, comparing 1980 and 1988, diptheria, pertussis, and tetanus immunization (DPT) coverage has increased from 24 to 66 percent, measles 15 to 59 percent, and polio 20 to 66 percent.

I know that you as data experts are probably sitting there thinking that there are probably some real problems with that data, and I agree. But, on the other hand, they do reflect real progress. Whether the exact figures are accurate or not, it is clear that in the 1980's the immunization efforts globally have made some significant strides.

We all know about oral rehydration therapy, and it is really remarkable what has been done in the past decade. It is hard to go anywhere in the developing world without finding oral rehydration therapy given a priority; you see the salts everywhere. Again, there is still a lot to do, but progress is definitely being made.

As a measure of the things that we have been able to do, UNICEF tells us that their estimate of the number of lives saved--just by the increased immunization coverage alone--is something on the order of two million a year. That is comparing 1977 and 1988 coverage data. But equally important to the number of lives saved is that it demonstrates the real potential for making gains.

I would not care to suggest a specific target; but we talk a lot about the year 2000. It may be possible, given the political will, to make enormous additional gains in child survival between now and, for example, the year 2000. We certainly have the technology and the know-how, and it is available at relatively low cost. Again, it is not easy. Many things are much more difficult to do than others, as we know.

What is missing, or what should be increased I guess we should say, is the political will. Jim Grant of UNICEF talks about this a great deal. He makes the point that the tools are there, as I have said; and, with increased political commitment and relatively modest additional resources we can make some enormous gains in child survival over a relatively short period of time.

There obviously are some danger signs on the horizon. We all know about the world economic problems. We know about the Third World debt crisis, which is becoming worse by the year. I was surprised to see a World Bank report that said of the developing countries collectively, they spend something like one-half of their total incomes on a combination of debt services and military expenditures. That is an awful lot of nonproductive spending, and at least the debt service part of it is getting worse.

As part of the effort to generate the political will, the International Task Force on Child Survival, UNICEF, six convening nations, and a number of others are promoting a World Summit on Children; and we are involved now, we the Public Health Service, in helping to plan for that activity. It is going to be held in September in New York in conjunction with the opening of the United Nations General Assembly, and the hope is to get as many Presidents and Prime Ministers as possible to look anew at the problems that remain in front of us in terms of reducing child mortality and at the potential for really doing something about it. We are at the point in our history where a critical mass may have been reached when we can really make some substantial gains.

There are some obvious limits on the utility of a political meeting like that. Many people would say it is all flash and no substance; that the Presidents and Prime Ministers get in the spotlight and after a day or two, people go away and forget about it. I am not quite that cynical. I really do believe in the spotlight effect. I believe that every time we are able to do something like this we not only focus the world's attention, we take advantage of an opportunity for coverage in the press and other media. We also generate to some extent an increased commitment on the part of both the individuals involved and the governments that they represent.

I might add in passing that I see this as one of the great values of the World Health Organization and UNICEF. Many people think of those two agencies primarily in terms of the technical assistance they provide and their role of coordinating the efforts of individual countries. But having worked with those organizations--and I am speaking primarily of WHO, but also UNICEF--for many years, and attending quite a few of the annual World Health Assemblies, I have been impressed by the moral suasion that is provided by WHO, particularly through the World Health Assemblies.

When you get government representatives, high-level people, together and you talk about these problems and you establish goals and objectives, and you make it clear that their country is going to be spotlighted, that their objectives are going to be reported on, that they are required to periodically report on what it is that they are doing, it provides the additional impetus, the motivation to go back and argue that much harder in the councils of their own governments for additional resources. It has, to a lesser degree perhaps, because they usually do not participate directly, the same effect on chiefs of states and heads of governments. It provides, as I say, a motivating force. And I believe that is one of the main values of those organizations, one that is often overlooked.

In closing, and I made it a point to try to be brief this morning, I would like to turn back a minute to this symposium and its importance.

You are going to be talking a lot during this symposium about our particular problems in the United States. You all know better than I do the problems with our international ranking in infant mortality and what has been happening to it in recent years.

The United States does not have any particular reason, obviously, to be proud of what is happening in view of our great wealth and in view of the percentage of our gross national product that is spent on health care in this country. There is no excuse for what has been happening to our international ranking in infant mortality. And particularly, of course, the differences between minority groups, especially our black citizens, and other socioeconomic groups. Strong words are really appropriate. It is a disgrace. It should not be that way, and we really need to do something about it.

This is where studies like the International Collaborative Effort (ICE) on Perinatal and Infant Mortality, I think, can be very important. When you are dealing with infant mortality rankings that are grossly high, 80, 100, or even 150 or more, you pretty much know what the kids are dying of. You know what you have to do to make pretty substantial gains in a relatively short period of time. That does not mean the resources are going to be there, and it does not mean the political support is going to be there; and as I keep saying, it does not mean that it is going to be easy. But basically, you know what you have to do.

When the rankings come down to the teens or even lower, things become much more difficult. It becomes much more difficult to make incremental gains. This is where increased knowledge, I think, is very, very important; and the types of studies that dissect the problem, that take it apart and give us the additional information that we need to plan, manage, and to set priorities are extremely important.

So, again, I am very pleased to have the opportunity to say these few words to you this morning. I think what you are doing is very important not only to the United States but to the other countries involved and to the developing world. The more we know about this terrible problem worldwide and the more we know about the problems here in the United States and how to deal with them, the more we all benefit.

So I wish you success. I think it is going to be a very interesting and exciting meeting. And I thank you again for allowing me to be here this morning.

MANNING FEINLEIB, M.D., Dr.P.H.: The National Center for Health Statistics joined the Centers for Disease Control just 2 years ago. One of the results of that move has been the joining of statistical technology to the programs in prevention and disease control mounted by CDC. Working with programs in chronic disease prevention, injury control, and surveillance has brought new dimensions to the statistical work of NCHS, and, we believe, new quantitative resources to other CDC programs.

Nowhere is this more apparent than in the area of infant health. Working with other CDC programs, the foundation has been laid for a program linking birth and infant death records. Now, linked birth and infant death files are available for researchers to examine the effects of factors noted at birth, such as infant birth weight, age of mother and factors like that to survival of the infant. This project involved the participation of each State's vital statistics program and illustrates another CDC concept of the Federal-State partnership in public health.

Dr. William Roper is the newly appointed Director of the Centers for Disease Control. Dr. Roper has served as Administrator of the Health Care Financing Administration and with the President's Domestic Policy Council. He, therefore, has a keen appreciation of the value of data in analyzing national problems and in setting goals and evaluating progress.

Dr. Roper was trained as a pediatrician. So, he certainly appreciates the issues we are discussing at this symposium. He has said that improving child health will be a major focus for CDC programs. It is, therefore, with a great deal of pride and pleasure that I am pleased to introduce the Director of the Centers for Disease Control, Dr. William Roper.

WILLIAM L. ROPER, M.D.: Good morning. I am delighted to be with you and to have a chance to say a few words to launch this important collaborative meeting. I am pleased to be introduced by Dr. Feinleib. In leading the National Center for Health Statistics, as he said now for the past 2 years a part of the Centers for Disease Control, Dr. Feinleib sets a real standard for the rest of us to measure up to in leading public agencies.

NCHS is extraordinarily important, not only to what CDC does but to what the whole United States Government, indeed, our entire United States health system is able to accomplish. I would like to begin my remarks this morning by building on the theme of where we are headed with our health system generally in this country.

I have spent the last several years primarily concentrating on issues of health care financing and health services delivery, and now at CDC I am focusing on issues of disease prevention and health promotion. I think it is worthwhile to take a moment and reflect on where we are headed in this country as we seek to compare ourselves with you in other countries.

Let me say at the beginning of this symposium, I am delighted to welcome those of you from other countries to this meeting and to the United States. We welcome your advice, and we seek to understand our own problems better when viewed in comparison with the progress made in other nations. In the United States today we spend more on health care than any other nation in the world, which is also more when viewed as a percent of our gross national product, more as a per capita expenditure, and more in just about any other way that one may draw such a comparison.

That trend has continued over time and we are now nearing 12 percent of our gross national product as expenditures for health, compared with about 9 percent for Canada, 7 percent for Japan, and 6 percent for the United Kingdom. In general, health expenditures in most of the developed countries range between 6 percent and 8 percent of GNP. We, in the United States, are the clear outlier as far as expenditures for health.

There are many explanations for this outlier status. Of late, we have focused our attention in this country on expenditures for physician services, but in general for hospital/nonhospital services and a variety of other measures, we continue to have expenditures greatly in excess of other countries.

When examining the United States' health system there is another issue that is of pressing interest. The fact is that despite these enormous expenditures of billions of dollars, now more than one-half trillion dollars annually, tens of millions of Americans do not have full access to our health care system.

The latest statistics, depending on which numbers you look at, show that 31, 35, or 39 million Americans do not have full health insurance--either through public programs or private programs. Whichever figure is correct, any number approaching this range is intolerable. We simply have tens of millions of Americans who are without full access to this splendid health care system that most Americans do enjoy.

Addressing these issues will require effective public and private action, and at the same time we must also target a third health issue. Not only is it a question of the cost to our system and that not everybody enjoys it, but there is a growing sense that all these billions of dollars are not well spent, and that the quality of services that result from them is not what it should be across our health system. There is a growing sense that the services that are purchased with these public and private dollars are not uniformly services that are of quality and are effective, indeed, are appropriate for the clinical conditions, the state of health that individual Americans had when they sought those health care services.

Broadly speaking, these questions of cost, access, quality, and effectiveness are framed, I think, best when we examine the following questions: What are we getting as far as value for the health care dollars spent in the United States? What are the outcomes that we are achieving for this mammoth investment in health services?

The topic of this symposium, this International Collaborative Effort on Perinatal and Infant Mortality, I think is a good case study for this examination of health in America and what we are getting for our national investment.

Simply put, plainly put, I hope, America's infant mortality rate is a national embarrassment. We have for years struggled with how to understand, and how to explain the fact that our infant mortality rate is significantly higher than that of other countries. The problem is that as we have grown in our efforts to understand and explain our infant mortality rate, it has gotten relatively worse. The information that Dr. Feinleib presented shows that the United States' international ranking in infant mortality has deteriorated over time.[1]

I think there is a growing determination in this country to do something about this disparity. It is not only a determination to get a better understanding of why we rank as we do--that is also important--but it is a determination to do something about it.

I think in order for our unified national will to improve our infant mortality rate and perinatal mortality rate, for that to be successful, we must begin with an understanding of why the problem is as it is so that we might take effective action. That is an important point which we must return to again and again. Unless we understand why we have the rate that we do, we are likely to continue with well-meaning efforts, even large-scale well-meaning efforts, that are not wholly successful.

Let me just take one example to illustrate what I mean by this. I mentioned in my remarks a few moments ago that not all Americans have full access to our health care system and health care services. It is important, I believe, for us to solve that problem so that all women in the United States who are pregnant have the nutrition and health care services that they need during their pregnancy in order to deliver babies at term who are healthy and who survive not only the first year of their life but who grow up to be healthy adults.

It is very important that we solve the problem of health care access. There is also a growing sense that our infant mortality rate is driven not only by inadequate access to health care services but by growing dislocations in American society, the drug epidemic, for example. We need to understand and do something about that social problem, as well as dealing with our health care services delivery system.

Now, understand clearly what I am saying. I am not saying that the problem of infant mortality is caused by drugs; therefore, we are blaming the victims, and therefore we need not take any action as a government in order to solve the problem. Far from it. I am simply saying that for us to be successful in achieving the reductions in infant mortality that we seek, we need to build the health care services and nutrition services programs that are essential. We need to target those and all of our activities, public and private, in a way that builds on an understanding of how we are in this unfortunate situation and how we can remedy that situation.

That is why the experience of other nations is so important in our understanding of our current status and how we might build our programs like those in other nations and learn from your experiences to improve our, again, embarrassingly high infant mortality rate.

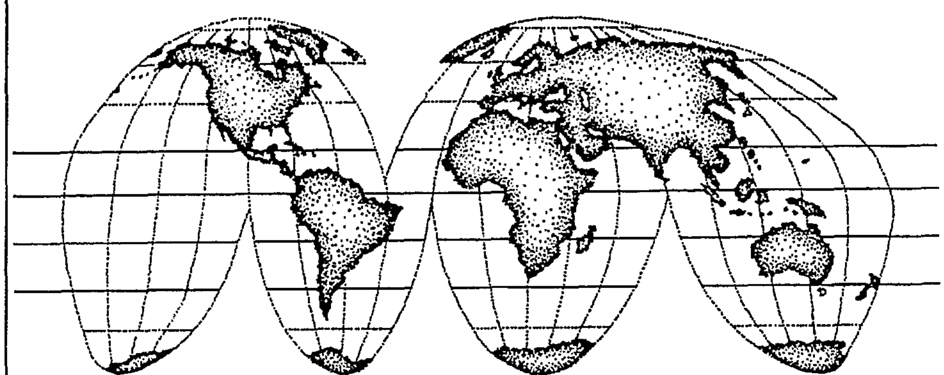
I believe that the determination to accomplish the successful reduction of infant mortality is a priority not only of the National Center for Health Statistics, but also for the Centers for Disease Control and the Public

[1]Feinleib, M. Preview of the symposium.

Health Service. Indeed, it is one of Secretary Sullivan's chief priorities as the Secretary of Health and Human Services, and it is a problem close to the heart of President Bush and the Congress.

So, let me end my remarks by again welcoming you here and thanking you for your collaborative effort with us as we seek to understand, but most important after that understanding, to undertake solutions that will truly be effective in solving this problem.

Thank you all very much.



Introduction

Preview of the Symposium

by Manning Feinleib, M.D., Dr.P.H.

Between 1950 and 1986, the infant mortality rate in the United States fell by roughly two-thirds from 29.2 deaths per 1,000 live births to 10.4 (figure 1). Despite this dramatic improvement and the strong economic growth of the United States in the world arena, our international ranking in infant mortality deteriorated from 6th to 22d (figure 2). During this same period, great strides were made in civil rights and equal opportunities; nevertheless, the disparity in infant mortality between black and white Americans increased rather than narrowed.

In 1950, the infant mortality rate of blacks, 43.9 per 1,000, was 1.64 times as high as the rate for whites (26.8) (figure 3). By 1986, the rates had fallen markedly to 18.0 and 8.9, respectively, but now the ratio had widened from 1.64 to 2.02. And in 1987, the latest year for which data are available, the ratio has increased even further to 2.07.

With these disturbing facts in mind, I decided in 1984 to establish the International Collaborative Effort (ICE) on Perinatal and Infant Mortality in an attempt to better understand our national problems through international comparisons, which is the theme for this symposium. Beginning with a core group led by Dr. Robert Hartford, the National Center for Health Statistics brought together eminent researchers from the public and private sectors of the United States and eight other industrialized nations to form the ICE Planning Group.

The international researchers were selected for their demonstrated expertise in the field of perinatal and/or infant health, and were chosen from countries that had achieved either very low infant mortality rates or that experienced obstacles similar to the ones faced by the United States in improving infant health. The countries participating in the ICE are Denmark, England and Wales, the Federal Republic of Germany, Israel, Japan, Norway, Scotland, and Sweden.

The ICE was inaugurated in August 1984 at a symposium in this auditorium, which provided background information on levels and trends in infant and perinatal mortality, information on health care systems, and information on priority concerns in infant and perinatal mortality in each of the countries. Recommendations prepared by the symposium participants provided guidance to the planning group in selecting specific topics for research.

What can we expect from this symposium? Broadly speaking, I shall be looking for three things. First, a better understanding of the reasons for the international ranking of the United States in perinatal and infant mortality. Second, how we might support and accelerate the decline in perinatal and infant mortality. And third, how we can help reduce the disparity among social, racial, and ethnic groups within the United States and other countries.

A major effort of the planning group has been to develop a standard base of comparable data that can be analyzed to quantify and explain the observed differences in selected pregnancy outcome measures between the countries. A basic data set was developed with fetal and infant mortality in 500-gram categories by plurality from 1970-83. This set was used as the basis of presentations at the American Public Health Association meeting in 1986 and for papers that were published in the *Acta Obstetricia et Gynecologica Scandinavica.*

A second, more detailed data set has recently been developed incorporating cause of death and length of gestation with birth weight and age at death in much finer categories. This data set is the basis of many of the presentations that will be given at this symposium.

A second focus of the ICE has been to document and describe the health care systems relevant to maternal, prenatal, and infant health in the collaborating countries. This has been accomplished by developing a standard questionnaire completed in each of the participating countries and the nine states contributing to the U.S. portion of the data base. This effort, complemented by reports on specific aspects of health care and intervention programs, will be presented in Session III.

Because of a lack of comparable data, it was not feasible to include social variables such as education, socioeconomic class, or occupation of father in the basic data set. Nevertheless, individual country presentations in Session IV will describe conditions in each country resulting in socioeconomic gradients in pregnancy outcomes. The purpose of this session will be to describe the range in social gradients that may exist between countries, and to provide some background to better understand the findings in Sessions V through VII.

The new ICE data set I mentioned earlier is used in most of the presentations in Sessions V and VI that focus on basic outcome-related variables: birth weight, plurality, length of gestation, cause of death, and age at death. The analyses continue in Session VII, in which issues of survivability and of goals we can expect to achieve in reducing perinatal and infant mortality are discussed.

The final session will be a panel discussion. Panelists will include two ICE planning group members and five eminent professionals with expertise in various fields related to perinatal and infant health. The ICE planning group will make its final report through its two panelists. The first report will focus on analytical issues, while the second will discuss implications for health policy and programs. The invited panelists will then give their assessment of the results presented in earlier sessions and of the final reports of the ICE working group.

Each panelist has been requested to include comments on certain specific topics. This panel discussion is expected to provide guidance to follow-on activities of an interagency effort between the NCHS and the National Institute of Child Health and Human Development to be carried out during the next few years.

I shall be particularly interested in the panel's answers to the following questions. How comparable are the data, and what can we do to make the data more comparable? Are current definitions, standards, and categories sufficient, or do they need revision; and, if so, what is recommended? What precisely contributes to differences in pregnancy outcomes among the ICE countries? Where can we expect to make improvements? How much can we expect to achieve, and in what foreseeable time period? And, finally, what are the implications for health care policy, services, and intervention programs at the National, State, and local levels?

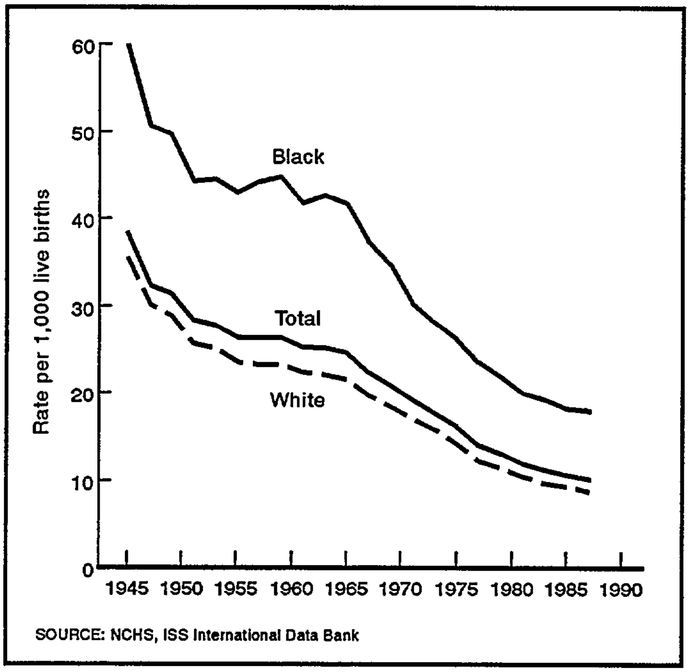


Figure 1. Infant mortality rates: United States, 1945-90

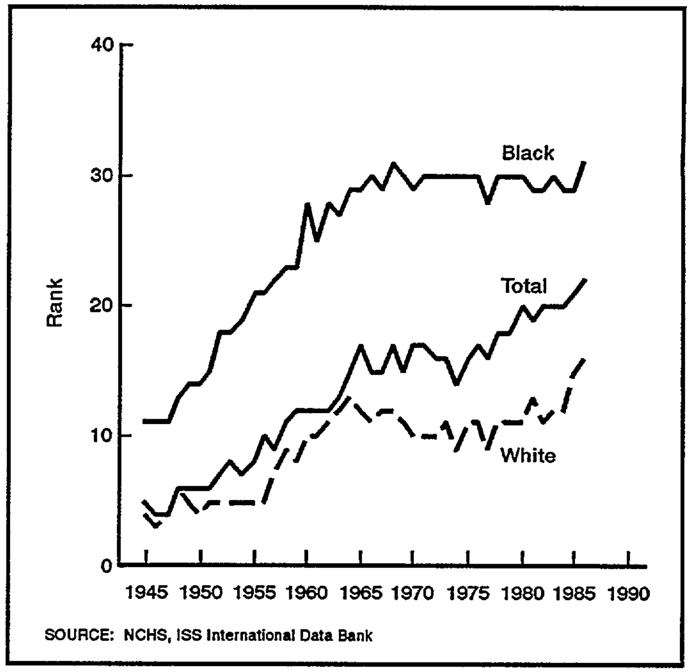


Figure 2. International rankings for infant mortality, United States, 1945-90

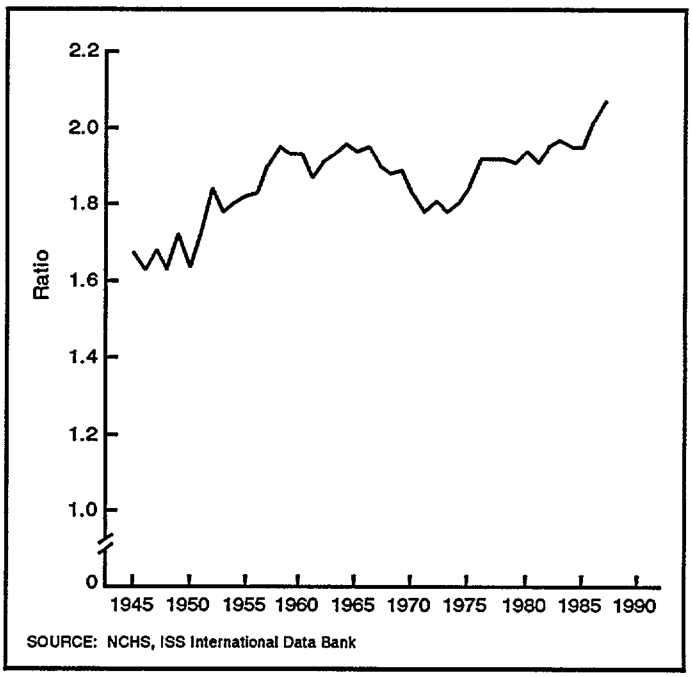


Figure 3. Ratio of black to white infant mortality: United States, 1945-90

The Demographic Setting: Trends in Rankings and Levels of Perinatal and Infant Mortality, Low Birth Weight, and Other Outcome Measures

by Manning Feinleib, M.D., Dr.P.H.

To better appreciate the material presented in this symposium, I will present some of the background information that was gathered as part of the International Collaborative Effort and permits examination of infant mortality in relation to several important variables. These variables include time trends of rates and rankings, some key economic measures, and selected biological and social measures. We will take each of these three groups in turn.

In figure 1 we have the infant mortality rates for 1955, 1970, and 1985 ordered by the infant mortality levels in 1955. For the United States and Israel rates were also available by race or ethnic group.

Figure 2 presents in graphic form some of the main trends among the numbers we saw in figure 1. In 1955 Sweden had the lowest rate and the Israeli non-Jews the highest. U.S. blacks, Germany, and Japan had similar rates (between 40 and 43). By 1985 all of the groups showed significant declines, particularly Japan, which had moved from the fourth highest rate to the lowest, by reducing its infant mortality by 86 percent. U.S. blacks, in contrast, had the lowest percent reduction among these populations and now have about the same rate as non-Jews in Israel, the population with by far the highest rate in 1955. Thus, the United States and Israel share a serious problem, namely--a large minority population whose infant mortality is twice that of the majority population.

In figure 3 we see how the ranking for the United States, both whites and blacks, worsened, while Japan's ranking worldwide improved from as high as 20th place in the mid-1950's to the lowest in 1984. Sweden's ranking has remained remarkably good through this nearly 50-year period. Germany, which is not shown, reduced its rate by nearly 80 percent between 1955 and 1985 and moved from 18th to 10th place. Among the remaining ICE countries the rankings deteriorated, but none as much as the United States.

An often quoted cliche is that infant mortality is the single most sensitive international indicator of social and economic well being. Let us see if the converse is true. How well do economic indicators predict infant mortality among the ICE countries? Figure 4 presents some of the data that have been accumulated during the last few years. The countries are ranked by population size and data available on three gross economic indicators: the per capita gross domestic product (GDP), health expenditures per capita, and the percent of GDP spent on health in the ICE countries as estimated for 1985.

While there is nearly a 60-fold difference in population size, the disparity in the economic indicators is much less. The per capita GDP varies from about $8,000 to $16,000 annually, while the per capita expenditures on health vary from about $400 to $1,800. The percent of GDP spent on health ranges from roughly 6 percent to about 11 percent.

We will now proceed to examine the ecological correlations of these measures with the national infant mortality rates. Figure 5 certainly raises a fundamental question. How is it that the economically richest nation in the world has such a comparatively high infant mortality rate? The United States, which has by far the largest per capita GDP among the ICE countries, has an infant mortality rate scarcely better than Israel, which has almost the lowest GDP. Notice also that Scotland and England have very dissimilar GDP's, but they have infant mortality rates that are nearly identical.

While the infant mortality rate may be a sensitive indicator of social and economic well being when developing countries are also included in the comparison, social and economic well being do not appear from these data to be any strong assurance of having a commensurate infant mortality rate within this group of industrialized nations.

Let us be more specific and see how the per capita expenditures on health services relate to infant mortality (figure 6). The question here is very obvious. Is the United States getting its money's worth? We are not just an outlier in this figure; we are an extreme outlier. The Japanese, in contrast, appear by far to be getting the best bang for their buck, or their yen, as the case may be. Notice that the similar infant mortality rates for England and Scotland are paralleled by similar per capita health expenditures.

Clearly, each country may set different priorities and allocate its resources quite differently from other countries. Figure 7 shows how the percent of GDP spent on health relates to infant mortality. If I were to base conclusions on this chart alone, I would have to say that there is no relation between infant mortality and the percent of GDP spent on health. Note, for example, that while Israel, Norway, and Japan spend about the same percent of GDP on health, they have very wide-ranging differences in infant mortality.

Again in this chart, like most of the charts that we will see, the United States is the extreme outlier, spending 11 percent of its GDP on health but having one of the worst infant mortality rates among this group of countries.

These four figures on the economic variables have presented a most disturbing paradox. While the United States is by far the richest of the countries shown and spends more both in absolute and in relative terms on health, we still have the second highest infant mortality rate. Moreover, as we have seen from the infant mortality trends, while we have been successful in reducing our infant mortality, other countries have achieved far better results and apparently for less economic expenditure.

Let us now look at some of the biological and social measures that are available from our collaborative effort in relation to infant mortality. High on the priority of goals in improving infant health in the United States is reducing the incidence of low birth weight among infants. While not a true cause of infant disease or death, low birth weight is the most clear indication that an infant is at grave risk.

Figure 8 shows the incidence of low birth weight; that is, the percent of infants who are born alive weighing less than 2500 grams, about 5 1/2 pounds, in 1975 and 1985. If there had been no change between these 2 years, the points would have fallen along this line, indicating the same rate in 1985 as in 1975. A country that falls below the line means that the 1985 rate is somewhat lower than the 1975 rate; and only three groups, U.S. blacks, U.S. whites, and Denmark, have shown a decrease in the percent of low birthweight infants during this decade. Israel, both the Jews and the non-Jews, and even Japan have shown an increase in the percentage of low birthweight infants.

This would suggest that infant mortality in Denmark and the United States should have improved more than in the other countries. However, figure 9 shows just the opposite. The three countries whose low birthweight rates increased the most actually show a greater percentage decline than the countries that showed a large decrease in low birthweight infants. Even more perplexing is that the two countries that showed virtually no change in low birthweight, Germany and Norway, registered the highest (55 percent) and the lowest (19 percent) reductions in the infant mortality rate. So, the low birthweight rate per se does not seem to be the sole answer to the changes in rankings of infant mortality.

How is low birth weight related to infant mortality in these countries? Figure 10 indicates a weak but generally positive ecological correlation. Recall from the previous two slides that the Israeli non-Jewish population showed the largest increase in the low birthweight incidence. As this population also showed the greatest decline in infant mortality of the ICE countries between 1975 and 1985, it seems plausible that the increase in low birth weight may be due to improved registration of low birthweight infant deaths rather than to deterioration in the birthweight structure. We will hear more evidence to this effect in the course of this symposium.

Less obvious is the situation with regard to Japan, whose infant mortality rate is somewhat lower than would have been expected from the general trends. Time and again it has been suggested that Japanese obstetricians are predisposed to classify certain deliveries as late fetal deaths that might be classified as infant deaths in Europe or the United States. If so, we would expect that if we replaced the infant mortality rate with the perinatal rate, Japan would no longer fall outside the norm. When we compare the perinatal mortality rate we see a more solid clustering, and Japan is now within the main pack (figure 11).

You see where this is leading. The ICE has concerned itself not only with analyzing prima facie differences readily apparent in the data, but we are also scrutinizing the underpinnings, the comparability of the data. You will hear much more about these findings in the next few days of the symposium.

Let us finally examine two factors that are related to complex social and political issues. We have all heard many times of the problems of teenage pregnancy. How do the ICE countries compare in this respect?

A strong positive relation between infant mortality and the prevalence of teenage births exists (figure 12). Clearly, with almost one-quarter of births among U.S. blacks occurring among teenagers, this is certainly an area that has to be targeted so that we can get back to this mainstream effort. The situation with regard to the non-Jews in Israel cannot be attributed solely to its teenage birth problems but points to the possibility of many other factors intervening.

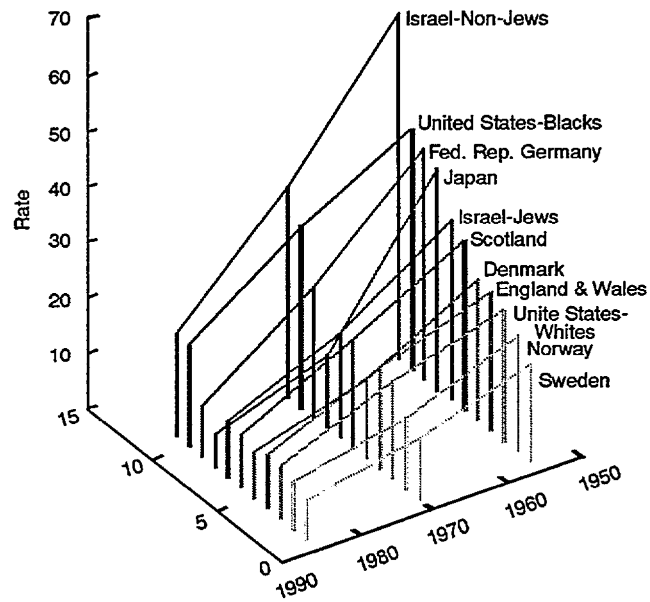
Finally, among the many queries concerning the international rankings in infant mortality, it is often suggested that abortion rates may be an important factor. This suggests that countries with high abortion rates attain low infant mortality rates by aborting high-risk pregnancies. What do the data show? Indeed, there does seem to be a strong negative relation between the infant mortality rates and the abortion rates within the countries (figure 13). However, I did not include the United States in this figure.

Figure 14 includes the United States and once again it is an outlier. We apparently have the highest abortion rate and almost the highest infant mortality rate. So, it seems that we must look elsewhere if we are to understand the international ranking of the United States in infant and perinatal mortality, and that is precisely the purpose of this international collaborative effort.

Country	1955	1970	1985
Sweden	17.4	11.0	6.8
Norway	20.6	12.8	8.5
U.S. Whites	23.6	17.8	9.3
England and Wales	24.9	18.2	9.4
Denmark	25.2	14.2	7.9
Scotland	30.4	19.6	9.4
Israel Jews	32.3	18.9	9.8
Japan	39.8	13.1	5.5
Fed. Rep. Germany	41.8	23.6	9.0
U.S. Blacks	43.1	32.7	18.2
Israel Non-Jews	62.5	38.1	18.4

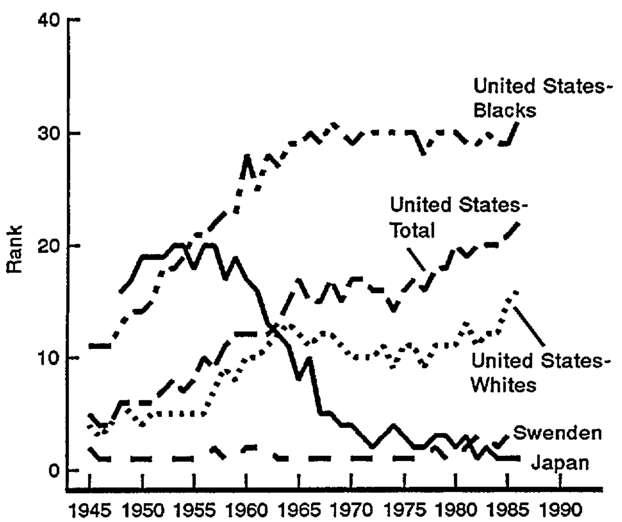
SOURCE: NCHS, ISS International Data Bank

Figure 1. Infant mortality rates,(ordered by 1955 rank): ICE countries, 1950, 1970, and 1985



SOURCE: NCHS, ISS International Data Bank

Figure 2. Infant mortality rates: ICE countries, 1950-90



SOURCE: NCHS, ISS International Data Bank

Figure 3. Infant mortality ranks: ICE countries, 1950-90

	1985 population (M)	Per capita GDP (US $)	Per capita Health expenditures	Percent of GDP spent on health
United States	239.3	16,494	1,776	10.8
Japan	120.7	11,803	783	6.6
Fed. Rep. Germany	61.0	12,179	983	8.1
England and Wales	49.8	10,915	627	5.7
Sweden	8.4	12,639	1,172	9.3
Denmark	5.1	12,255	755	6.2
Scotland	5.1	8,236	650	7.9
Israel	4.2	8,470	412	6.8
Norway	4.2	13,899	917	6.6

SOURCE: NCHS, ISS International Data Bank

Figure 4. Population, selected economic and health expenditure measures: ICE countries, 1985

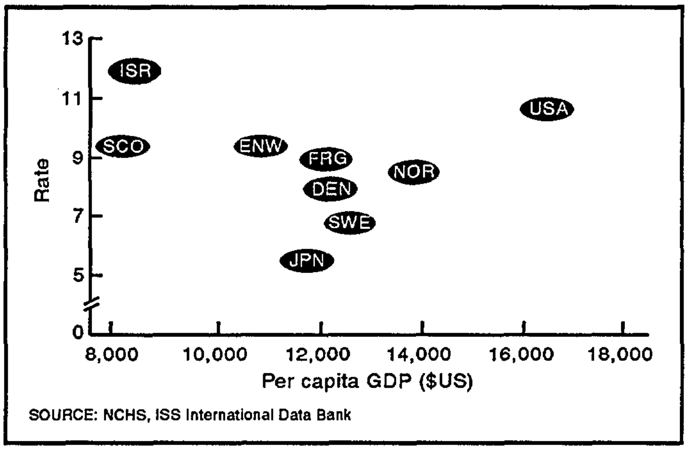


Figure 5. Per capita gross domestic product and infant mortality rate: ICE countries, 1985

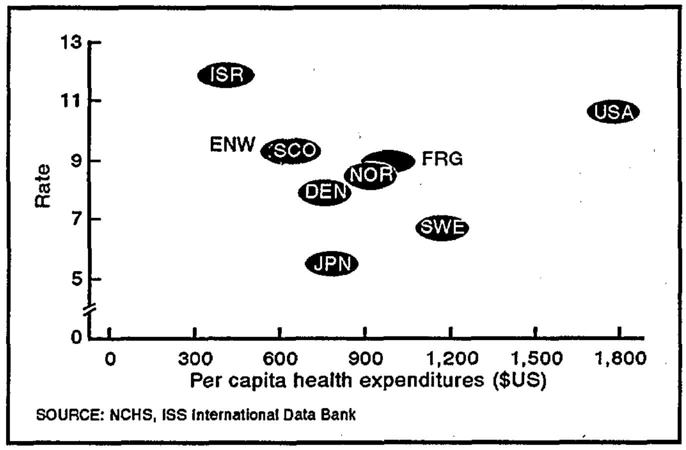


Figure 6. Per capita health expenditures and infant mortality rates: ICE countries, 1985

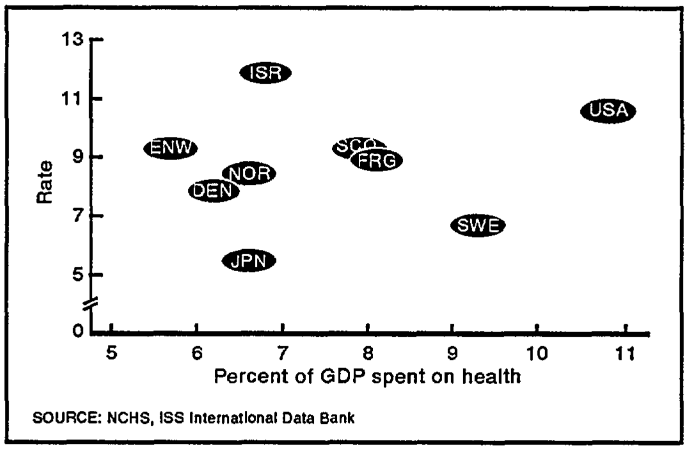


Figure 7. Percent of GDP spent on health and rate of infant mortality: ICE countries, 1985

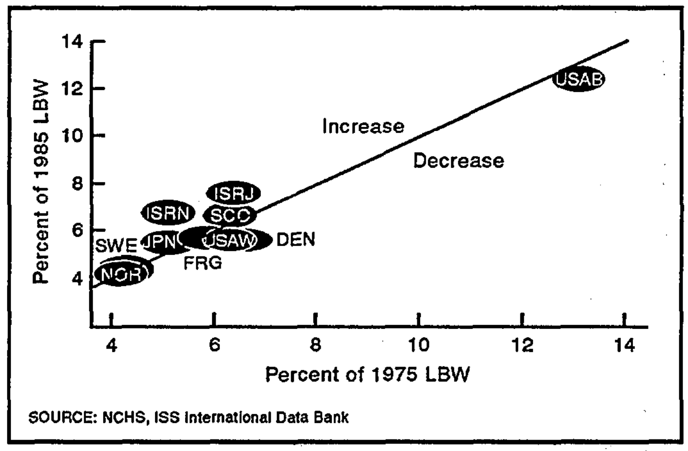


Figure 8. Percent of low birth weight: 1975 versus 1985, ICE countries

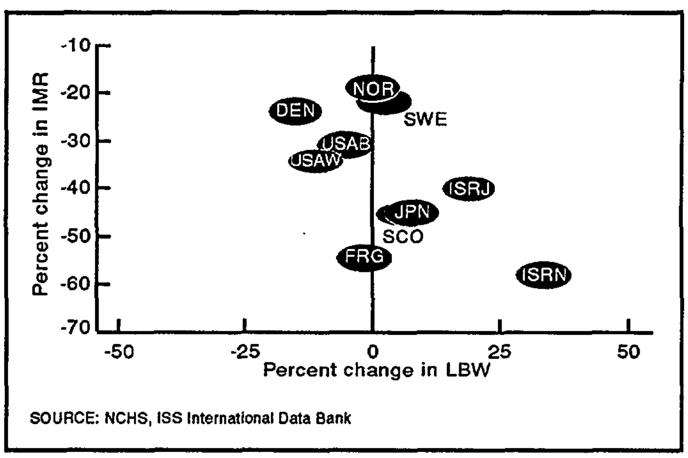


Figure 9. Percent change in low birth weight and in infant mortality rate: ICE countries, 1975-85

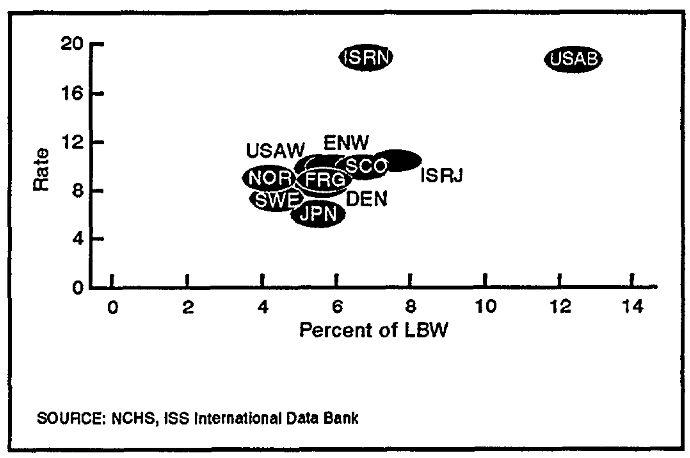


Figure 10. Percent change in low birth weight and in infant mortality rates: ICE countries, 1975-85

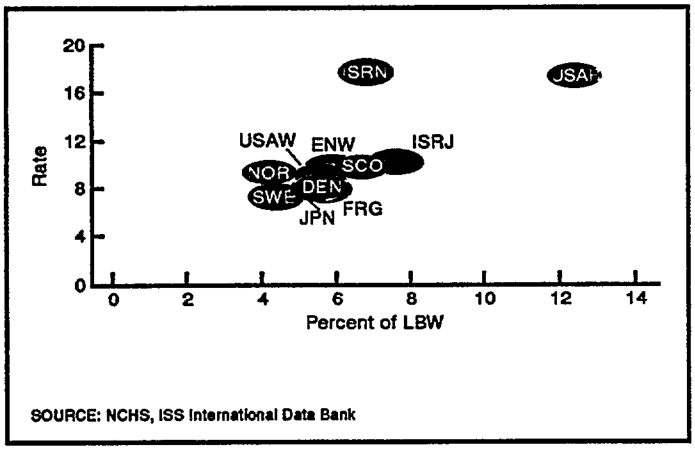


Figure 11. Percent of low birth weight and perinatal mortality rate: ICE countries, 1985

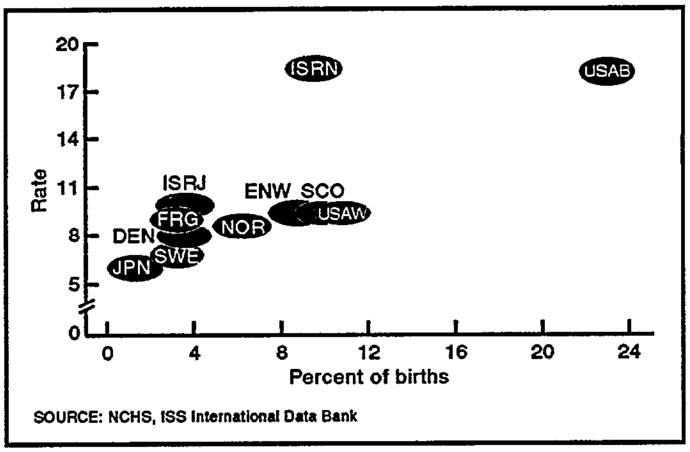


Figure 12. Percent of teenage births and infant mortality rates: ICE countries, 1985

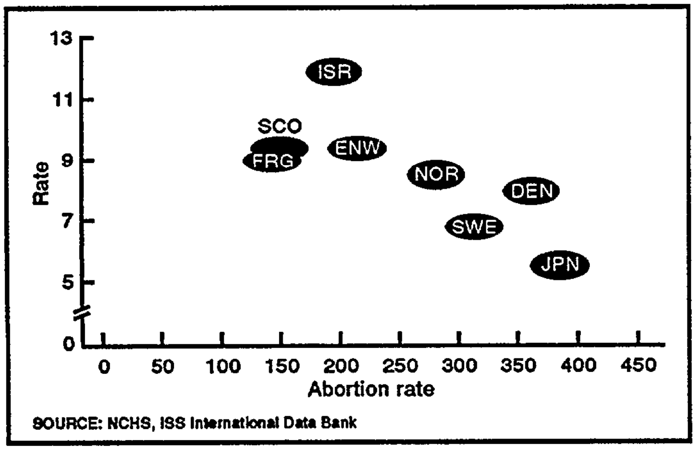


Figure 13. Rates for abortion and infant mortality: ICE countries, 1985

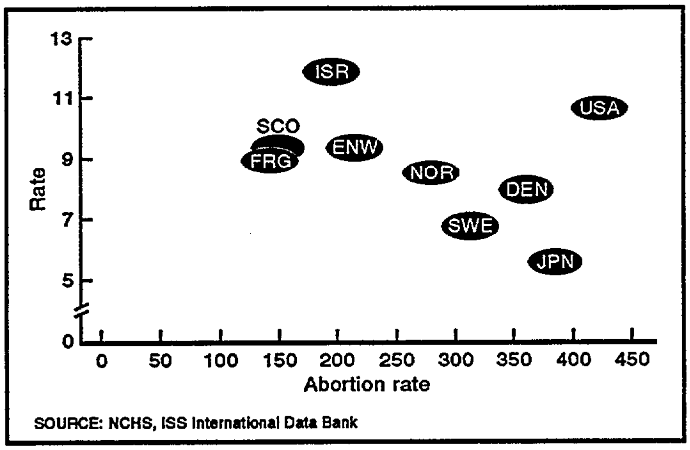


Figure 14. Rates for abortion and infant mortality: ICE countries, 1985

Definitions, Standards, Data Quality, and Comparability

by Robert B. Hartford, Ph.D.

First, I want to say thanks to the ICE Planning Group that has worked so diligently over the last few years to put together what I consider a really excellent data set. This morning I would like to describe the set and discuss a few points concerning some issues of definitions and comparability.

In order to include recent trends in our analyses, we asked the collaborators to provide us data that cover birth cohorts 1980-85. We would have preferred to include earlier years, but because linked birth and death data sets are a relatively recent innovation in many areas, it was not feasible to include data from an earlier time period. While most data sets cover birth cohorts 1980-85, there were exceptions. Denmark provided data from 1982-87 and the Japanese data, which came from an NICHD multinational study, covered only a 5-year period, 1980-84. Norway converted from ICD-8 to ICD-9 in 1985, so birth cohort data from 1979-84 were used to avoid introducing additional problems of comparability.

With the exceptions of Germany, Japan, and the United States, national level data were used. Neither Germany nor Japan have national linked files, so data from the State of North Rhine-Westphalia in Germany and from the Prefecture of Osaka in Japan were substituted. At this time the national linked file of the United States covers only 2 years (birth cohorts 1983 and 1984); therefore, we have aggregated individual State data from linked files of nine States: California, Georgia, Michigan, Minnesota, Missouri, North Carolina, upstate New York, Utah, and Wisconsin.

The North Rhine-Westphalian infant mortality is somewhat higher than the national level, but the Osaka infant mortality is very close to the overall Japanese level. Infant mortality for whites in our nine-State aggregate is approximately 10 percent less than the national rate for whites, but the composite rate for blacks in the nine States is very close to the national rate.

Variables included in the set are: birth weight in 100 gram intervals; plurality--singleton and multiple births; length of gestation given in seven categories--less than 20 weeks, 20-27 weeks, 28-33 weeks, 34-36 weeks, 37-39 weeks, 40-41 weeks, 42 weeks or more, and "unknown." Fetal and infant death causes are categorized into congenital conditions, asphyxia-related conditions, immaturity-related conditions, other specific conditions, infections, sudden infant death syndrome (SIDS), external causes, and a residual group. Age at death for infants is given as under 1 hour, 1-23 hours, 1-6 days, 7-27 days, 28 days-2 months, 3-5 months, 6-8 months, and 9-11 months. The U.S. data are presented separately for whites and blacks, and Israeli data are classified as Jewish and non-Jewish.

As we are dealing with grouped data rather than individual records, it was not feasible to work with individual causes of infant and perinatal death. The ICE group spent considerable time and effort in developing groupings of causes of death that are susceptible to different interventions and that are comparable across the World Health Organization's (WHO) International Classification of Diseases and Causes of Death (ICD), revisions 8 and 9. These categories are used in a number of the presentations of this symposium (tables 1, 2). The terms are deceptively similar to chapter headings in the ICD manuals but there are important differences. For example, congenital conditions in the ICE categorization includes not only the causes from Chapter XIV, "Congenital Anomalies" of the ICD, but other congenital conditions that can be found throughout the ICD list. Likewise, the "Infections" category is not limited to ICD Codes 1 through 140, but includes those infections appearing in other chapters. For example, Code 771, "infections specific to the perinatal period" from Chapter XV, "Certain Conditions Originating in the Perinatal Period," is included in the ICE category, "infections."

There are problems of comparability in asphyxia and immaturity between the ICD-8 and ICD-9 revisions that occurred from a substantial change in diagnostic philosophy. While most countries adopted ICD-9 in 1979, the Scandinavian countries elected to continue with ICD-8. As mentioned earlier, Norway adopted ICD-9 in 1985 and Sweden in 1987. So please keep in mind that when you see comparisons between asphyxia and immaturity in the ICD-9 countries and those in the Scandinavian countries, there is a problem of comparability. If the two categories are combined, however, there is excellent comparability. However, even within the Scandinavian countries there is a problem of comparability. It appears that Norwegian doctors are more likely than their Danish and Swedish colleagues to select an asphyxia-related cause in preference to an immaturity-related cause.

The category, "other specific conditions" is made up of well-defined causes that do not fit in other categories but are too few and diverse to justify separate treatment.

The sudden infant death syndrome (SIDS) category includes not only the standard ICD codes, but other codes representing probable misclassifications of deaths that should be SIDS. This has worked out fairly well except in the case of Israel, particularly among non-Jews, for whom the expanded category includes many cases in which the cause of death was really "unknown."

The final category is external causes; in this category, as with all others with the exception mentioned above, there seems to be excellent comparability across ICE countries.

The two outcome variables of major interest to the symposium are perinatal and infant mortality. Perinatal mortality, as you know, is a measure that was developed some years ago to overcome inconsistencies in the classification of birth outcomes as late fetal deaths or infant deaths. As Dr. Feinleib mentioned, the ICE group has spent considerable time in addressing this problem. Because biases in classification are more likely to occur when death is close to the time of birth, we compared the relation of late fetal death rates (LFDR) to the perinatal mortality rates (PMR).

Figure 1 shows that there are considerable differences in the relative importance of fetal deaths to the perinatal mortality rates. For example, the LFDR of Osaka and Israeli non-Jews seems rather high in comparison to the PMR; the opposite is true of Israeli Jews, Hungary, and Sweden. Additional evidence of possible differences in classification of outcomes is illustrated in figure 2, showing the percent of infant mortality occurring in the first 24 hours as a function of the infant mortality rate. Here we see that both U.S. populations are extreme outliers with very high percentages of infant deaths occurring in the first 24 hours. Osaka and Israeli non-Jews fall substantially below the norm. It is difficult to determine from these data the exact source of the observed differences, because there may be differential under-reporting, particularly of fetal deaths. It should be noted that each year the percentage of infant deaths occurring in the first 24 hours in Japan is coming closer into line with the European countries.

In the past we have been so preoccupied with what is going on in Japan that we have forgotten to see if our own house is in order. You will notice that the variation in the percentage of infant deaths under 24 hours ranged from about 24 percent in Osaka to around 40 percent in the two U.S. populations. However, that is less than the variation that we have among our own States here in the United States. We have a variation that runs from about 24 percent to almost 50 percent.

Finally, several of the speakers will be presenting a new mortality outcome measure developed by the ICE, the feto-infant mortality rate. This measure, which extends the concept of perinatal mortality to the entire infant period, adds fetal deaths of 28 weeks or more of completed gestation to both the numerator and to the denominator of the infant mortality rate. The feto-infant rate is seen as having two advantages over the traditional infant mortality rate. Not only does it get around the fetal death/live birth distinction problem, it gives a more complete measure of pregnancy performance. Figure 3 compares the trends in the new measure and the infant mortality rate for Japan and the United States. Notice that the values for the feto-infant rate are roughly twice the infant mortality rate in Japan. The ratio is much less in the case of the United States.

Figure 4 shows the trend in international ranking of the United States in the two measures. We see that the ranking according to the feto-infant rate is better than the ranking according to the infant rate, suggesting that there are a number of countries that either use different definitions of live births or systematically apply the WHO criteria differently from the United States.

But let us not be lulled into believing that the international differences can be explained away on the basis of different classification or registration criteria. As figure 4 clearly shows, the international ranking of the United States has deteriorated throughout most of the last 35 years according to both measures.

You will hear more about the feto-infant mortality rate from other presenters who will demonstrate some of its advantages.

Table 1. Cause of Infant Death Categories ICD-8

Congenital conditions	250, 270-275, 282-284, 286-288, 330-333, 343, 390-398, 424-426, 437, 538, 550-553, 560, 571, 573, 599, 738, 740-748.2, 748.4-759, E930, E932
Asphyxia-related conditions	764-768, 769.9, 770, 771; 776:.0, .3, .4, .9
Immaturity-related conditions	9.2 if neonatal; 423, 561, 748.3, 760-763; 769:.0-.5; 772-774; 776:.1,.2; 777, 778, 782, 783
Infections	1-8, 10-136, 320-324, 381, 382, 420-422, 460-483, 485-491, 510, 511, 513, 540, 567, 570, 590, 682, 686, 720
Other specific conditions	9:.0, .1, .2 if post-neonatal, .9; 140-246, 251, 253, 279, 347, 430, 431, 438, 441, 444, 484, 493, 514, 517, 561, 563, 692, 775
S.I.D.S.	795, 796, E913
External causes (E-codes)	269, E800-E912, E914-E929, E931, E933-E999
Remaining causes	All remaining codes

Table 2. Cause of Infant Death Categories ICD-9

Congenital conditions	270-275, 277-279, 282, 284, 286-288, 330, 335, 343, 359, 394-411, 414-417, 424-426, 550-553, 560, 571, 572, 740-759, 777.1
Asphyxia-related conditions	761:.6,.7; 762:.0-.2,.4-.6; 763, 766-768, 770.1, 772.2; 779:.0,.2;
Immaturity-related conditions	761:.3-.5,.8,.9; 762.7, 764, 765, 769; 770:.2-.9; 772.1, 774; 777:.5,.6; 778:.2; 779:.6,.8
Infections	001-139, 254.1, 320-326, 382, 420-422, 460-466, 475-477, 480-491, 510, 511, 513, 540, 541, 566, 567, 570, 572.0, 590, 591, 770.0, 771, 790
Other specific conditions	140-250, 251-253, 283, 331, 423, 430-432, 441, 442, 493, 494, 514-516, 556-559; 762:.3,.8,.9; 772:.0,.3-.9; 773, 775, 776, 778.0; 779:.4,.5
S.I.D.S.	798, 799, E913
External causes (E-codes)	260-263, 507, E800-E912, E914-E999
Remaining causes	All remaining codes

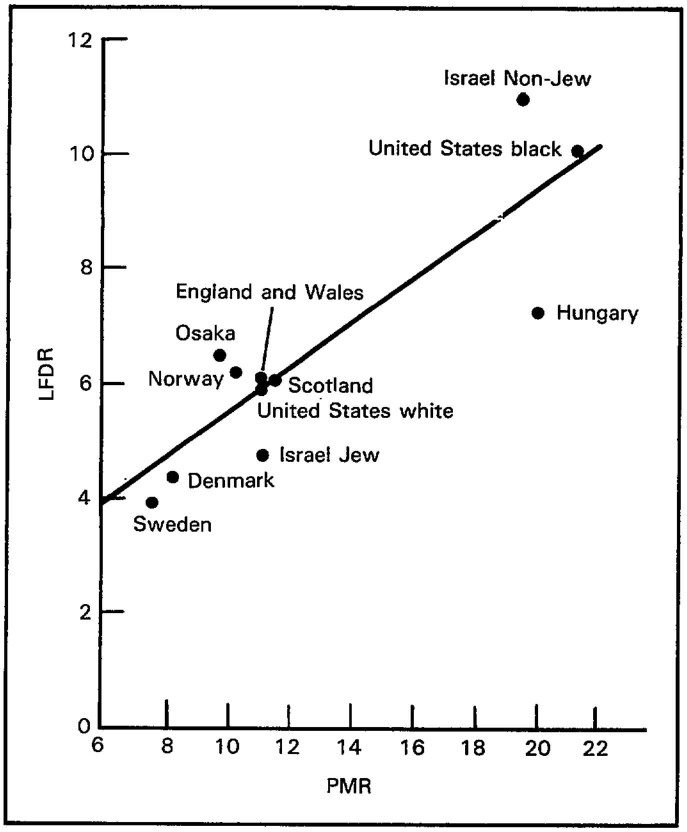


Figure 1. Late fetal death rate, LFDR, by the perinatal mortality rate, PMR: ICE countries

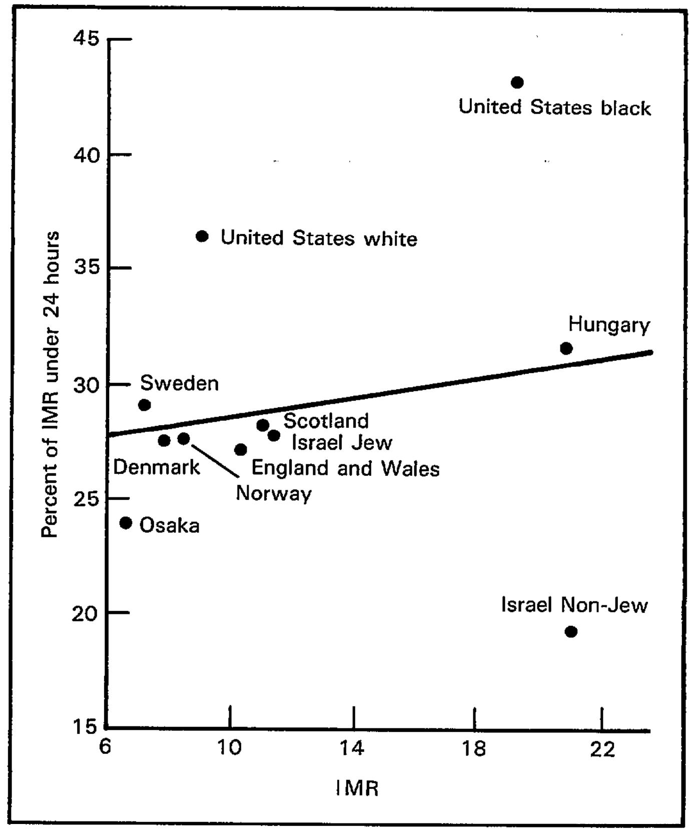


Figure 2. Percent of infant mortality <24 hours by the IMR: ICE countries

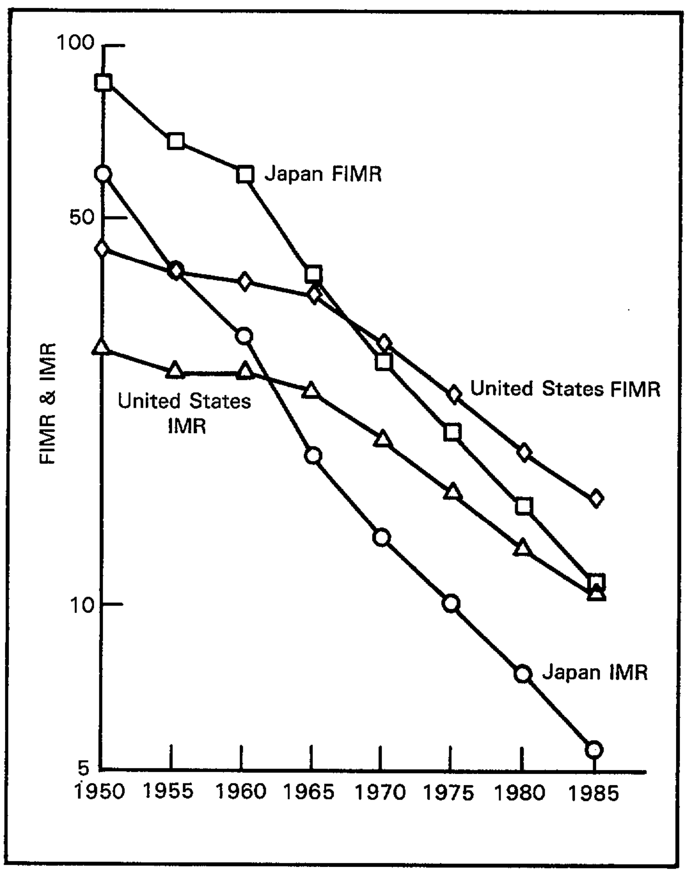


Figure 3. Infant and feto-infant mortality rates: Japan and the United States, 1950–85

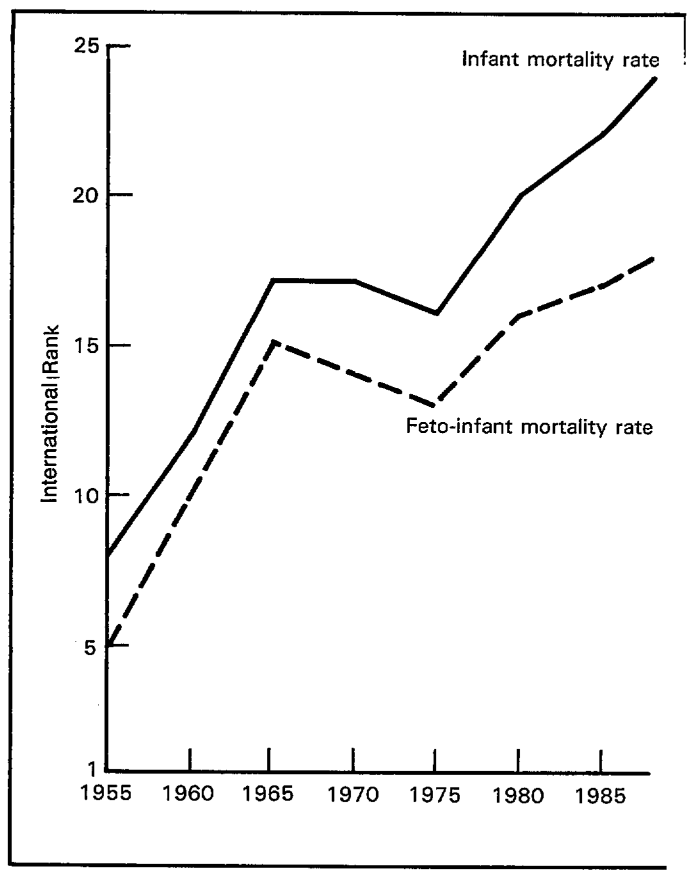
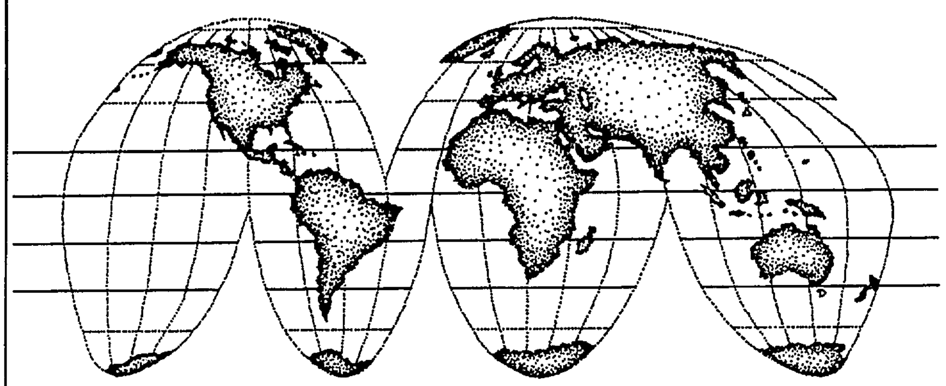


Figure 4. International rank of the United States in infant and feto-infant mortality: 1955–87



Health Care and Services

Overview of Maternal and Infant Care in ICE Countries and States

by Per Bergsjø, M.D., and Leiv S. Bakketeig, M.D.

At the first ICE symposium in August 1984, one session was devoted to a description of maternal and child health care systems in the ICE countries. The presenters gave a wealth of information about their respective countries, which made us realize that important differences existed in legal rights during pregnancy and early motherhood, in economic remuneration for medical services, in organization, and in content and continuity of medical and nursing care for mothers and newborn children. In his overview, Dr. Vince Hutchins said "... it is important to understand the health care system in each country that may affect the statistics and perhaps help to explain the difference" (1). However, the presentations were not formally structured, and we were left with a feeling of lack of comparability, which is the aim of our whole exercise. The health care system in the host country was described as being "... as divergent as are the 50 States and as autonomous as the 6,000 hospitals and half a million physicians practicing in the United States" (2). The attempt to penetrate it was likened to a thorny forest.

At the second ICE symposium in November 1985, we presented a model for a descriptive comparison between perinatal care systems. Eberhard Schmidt and I had experience from a study in Europe some years earlier, which resulted in the World Health Organization publication "Having a Baby in Europe" (3). Leiv Bakketeig, Finn Kamper-Jørgensen, and I were engaged in a similar comparison in the Nordic countries, which was completed in 1986 (4).

We knew that a seemingly trivial questionnaire on this content matter was very difficult to complete because no single individual has all the desired information at hand; and the dedicated persons must spend time and ingenuity to get to the sources, if indeed there are any.

Therefore, when it was decided at the planning meeting to put the plan into action, we devised a user-friendly, abbreviated version with only 59 questions (and numerous subcaptions), and sweetened it with an innocent promise that filling it out is easier than you think. To which we got the inevitable rebuttal from Scotland: "No, it isn't."

Thirteen questionnaires had been returned to us by mid-March 1990. In the United States, Patricia W. Potrzebowski coordinated data collection from a number of States. Originally, there were seven (California, Georgia, Michigan, Minnesota, Missouri, New York, and North Carolina), but two more (Utah and Wisconsin) were added after the tables and figures had already been completed. There were six countries (Denmark, England and Wales, West Germany, Japan, Norway, and Scotland). Israel and Sweden responded too late to be included in the figures and tabulations. I shall refer to the latecomers as I go along. Some of the figures given in the England and Wales questionnaire refer to England only. Of these countries and States, 10 ranged from 4 to 10 million in population, with Norway as the smallest; California and New York, England and Wales, and West Germany have between 18 and 60 million; and Japan is in a class by itself, with 123 million people. Utah has 1.7 million, Israel 4.5, Wisconsin 4.9, and Sweden 8.5 million people.

We take this opportunity to thank all the individuals who completed the questionnaires.

The art of posing questions is to make them unambiguous. We tried to avoid the problem by consultation before the final draft, but in retrospect I realize that it is almost impossible to be completely specific. For example, when you learn that in one country 50 percent of the registered midwives do not practice midwifery, how do you make the comparisons when the others have not commented on this problem? I also learned that "fertility rate" is variously defined, which forced us to recalculate from birth and population figures.

The figures we present mainly refer to the year 1988 or to the status as of January 1, 1989. We have taken most of the answers at face value, although misunderstandings may have crept in here and there.

We shall start with incidence of birth as a measure of reproduction and abortion-to-birth ratio as an indicator of social endorsement of a need, or demand, for pregnancy interruption.

The number of births per year ranged from 58,000 in Norway to 1,314,000 in Japan (Utah 36,000, Wisconsin 70,711, Israel 101,500, and Sweden 112,080). In figure 1 the countries are listed as follows: Denmark, Norway, Scotland, England, Germany, and Japan; while the U.S. States are New York, Michigan, Minnesota, Missouri, North Carolina, Georgia, and California. Germany and Japan had the lowest birth rates among the countries; Denmark was intermediate; while England, Scotland, and Norway had the highest birth rates. Israel has twice the rate of the other countries, 22.7, and Sweden has 13.2. The U.S. States in general had higher rates than the countries. Utah has the highest birth rate, 21.3, and Wisconsin has the lowest, 14.6. In figure 1 California has the highest birth rate and Missouri the lowest.

The ratios of legal abortions per 100 births showed a wider fluctuation, with Scotland and Germany (and Israel with 15) having the lowest, and Denmark and Japan having the highest among the countries. The ratios differ by a factor of about 2.2 (Sweden had 34). California (64.6 was the figure provided later), New York, and North Carolina were at the top of the scale among the States, and Minnesota and Missouri were at the bottom (Wisconsin 23.6). However, Utah has a remarkably low abortion ratio of 11.5, lower by far than any of the other States and countries. There is a factor of 5.6 between the California and the Utah ratios. One may speculate that high birth rates and high abortion ratios combined indicate a relative lack of contraceptive measures in that country or State as one explanatory factor among others.

Figure 2 focuses on the availability of doctors and nurses. The upper part of the figure represents doctors per 10,000 population, and the lower part represents nurses on the same scale, so that these bars can be compared directly. Denmark and Norway have the highest number of doctors (Sweden is also at the top with 30 and Israel is relatively high with 27), while England is remarkably low. The U.S. States have fairly equal rates, with California (26) and New York slightly higher than the rest. The story of nurses is somewhat different, with Germany (and Israel, 33.0) with the least amount of nurses, and Norway and New York with the highest number (Utah, 62.0, and Wisconsin, 100.9). Germany presented approximated figures. Norway and New York commented that only 85 percent and 62 percent, respectively, are employed as nurses.

Figure 3 shows the number of obstetricians and midwives per 1,000 births. This figure reflects the differences in organization and service delivery systems between the ICE member countries. Here, too, we have identical scales and the same denominator in both parts of the graph. The most striking observation on obstetricians (upper part) is their scarcity in Scotland. A shortage in England may well reflect the shortage of doctors in general, but in Scotland, with the lowest rate, there must be an additional explanation. (Israel is on the same level as England and Wales, 4.9). Germany tops the list, with Japan (and Sweden, 9.8) in second place, while the U.S. States are on level with, or a little higher than, Denmark and Norway. Utah leads, with 16.0 obstetricians per 1,000 births.

The really interesting observation, however, lies in the distribution of midwives, who are almost absent in the United States (Utah with 1.5 and Wisconsin with 0.6), but seem to thrive in the other countries, with the possible exception of Germany. Scotland towers above all the others, in fair compensation for its relative lack of obstetricians; the same argument can be used about England. Sweden is also high with 39.3. The figure for Norway represents the crude number of registered midwives. I have been informed that only one-half of them are actively working, which means that Norway, in reality, would be equal to Denmark and Japan (assuming that they have reported working midwives only).

As demonstrated here, the United States has a different system from the other countries, as concerns monitoring and care of birthing mothers. While the others rely on midwives to handle uncomplicated labor and delivery, with doctors as a second line resource for unexpected events and planned deliveries, the U.S. obstetricians apparently take a more active part in the whole process in every delivery. From another source we know that there is a tendency in the United States during the past several years for midwives to attend an increasing number of births, particularly for hospital births. In 1985, however, only 2.7 percent of the births in the United States were attended by midwives (5). Without discussing the pros and cons of the two approaches, I would like to emphasize that a comparison of mortality only does not permit any conclusion with regard to the excellence of one system over the other.

Where do the births take place? In the ICE countries and States, almost without exception, in institutions. The percentage of home births reported were: Japan, 0.2 percent; Israel, 0.3 percent; and Denmark, England, and Sweden, 1.0 percent. Among the States, Utah reported 1.3 percent and Wisconsin 0.7 percent. In Norway one-half of the home births are unplanned, often precipitate pre-term labors, where time prevents transportation to a hospital. The other one-half are planned home births, often encouraged and supported by midwives who advocate alternative birth care. This trend of alternative care is possibly more pronounced in Denmark and Sweden, which have home birth rates of 1 percent, compared with Norway's 0.4 percent. There is a similar trend in alternative birthing in some areas of the United States, yet the total rate is still well below 1 percent.

We asked about the distribution of births in teaching versus nonteaching hospitals, and where applicable, in other types of birth institutions. The answers were partly incomplete, but we learned that in Denmark and Norway about two-thirds of the births take place in teaching hospitals and one-third in other types of hospitals. In Scotland, 31 percent were in university hospitals and 63 percent in other hospitals with obstetrical care. In California, Minnesota, Georgia, and North Carolina the corresponding distribution was approximately 10 to 20 percent in teaching and 80 to 90 percent in nonteaching hospitals (Utah 5.1 to 92 percent and Wisconsin 0 to 99 percent). In Missouri 50 percent of the births were in teaching hospitals. In Japan 56 percent of the births were in hospitals, while so-called clinics were responsible for 42 percent. This is especially interesting, in light of Japan's very favorable mortality statistics in recent years. Utah reported 1.8 percent of births in small (midwife) units.

We now turn to the question of paid work during pregnancy. Most of the reported percentages are based on estimates or ad hoc research projects. Although the figures differ substantially (table 1), some general conclusions can still be drawn. In Denmark and Norway the large majority of women do have paid work while they are pregnant. In England, Germany, and Israel about one-half of the mothers work and in Japan one-quarter. From Scotland and the U.S. States no information was provided.

With the exception of some workplaces with teratogenic potential, little is known about the effect of work on the outcome of pregnancy. Perhaps something will be said in a later session on social and cultural factors. Little is known about the effect of pregnancy on work performance. In Norway, about 60 percent of the women take sick leave on medical grounds one or more times during pregnancy, one-half of them for more than 3 months. In the right column of table 1 we see that in England and Japan, between 90 and 95 percent will stop working sometime before term. In Denmark and Norway about 50 percent will stop working before term (no information was provided for Israel and Sweden). This should be linked with the information that pregnancy leave, between 4 and 12 weeks in the different countries, may be taken before birth. It is our understanding that the decision to avail oneself of this pre-pregnancy leave is left entirely to the woman herself. Taking one or more weeks before birth means correspondingly less leave after birth. Therefore, it must be tempting to get sick leave on medical grounds instead of eating one-half the cake beforehand. This problem should be considered in countries that have the social benefit of paid maternity leave.

A question on whether women are encouraged to take part of their maternity leave before birth was answered "yes" by Denmark, England, Japan, and Sweden, and "no" or "not known" by all of the others.

Laws or regulations about maternity leave exist in all of the eight countries under study, but in only two of the nine U.S. States, namely Minnesota and Wisconsin. In the other States it is based on individual company policies. In California, Georgia, Missouri, and Utah, State employees have similar rights. Duration and coverage are shown in figure 4. The amount of time that may be taken off before birth is indicated in the left column. In some locations, this antenatal leave is subtracted from the total amount of paid leave. Therefore, individual comparisons may be partly misleading. Of the countries displayed in this figure, Denmark has the longest period of paid leave. Sweden, however, now has 15 months of maternity leave, 12 of them fully paid and the 3 last months partly paid. Last year, Norway extended its period from 22 to 29 weeks, which is just 1 week short of Denmark's. Four of the countries have voluntary, unpaid extended leave up to 40 weeks or 1 year. Coverage ranges from 80 to 100 percent in all the countries except England, where only 50 percent of the women are covered. Israel has 12 weeks of leave, with 75 percent of salary tax free (certain conditions exist). Four of the States supplied information stating that maternity leave ranged from 6 to 13 weeks, depending on company policy. In Minnesota and Wisconsin there is a State policy of 6 weeks. In Utah leave is up to 52 weeks, according to need and administrative approval. It is paid only up to that which is earned by annual or sick leave. California grants leave for up to 1 year without pay to female permanent employees.

To complete the picture of parents' rights, fathers in Denmark, Norway, and Sweden have the right of 2 weeks paternity leave, fathers in Minnesota and Wisconsin 6 weeks, and fathers in Israel as many as 12 weeks. Paternity leave is being planned in Germany. In California a male employee is granted the same right of leave to care for his newborn child as is the mother.

An obvious question connected with the right to maternity leave is whether working mothers have the right to return to their former workplace after the maternity leave. Such rights exist in Norway, Sweden, Germany, Japan, Minnesota, Georgia, and Utah, and with some reservation in Denmark, England and Wales, Israel, Scotland, North Carolina, Missouri, and Wisconsin, but not in New York (table 2). Considering the present unemployment rates, at least in Europe, this is important.

Given this right of returning to the old workplace, what about breast-feeding? Will the lactating mother have a legitimate right to respond to the child's demands while she is at work? Here, again, the rules differ, and the distribution of "yes," "yes, some," and "no" resembles the distribution of right to return to the workplace (table 3). (Israel and Wisconsin "yes, some" but Sweden "no"). If mothers are not permitted to breast-feed their babies during the working day, the alternatives are early weaning and milk expression or mechanical pumping, the latter probably being as time-consuming as breast feeding. Not having this right is a disadvantage, from a medical as well as from a humanitarian point of view. On the other side of the coin: To have at one time three lactating mothers who exercise this right on your medical staff in an obstetrical department, of which I have personal experience.

The last, but not least important, question on rights concerned abortion. All of the countries and States said that they did have a law that regulates abortion. Michigan, Wisconsin, and Georgia had abortion on demand and did not list any restrictions. All of the others had certain restrictions, which were either medical or procedural. Some of the restrictions were conditioned upon gestational age limits, which appear to be drawn quite haphazardly by each individual country or State. This merits further study.

To complete the picture of abortion services, we also asked if abortion was covered by an insurance system, whether official or private. Among the countries, Japan has no official or private insurance system for abortion. All of the others have an official system, which appears to have universal coverage (in Germany only 90 percent). Interestingly enough, in England and Wales, with 170,000 abortions in 1988, only about one-half of the women availed themselves of the National Health Service help, the other one-half used the private health care system at their own expense.

Among the U.S. States, Michigan, Minnesota, Missouri, Utah, and Wisconsin stated that they had no official insurance for abortion services. Furthermore, in Missouri it is illegal for any public facility to be used for the purpose of performing an abortion not necessary to save the life of the mother. In New York, California, and Georgia, abortion is covered by Medicaid for those eligible. In New York, Medicaid pays for 30 percent of all abortions and in California for about 25 percent. In Georgia, although 25 percent of abortions occur to Medicaid women, the women must pay for the procedure except to save the life of the mother. North

Carolina has State insurance, which covers about 12 percent. Coverage by private insurance varies, in most States, to an unknown degree. California estimated coverage to be at least 50 percent.

We now turn to more ordinary antenatal care services, beginning with a survey of the money providers (table 4). The tabulation shows that in all the countries except in Japan, all the women are covered, one way or the other. (In Israel 2 percent were not covered.) However, from the right column we learn that cost is no obstacle to Japanese women attending.

In the U.S. States, things are different, with substantial variation from one State to the next (table 5). Six of the States have some official coverage from different systems, (Utah 20 to 25 percent and Wisconsin 19 percent), while New York has substantial coverage by private systems. In Georgia, 45 percent of the births occur to women covered by insurance, the remaining 55 percent are covered by Medicaid or are without insurance. Cost was no obstacle to attending in six States, while two did not answer this question. The overall impression is one of divergent systems, and that there is some economic restraint to attending, for a minority of women, in most of the States that responded.

More than 95 percent of pregnant women in member countries and States receive antenatal care. In Denmark and Norway 90 percent start during the first trimester (Sweden 98 percent) (table 6). In Scotland the majority seems to start later (Israel 30 to 40 percent during the first trimester). The only country that reports more than 1 percent nonattenders is Germany, with 5 percent. The U.S. States have remarkably accurate records of nonattenders (table 7). Nonattenders range between 0.3 and 3 percent. The proportion starting during the first trimester is in the range of 70 to 80 percent, which is in fair agreement with the countries.

The officially recommended number of visits is 12 to 14 for most of the countries and States, with Scotland as the notable exception of 5 as a minimum. Denmark reports 9, Israel 15, Sweden 16, and Norway 12 for para 0 and 8 for para 1+ mothers. However, recommendations and actual practice do not always coincide. We know that in Norway 1+ mothers attend more frequently than the recommended number of visits, on average. In recent years there has been much discussion on the number and content of antenatal care visits. In this connection a recent publication from the Department of Health and Human Services in the United States is worth mentioning, "Caring for Our Future: The Content of Prenatal Care" (6). In this report, an expert panel advised fewer visits for low-risk mothers with increased emphasis on the early part of pregnancy (figure 5). It should be mentioned that three countries and four States have a home visiting system for nonattenders and dropouts; the rest do not, or did not reply to this question.

Questions on facilities for genetic analysis and the cost coverage of this service revealed that Norway, England, Israel, Michigan, and Missouri had insufficient laboratory capacity for chromosome analysis; the others said that the service was adequate. In Japan and the U.S. States this service is not covered by public insurance and has to be paid by the patient (coverage of private insurance is unknown), whereas all the countries in Europe had insurance coverage. Israel has coverage for special indications, otherwise the patient pays the total cost.

Continuity of care is psychosocially important. From the woman's point of view, meeting a new health worker at every consultation is not satisfactory. In Europe and Israel continuity between antenatal and birth care is either nonexistent or the exception. Some of the U.S. States qualified their answers on this point. Three said that private patients might have the same person for personal care, while low income or public patients, as a rule, would not. Minnesota drew the distinction between rural areas (with continuity) and metropolitan areas (without), whereas in Georgia there may be continuity for those who consult nurse midwives or small group practices.

Finally, in this overview we wanted to know who attends at a normal delivery. The alternatives were midwife, obstetrician, general practitioner, and other. We were possibly not explicit when asking for percentages, as some of the line sums for the countries add up to more than 100 (table 8). The interpretation, however, is obvious. In all the countries the midwife is the main attendant. Obstetricians in Denmark, Germany, Israel, and Japan (midwife over 95 percent and obstetrician over 80 percent) seem to be present at the majority of births, whereas this task is often left to junior doctors in Scotland and in other countries as well, at least during the wee hours.

As you can see in table 9, all of the U.S. States have the same pattern of attendance, with obstetricians as the key attendants. In Missouri and Georgia general practitioners also have a share of about 10 percent, whereas midwives attend at somewhere between 0 and 6 percent. This is a reflection of the distribution of obstetricians and midwives shown earlier. Utah answered that 3.5 percent of births are attended by midwives, 95 percent by general practitioners, and as many as 1.3 percent by lay midwives.

To end on another psychosocial note, the policy of allowing persons other than medical personnel in the delivery room seems to be liberal in most countries and States. In Denmark they permit the child's father, brothers and sisters, and friends of the parents (hopefully not all at the same time) to attend. Japan is the other extreme, with only about 10 percent attendance by nonmedical persons. In some of the U.S. States, policy varies by hospital, with only Utah giving a figure, which was an estimate of 9.5 percent of fathers attending.

We have only been able to elaborate on some points of the questionnaire. Eberhard Schmidt will discuss the care of the neonate. The data so far presented justify a conclusion of diversity in health care policy and services between ICE member countries and States. The comparisons may be helpful to politicians, health officials, and practicing physicians and midwives who want to improve their professional standards.

Annex:
Some States and countries provided additional information, a few amendments, and corroborative information after the symposium. These have been incorporated in the final text.

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Table 1. Paid work during pregnancy

	Paid work at start of pregnancy (percent)	Percent who stop during 2nd and 3rd trimester
Denmark	90	45
Norway	75	40
Scotland	NA	NA
England	48	90
Germany	40	NA
Japan	23	94
Israel	50	NA
Sweden	NA	NA
U.S. States	NA	NA

NA: Not answered.

Table 2. Right to return to former workplace?

<u>Yes</u>

Norway, Germany, Japan, Sweden
Minnesota, Georgia, Utah

<u>Yes, some</u>

Denmark (60%), England and Wales (50%), Israel,
Scotland (if employed for 2 years),
North Carolina, Missouri, Wisconsin

<u>No</u>

New York

<u>Not answered</u>

Michigan, California

Table 3. Right to time off for breast feeding?

<u>Yes</u>

Norway, Germany, Japan

<u>Yes, some</u>

Israel, Minnesota, North Carolina, Wisconsin

<u>No</u>

Denmark, Scotland, England and Wales, Sweden,
New York, Georgia, Missouri

<u>Not answered</u>

Michigan, California, Utah

Table 4. Insurance coverage for antenatal care (countries)

	Percent coverage			
	Official system	Private system	Not covered	Is cost obstacle to attending?
Denmark	100	0	0	no
Norway	100	0	0	no
Scotland	100	0	0	no
England/ Wales	98	-	-	no
Germany	90	10	-	no
Japan	0	0	100	no
Israel	95	-	<2	no
Sweden	100	-	0	no

Table 5. Insurance coverage for antenatal care (U.S. States)

	Percent coverage			
	Official system	Private system	Not covered	Is cost obstacle to attending?
New York	30-50	50	0-10	no
Michigan	NA	NA	NA	yes
Minnesota	0	NA	NA	yes
Missouri	0	NA	NA	NA
N. Carolina	24	NA	NA	yes
Georgia	40	40	20	yes
California	30	NA	NA	NA
Utah	20-25	60-75	5-10	yes (5 percent)
Wisconsin	19	10	NA	yes

NA: Not answered.

Table 6. Antenatal care (percentages) (countries)

	Start during first trimester	No antenatal care
Denmark	90	1
Norway	90	0
Scotland	40	0.5
England/Wales	NA	5
Germany	70	5
Japan	50	1
Israel	30-40	<1
Sweden	98	0

NA: Not answered.

Table 7. Antenatal care (percentages) (U.S. States)

	Start during first trimester	No antenatal care
New York	70	2.2
Michigan	80	2.5
Minnesota	68	0.8
Missouri	79	1.1
N. Carolina	75	1.6
Georgia	72	2.5
California	75	3.3
Utah	83	0.3
Wisconsin	83	0.6

Table 8. Who attends at a normal delivery (countries)?

	Midwife	Obstetrician	General practice	Other
Denmark	100	80	0.5	20
Norway	100	NA	NA	NA
Scotland	100	NA	5	30
England/ Wales	70	NA	NA	NA
Germany	100	100	NA	NA
Japan	96	98	NA	NA
Israel	95	80	NA	NA
Sweden	100	NA	NA	NA

NA: Not answered.

Table 9. Who attends at a normal delivery (U.S. States)?

	Midwife	Obste- trician	General practice	Other
New York	3.9	95.4	0.3	0.4
Michigan	1.3	98.0	0.7	0.1
Minnesota	4.0	95.5	0.4	0.0
Missouri	0.1*	73.6	11.7	14.2
N. Carolina	1.5	93.0	5.0	-
Georgia	6.3	85.0	8.1	-
California	NA	NA	NA	NA
Utah	3.5	——— 95 ———		1.3**
Wisconsin	NA	NA	NA	NA

NA: Not answered.

* Plus 0.2 percent attended by non-certified midwife.
** Lay midwife.

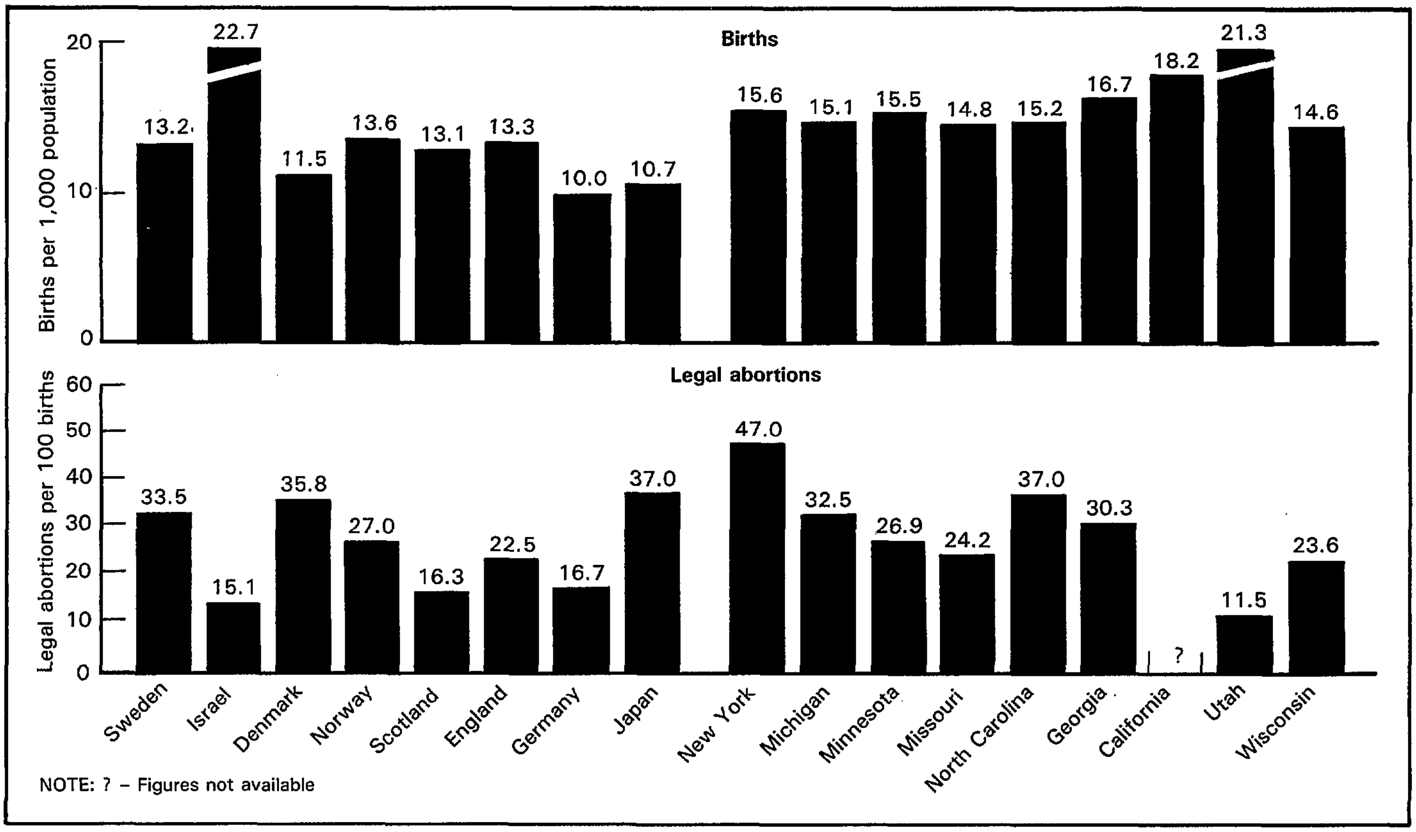

Figure 1. Births per 1,000 population and legal abortions per 100 births: selected countries and U.S. States, 1988

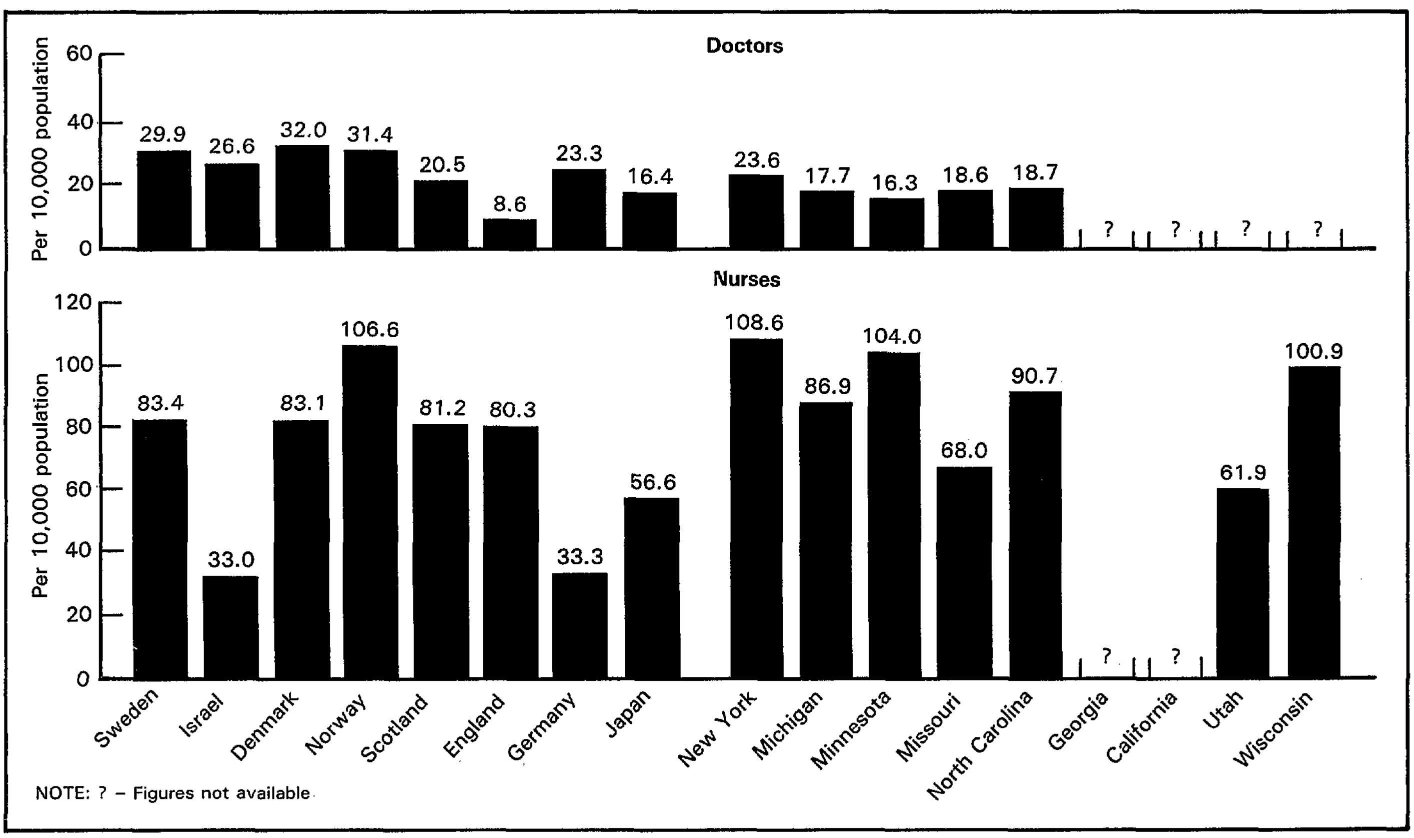

Figure 2. Doctors and nurses per 10,000 population, selected countries and U.S. States, 1988

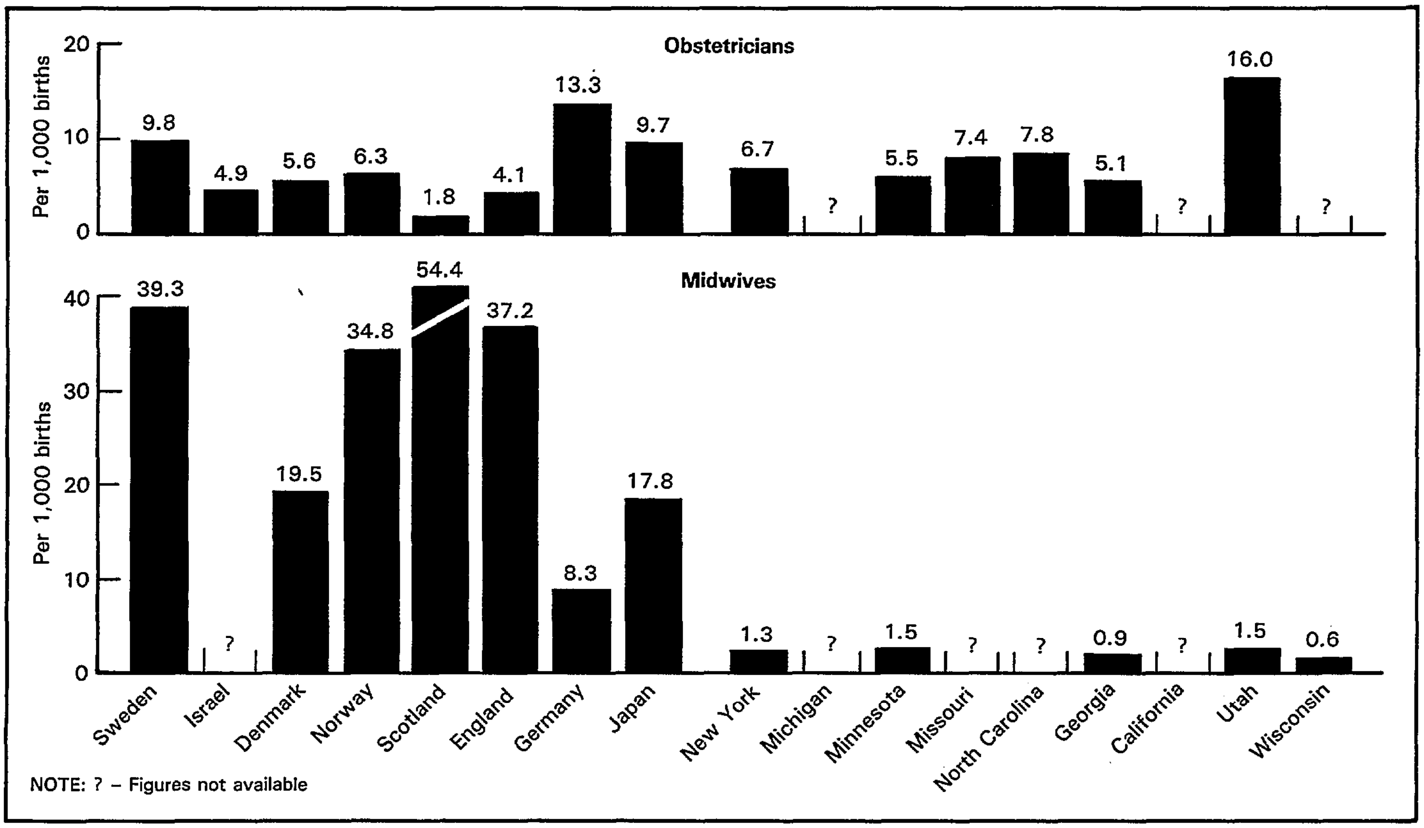

Figure 3. Obstetricians and midwives per 1,000 births, selected countries and U.S. States, 1988

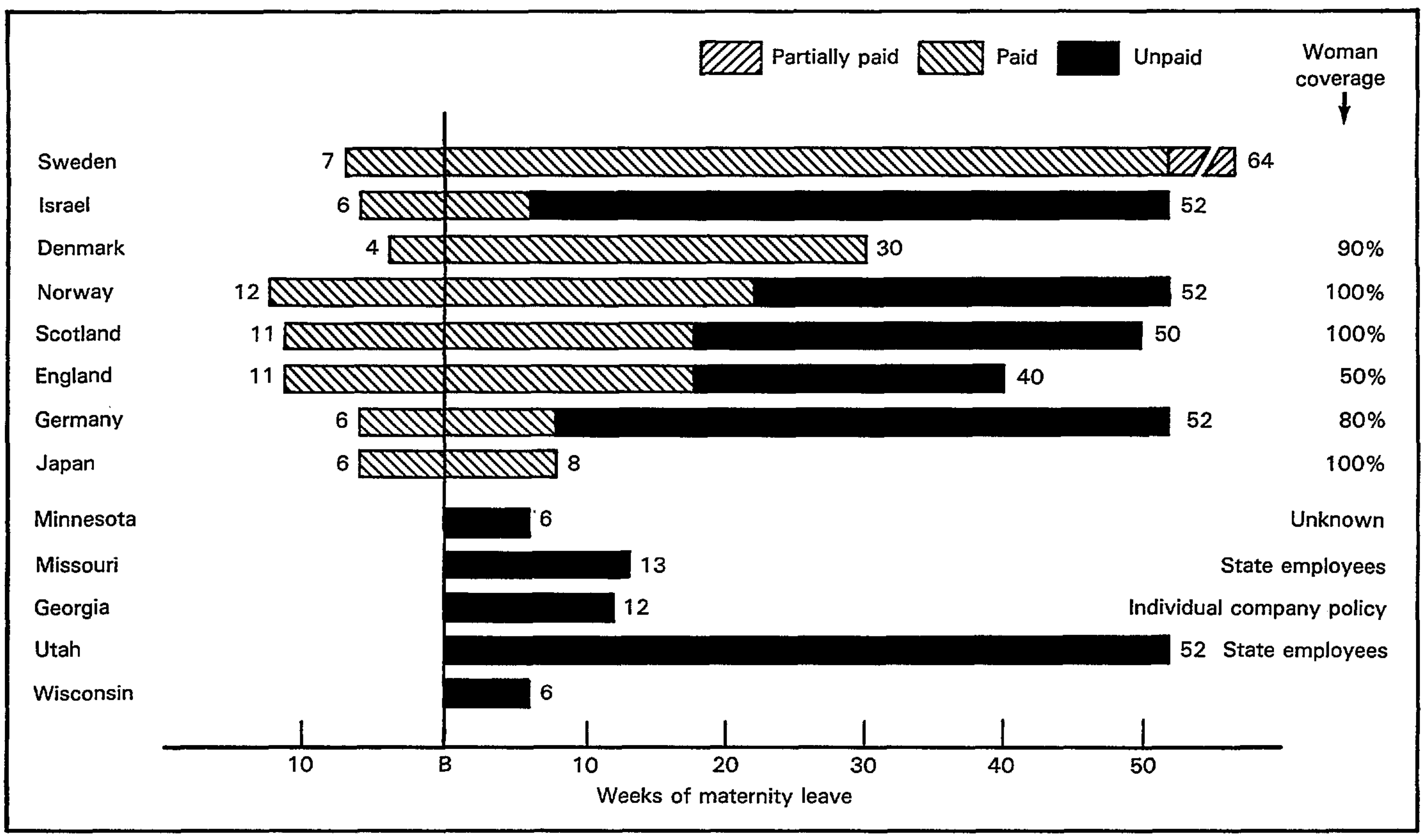

Figure 4. Maternity leave provided by law and percent of women covered, selected countries and U.S. States, 1988.

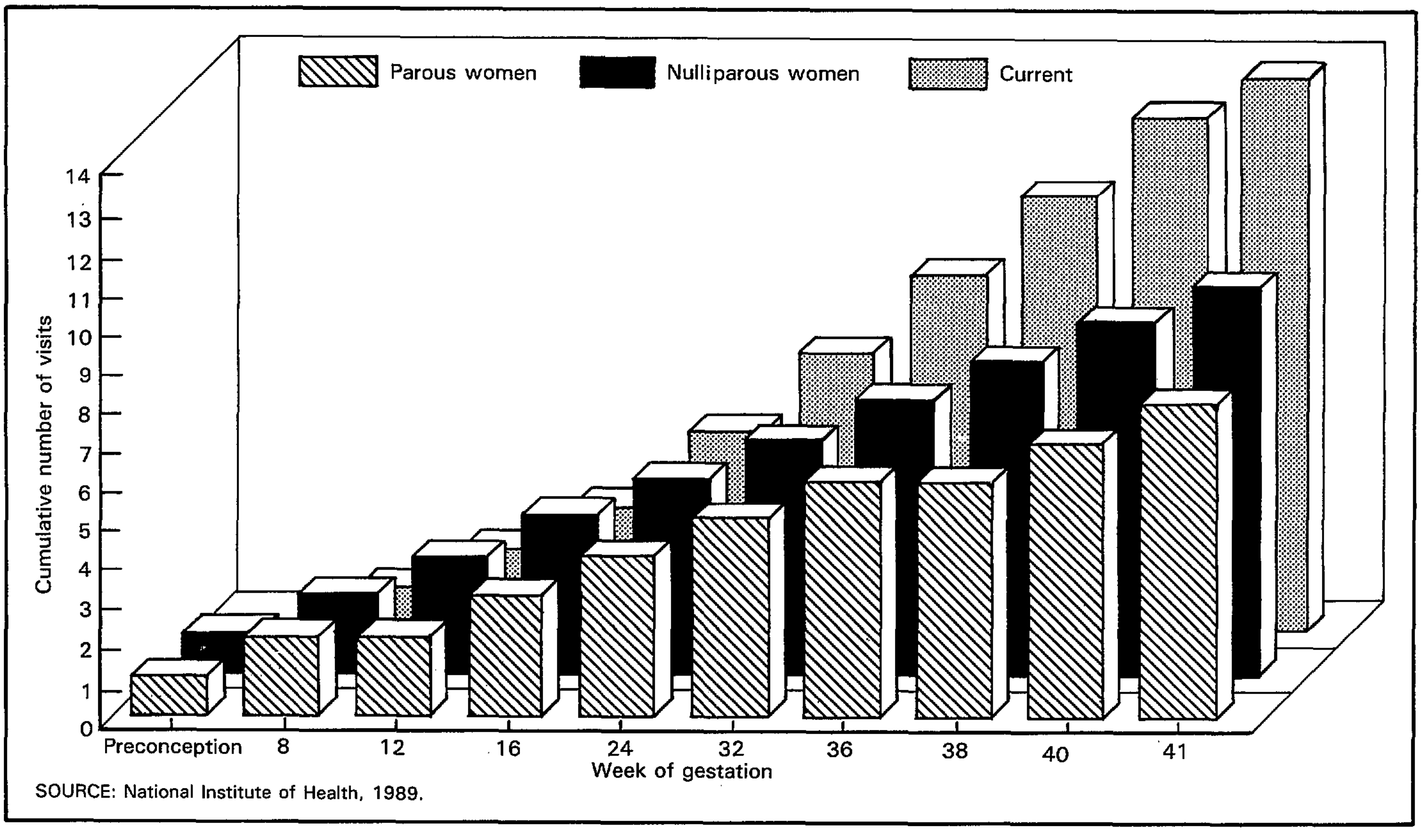

Figure 5. Comparison of current and recommended cumulative visits by week of gestation for healthy women

**Differences in Obstetrical Delivery Practice:
Norway, Scotland, and the United States**

by Francis Notzon, Ph.D., Per Bergsjø, M.D., Susan Cole, M.D.,
and Patricia Potrzebowski, Ph.D.

The years since 1970 have seen remarkable changes in obstetrical delivery practice across the industrialized world. In 1970 cesarean section was an intervention generally reserved for the most difficult of deliveries, and national cesarean section rates were correspondingly low, ranging from 2 to 6 percent of all hospital deliveries in industrialized countries (1). By the mid-1980's, this method of delivery was applied to a wide range of complications. In the United States about one birth in four was by cesarean section, and in most other industrialized countries the rate ranged between 10 and 15 percent (2). In addition, since the mid-1970's the cesarean rates for most nations appeared to be increasing at approximately the same pace (1). These trends are important because of the exposure of so many women to the risks of abdominal surgery and the contribution of these deliveries to the rising cost of health care.

Numerous articles have been written on this topic, reflecting the growing concern over the rise in cesarean deliveries (1-5). International comparisons of cesarean delivery practices produced to date have been hindered however, either by a lack of comparability of data across countries, an absence of trend information, and/or a very limited range of variables available for analysis.

In order to improve our understanding of this rapid and widespread transformation in obstetrical practice, we have joined together to carry out a more thorough comparative study of the transformation in obstetrical practice in Norway, Scotland, and the United States during the 1970's and 1980's. The study is, for the present at least, separate from ICE's main focus on perinatal and infant mortality and from the ICE data base. There were two main reasons for this. First, many of the variables we wanted to include in this study were not part of the standard ICE data file. Second, we did not want to further complicate the arduous task of assembling and editing the ICE data base.

In designing the project, we agreed to prepare a common set of tables with information on method of delivery and variables covering characteristics of the mother and child, complications of labor and delivery, characteristics of the hospital where the birth occurred, and others. These tables were to be prepared for the years 1970, 1975, 1980, and 1985. However, because of the relatively small number of births occurring annually in Scotland and Norway, and because the U.S. data are based primarily on a sample survey, each period was expanded to cover 3-year intervals, centered on the target years. In addition, the Scottish data cover only the years from 1975 on, as intervention rates for the earlier years are not reliable.

Table 1 describes the data sources for each country, along with the years for which data are available from each source. While the central registries in Norway and Scotland provide most of the information desired, the U.S. Hospital Discharge Survey is much more restrictive. Additional information for the United States was obtained, first by linking Hospital Discharge Survey records with the American Hospital Association's Annual Survey of Hospitals to obtain several hospital-related variables. Second, information on several important characteristics, such as birth weight, gestational age, and others available from vital statistics were obtained from a selected number of U.S. States. Data years differ somewhat across sources and across countries but are roughly comparable.

The list of U.S. States differs slightly from the set of States contributing to the ICE data base, but nonetheless represents most regions of the United States (table 2). More importantly, the cesarean rates reported by this set of States follows the national cesarean trend line very closely (figure 1).

Results

Table 3 provides cesarean section rates for eight of the nine ICE countries, along with other selected countries in 1985. While the rates for Brazil and Puerto Rico may appear surprisingly high, the U.S. rate of 23 percent remains sharply higher than the other industrialized countries of Europe, North America, and the Pacific. The Canadian rate is the only one to approach the level recorded in the United States. Scotland and Norway occupy intermediate positions, at 13.5 and 12 percent, respectively, while one of the lowest rates is reported by Japan. Because of the high proportion of home deliveries in the Netherlands, the Dutch rate would be about 7 percent if calculated on the basis of all deliveries, one of the lowest rates reported by any country.

Figure 2 describes the increase in cesarean rates in the three countries from 1970 to 1986. While attention is usually focused on the rapid rise in U.S. cesarean deliveries, the cesarean rate in Scotland rose by almost 60 percent, from 8.5 to 13.5, between 1975 and 1986, while the Norwegian rate increased by a factor of 5 between 1970 and 1986. In fact, the American and Norwegian growth rates are quite similar over the interval, and both are considerably higher than the Scottish growth rate.

We are also able to depict trends in operative vaginal delivery rates, defined as the sum of forceps and vacuum delivery rates (figure 3). Two very different patterns emerge in this graph. The declining rates in the United States and Scotland are consistent with the trends found in most other countries, in which operative vaginal deliveries decline as cesarean births rise. Norway, on the other hand, has experienced a long-term rise in both cesarean and operative vaginal rates, a combination found in very few countries.

The U.S. trend line begins in 1979 because operative vaginal procedures were not coded by the Hospital Discharge Survey before that year. We do have information on operative vaginal deliveries from the nine U.S. States, although these appear to be somewhat lower than the rates shown here. Nonetheless, the State-based rate for the United States was 21 percent in 1975, and an amazing 28 percent in 1970. In fact, in one of the U.S. States in 1970, forceps were used in 51 percent of all deliveries.

Now that we have described the trends and current levels of these interventions we can make use of information on maternal and infant characteristics, as well as complications of labor and delivery, to begin to sort out the reasons for this transformation in delivery practices.

We will start by considering cesarean rates simultaneously by maternal age and birth order. Age- and birth-order-specific cesarean rates have not been routinely available for the United States in the past, and in fact have only rarely been produced. Table 4 presents cesarean section rates for two specific age/birth order groups: first births to women aged 35 and over, and second births to women aged 25-29. Because cesarean section rates generally rise as age increases and within age categories are highest for first births, cesarean delivery is most common for first births to women 35 and over. In the 1985 interval, the cesarean rate for this group ranged from 32 percent in Scotland to 40 percent in Norway (38 percent in the United States).

That a high proportion of births in this category are delivered by cesarean section is perhaps to be expected, as first births to women in this age group are likely to suffer from complications such as uterine inertia or failure to progress. What we did not expect to find, however, was roughly equivalent cesarean rates for this category of women 10 to 15 years earlier. In the 1970 interval, the cesarean rate for this group was 23 percent in Norway, when the overall Norwegian rate was 2 percent; in the United States the rate for this group was 27 percent. In Scotland cesarean deliveries for this group were even more likely in 1975 (42 percent) than in 1985.

One implication of these findings is that changes in age- and birth-order-specific fertility over time probably will not account for a large proportion of the increase in cesarean deliveries. In fact, adjusting for age- and birth-order changes over time accounted for only a small proportion of the rising cesarean rate in each country.

To illustrate the trends in cesarean deliveries in other age- and birth-order categories, table 4 also shows the change in cesarean rates for second births to women aged 25 to 29. This category represents a much larger proportion of all births--from 15 to 25 percent of the total, depending on the country and time period. In addition, this group is sufficiently far away from the high-cesarean ages and birth orders that its cesarean rate is in about the middle of the distribution. Cesarean rates for this group rose sharply over time in all three countries, but this was particularly true for the United States, where the rate increased from about 7 percent in 1970 to over 21 percent by 1985.

Cesarean rates also vary greatly by birth weight in all three countries and are highest for births weighing 1,000-1,499 grams (table 5). For births in this weight category, cesarean delivery rates have risen sharply since 1970 in all three countries, reflecting an important change in management of these deliveries. While cesarean rates for this category of births were less than 10 percent in the United States and Norway in 1970, by 1985 almost 60 percent of these births were delivered by cesarean in Norway and over 50 percent in the United States.

Table 5 also presents trends in cesarean section rates for the birth weight category in which cesarean delivery is least likely--2,500 to 3,499 grams. Here again strong increases are reported in Norway and the United States, with a somewhat lower rate of increase in Scotland. Most notable is the increase and the actual 1985 rate in the United States.

Method of delivery for multiple births also varies significantly by country and over time (table 6). In the United States cesarean delivery became increasingly popular over the interval, so that by 1985 a majority of multiples were delivered by cesarean section. At the same time, the operative vaginal rate declined modestly. In Norway, by contrast, the cesarean rate rose rapidly but the operative vaginal rate also rose over the interval. Finally, in Scotland the proportion of multiples delivered by cesarean rose more slowly than in the United States or Norway, and by 1985 a substantial proportion of multiples were still delivered by operative vaginal methods.

A complication of delivery that has not yet been mentioned, and that may underlie a significant part of the differential in cesarean rates between the United States and other countries, is the proportion of women delivering vaginally after a previous cesarean delivery. In the United States less than 3 percent of women with a previous cesarean had vaginal deliveries in 1970, and by 1985 the proportion had risen to only about 7 percent. In Scotland almost 40 percent of these births were delivered vaginally in 1985, while in Norway almost one-half of these births were delivered vaginally.

Discussion

This presentation has focused on differences in method of delivery for several clearly definable characteristics of the mother or child, including birth order, maternal age, birth weight, and multiple gestation. These characteristics were chosen because they do not suffer from the international comparability problems common to diagnoses such as dystocia or fetal distress. By focusing on these characteristics, we are able to delineate real differences in obstetrical practice across three countries and over time.

We have shown that, for certain subgroups such as first births to older mothers, cesarean section rates were very high as early as 1970 and have increased relatively little since then. For other subgroups, such as very low birthweight infants, rates have risen dramatically between 1970 and 1985 in all three countries. For groups that represent a much larger proportion of all births, cesarean rates have risen sharply and steadily in both the United States and Norway and to a lesser degree in Scotland.

An explanation of changing delivery methods in these larger categories will require consideration of other indications for cesarean delivery, such as dystocia and fetal distress. We are presently attempting to resolve differences in diagnostic practices across the three countries that will allow us to make meaningful comparisons of method of delivery for these "softer" diagnoses. One factor that is clearly different among the three countries is the use of a previous cesarean as an indication for cesarean delivery. In the United States, where the practice of "once a cesarean, always a cesarean" is alive and well, one can be reasonably confident that, among women with prior cesarean births, "previous cesarean" is the actual medical indication for the current cesarean delivery. In countries such as Norway and Scotland, where only about one-half of such women will have cesarean deliveries, one is much less certain about the actual medical indication for the current cesarean delivery.

Finally, we hope to add a "method of delivery" variable to the ICE data set, at least for these three countries, so that we can begin to measure the contribution of delivery method to infant survival for specific complications. We will report on these and other factors associated with method of delivery at a future date.

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Table 1. Data sources and data years available

Country	Source	Data years
Norway	Birth registration; Medical Birth Registry	1970-71, 1974-76, 1979-81, 1984,86
Scotland	Hospital discharge summaries (SMR2); Scottish Health Service	1975-76, 1980-81, 1985-86
United States	Hospital Discharge Survey; NCHS	1970-71, 1974-76, 1979-81, 1984-86
	Annual Survey of Hospitals; American Hospital Assn.	1970-71, 1974-76, 1979-81, 1984-86
	Vital statistics; Nine U.S. States	1970, 1975, 1980, 1985

Table 2. Participating U.S. States/Registration Areas

California	New York City
Maryland	New York State
Minnesota	Pennsylvania
Missouri	Wisconsin
Montana	

Table 3. Cesarean section rates per 100 hospital deliveries, selected countries, 1985

Country	Rate
Brazil, 1981-86	31.6
Puerto Rico	28.8
United States	22.8
Canada	18.8
Bavaria	14.5
Scotland	13.5
Denmark	13.3
Sweden	12.1
Norway	11.9
England/Wales	10.4
Netherlands:	
hospital births	10.4
total births	6.6
Hungary	10.1
Japan, 1984	7.3
Czechoslovakia	6.3

Table 4. Cesarean section rates by age of mother and birth order: Norway, Scotland, and the United States, 1970-85

Country	1970	1975	1980	1985
	First births to women age 35 and over			
Norway	23.3	31.5	39.9	39.9
Scotland	NA	42.2	37.3	32.3
United States	26.6	37.1	37.9	38.1
	Second births to women age 25-29			
Norway	1.9	3.2	6.3	9.2
Scotland	NA	7.4	10.4	12.3
United States	6.6	11.1	17.8	21.3

NA: Not available.

Table 5. Cesarean section rates by birth weight of infant: Norway, Scotland, and the United States, 1970-85

Country	1970	1975	1980	1985
	Birth weight 1,000-1,499 grams			
Norway	4.9	9.8	26.2	58.0
Scotland	NA	11.6	32.0	45.7
United States	8.9	17.4	36.1	49.8
	Birth weight 2,500-3,499 grams			
Norway	2.2	4.2	8.8	11.8
Scotland	NA	8.4	10.8	12.0
United States	5.6	10.8	15.5	19.3

NA: Not available.

Table 6. Method of delivery rates for multiple births: Norway, Scotland, and the United States, 1970-85

Country	1970	1975	1980	1985
	Cesarean section rates			
Norway	3.1	6.5	21.2	34.9
Scotland	NA	23.6	23.2	30.0
United States	9.5	17.3	38.3	55.1
	Operative vaginal rates			
Norway	5.8	7.2	8.7	9.1
Scotland	NA	NA	23.5	17.7
United States	NA	NA	8.0	6.2

NA: Not available.

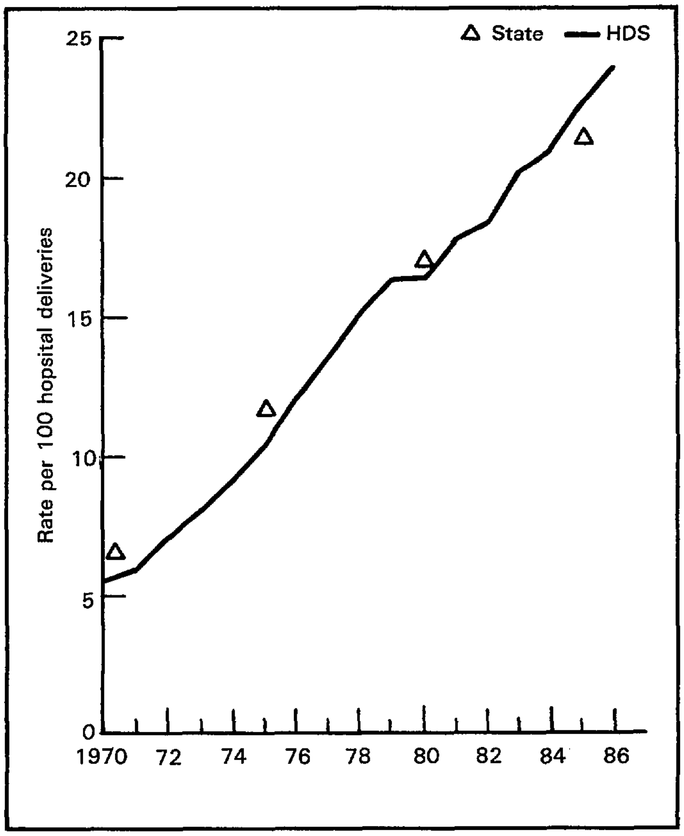

Figure 1. Casarean section rates, Hospital Discharge Survey (HDS) and State vital statistics: United States, 1970–86

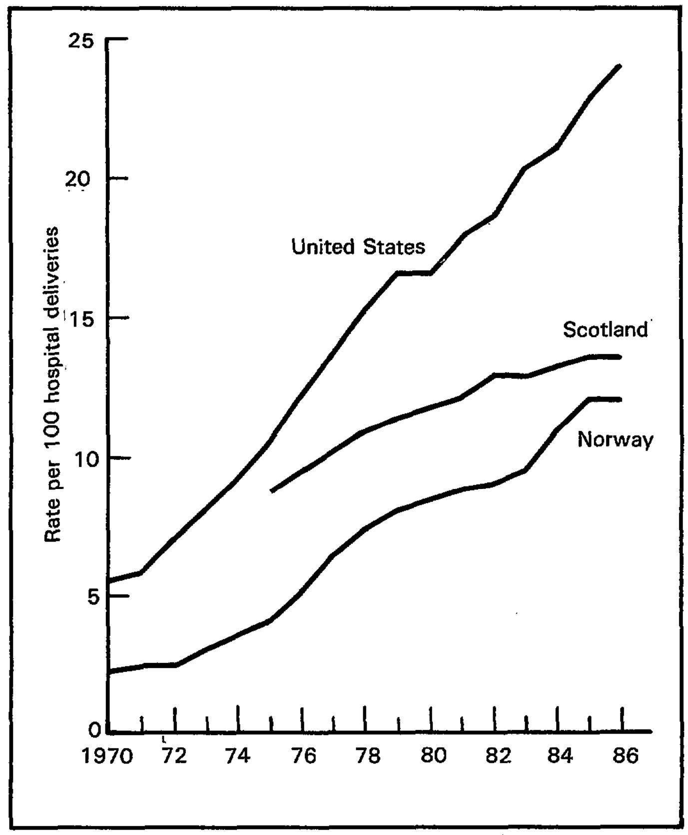

Figure 2. Cesarean section rates: Norway, Scotland, and United States 1970–86

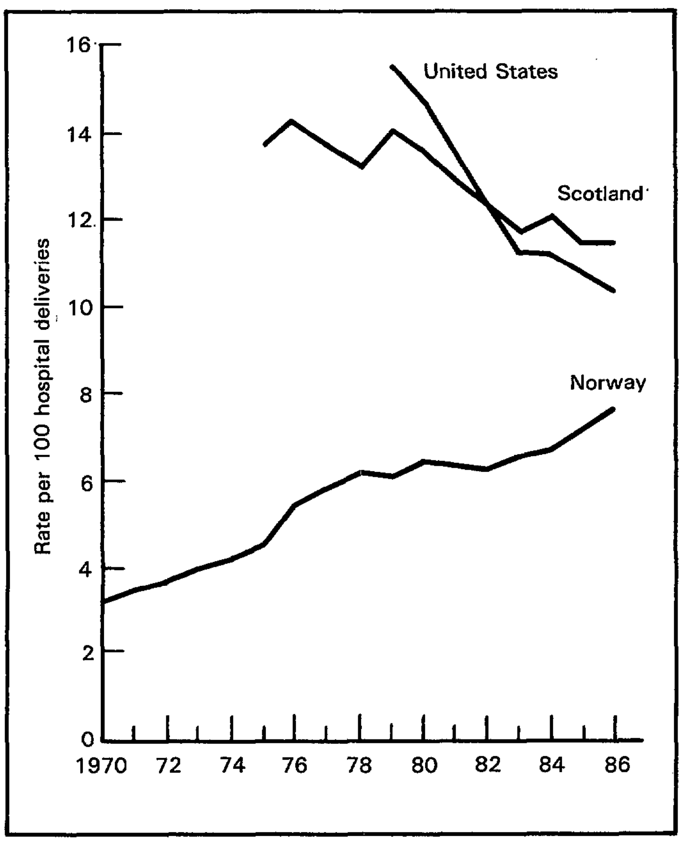

Figure 3. Operative vaginal rates: Norway, Scotland, and United States 1970–86

Care of the Infant

by Eberhard Schmidt, M.D., Pauline Verloove-Vanhorick, M.D.,
and Per Bergsjø, M.D.

Data for this presentation have been obtained from a questionnaire planned at the meeting of the ICE group in October 1989 in Chicago, Illinois. The following countries responded:

North America:	Asia:	Europe:
United States:	Japan	Denmark
California		England/ Wales
Georgia		Scotland
Michigan		Federal Republic of Germany
Minnesota		Netherlands
Missouri		Norway
North Carolina		
New York		
Utah		
Wisconsin		

Answers were provided by members of the ICE group in European countries and Japan and officials of State Maternal and Child Health (MCH) departments in the United States. Data sources were requested for each question; sources cited included State statistical bureaus, medical associations, surveys, insurance companies, and estimates. The large number of estimates and unknowns underlines the need to be cautious in the interpretations to follow.

In this presentation, we plan to review the data given concerning:

State statistics:	Demography
Birth institutions:	Obstetrics Pediatrics Regionalization
Postnatal and infant care:	Postpartum days in hospital Breast feeding Home visits Primary care Day care

Relevant demographic data

The population of seven U.S. States, six European countries, and Japan account for a total of 378 million people and 4,330,000 births. The birth rate in the United States is higher than in European countries. The highest rates are in California and Georgia followed by England and Wales, and the lowest in Denmark, the Federal Republic of Germany, and Japan (figures 1-2).

The columns give the number of legal abortions per thousand births in each country. The ratio is the lowest in the Netherlands followed by Germany and Scotland, and the highest in New York State followed by Denmark and Japan. The data for the Netherlands and Norway are considered reliable, whereas in Germany, where legal abortion is dependent on indications, an estimated 50 to 100 percent has to be added to these figures, placing them into the same range as many of the other countries and States.

Number of births per midwife, general practitioner, and obstetrician

Figure 3 gives data about the number of births per midwife, general practitioner, and obstetrician. The interpretation of these calculations is very speculative. We have no information about the type of work the midwives are engaged in--whether they are in the delivery room or out in free practice. The United Kingdom has the most favorable figures in regard to the number of births per midwife, and the figures in Europe and Japan are somewhat more favorable than in the United States.

We do not know to what extent general practitioners are in charge of deliveries, so to calculate the number of births per practitioner may be totally erroneous. However, looking at this figure for obstetricians, we see favorable figures in Germany, the number of births being lower than for midwives, but we see them being rather rare in the United Kingdom.

Figures from the United States point to greatly different management of delivery. Midwives and general practitioners were extremely rare in Georgia and Minnesota; figures given for obstetricians, however, are similar to the European data. From these data one wonders, for instance, how Georgia and Minnesota are able to manage with such a small number of obstetrical personnel. But there are certainly structural characteristics not obvious from the data given to us.

Birth institutions and number of home births

The question concerned assignments of births to birth institutions with different levels of care, including:

- University hospitals
- Teaching hospitals
- Nonteaching hospitals
- Small nursing or midwifery units
- Home births

In Missouri and New York about 50 percent of the babies are delivered in high-level hospitals. In Minnesota and North Carolina about 15 percent were delivered in high-level hospitals (figure 4). In Japan, teaching and nonteaching hospitals together make up 60 percent of the deliveries and about 40 percent of the deliveries occur in small units.

In most States and countries home deliveries remain below 1 percent. Turning to the big exception--the Netherlands offers a fascinating, completely different system with 37 percent of deliveries at home, only 10 percent in high-level hospitals, and the rest (about 50 percent) occurring in nonteaching hospitals including midwifery schools. The Dutch system is based on thorough primary care in pregnancy, which then allows women without risks to deliver at home with a midwife, where they are then cared for or supported by visiting personnel with special qualifications.

Neonatal intensive care units

We calculated the number of births per neonatal intensive care unit in each country because the availability of intensive care beds within reasonable distance and in adequate numbers is one of the most important pillars of good perinatal care. No information could be gained as to the size of the units. The fact that some of the figures for neonatal intensive care units are "estimates" may also mean that all units counted may not be level III--24-hour service, including a transport system (tables 1-2).

The ideal size of a neonatal intensive care unit with regard to the cost of personnel and equipment is said to be 12 to 14 beds. The optimum seems to be 1.8 to 2.1 beds per 1,000 births. This is compatible with 18,000 to 20,000 births per neonatal intensive care unit.

Scotland and Norway, with only 3,500 and 5,700 births, respectively, per neonatal intensive care unit, run smaller units as suitable in widespread and sparsely populated areas. In this context the low figures in New York are of special interest and need explanation.

Postpartum days spent in hospitals and home visiting systems

There is a great variation in the number of postpartum days spent in the hospital after uncomplicated delivery. The range varies from 7 days in Japan, 5 to 6 days in Germany and Norway, 2.8 to 3.1 days in Minnesota and New York, down to 0 days in the Netherlands and Georgia, where the postpartum time in hospitals is given to be between 4 to 12 hours (figures 5-6).

Each country and State has a home visiting system. In the United States, complete coverage is not practiced anywhere, and coverage of risk babies appears to be rather low where figures are given. In Europe, Germany is lagging behind with a risk selection system with unknown coverage of the risk population, in comparison to the other European countries with complete coverage of all newborns. In Japan, 27 percent of babies are visited, which is a high figure if only risk infants are concerned but of course a low one if the total infant population is envisaged.

Breast feeding

Data on breast feeding were reported for frequency at birth, at 1 month, and at 6 months of age. Taking into account the problems of defining breast feeding and the difficulty of obtaining national data on long-term breast feeding, most of these figures should only be regarded as estimates (figure 7).

However, it has been known for a long time that breast feeding prevalence within Europe is highest in Scandinavia, especially in Finland and Sweden. Little can be said about facts behind comparatively poor data from some countries at birth and, more so, thereafter.

There are systems for the promotion of breast feeding in every country, but only the knowledge about details of such systems on operations and persons involved can give background explanations about their failure or effectiveness. Taking into account the advantages of breast feeding for infant and mother and the efforts of WHO to spread the knowledge, figure 7 indicates that a lot has to be done to get better results.

Recommended number of primary care visits and their coverage

Systems for primary care of infants have been instituted everywhere in the industrialized world during the last decade (figures 8-9). It is surprising, however, that during the past 10 years efforts have been started and are still continuing to revise these systems. There are two reasons for this development:

1. The attempt to evaluate these systems has revealed some severe methodological failures with the consequence of excess false results;
2. These failures add more costs to a system which is already costly enough.

One expression of the general uncertainty regarding what a primary care system should offer and at what ages it should be used may be seen in the many different ways in which the problem is handled in Western countries, with required primary care visits varying from a minimum of 2 to a maximum of 13, and 2 countries in which primary care is left to the discretion of the medical profession.

No data have been given for participation in these systems. One hundred percent coverage means no cost for the family. But a primary care system is only as good as the compliance in the population, about which data are incomplete. The forthcoming years will hopefully bring positive developments in regard to content and effectiveness of primary care systems in the Western World.

Eye drops

In Europe, WHO published a survey in 1985 on the perinatal situation called "Having a Baby in Europe." In this survey, 16 European countries reported that silver nitrate eye drops were still used for the prevention of gonococcal conjunctivitis (figure 10).

Progress has been made since 1955. Many mothers have criticized the fact that first and early eye-to-eye contact with their newborn baby may be spoiled through chemical conjunctivitis in their infants caused by silver nitrate drops. Now the Federal Republic of Germany is the only European country where silver nitrate drops are still in use. We are, however, in good company with California, Minnesota, Missouri, and New York, whereas the alternative in the rest of the surveyed countries is "observation or antibiotic eye drops, mostly Erythromycin."

Day care for infants of working mothers

The question regarding day care for infants of working mothers was answered with a "no" by Georgia, Missouri, New York, and Scotland (figure 11).

The others report such systems as being offered by the state, the employer, or privately to a varying degree. However, with the exception of Denmark, where women have to take over not more than 33 percent of the cost, the rest being covered by the state, women very often have to pay 100 percent to mostly privately organized services (figure 12). In the Federal Republic of Germany, the state provides only about 2 percent of the places needed.

Private provision of day care is apparently impossible to measure in countries, but may be largely insufficient in many of them. But as is obvious from the figures presented, very little is known about this important sociopolitical problem, which certainly is an existential one for women who are forced to work.

Screening in pregnancy and in the newborn

Screening alpha-feto protein for the detection of neural tube defects is not done routinely but only selectively except in England and Wales, and Norway.

Finally, neonatal screening is rather uniform throughout the areas observed. Phenylketonuria and hypothyroidism is looked for everywhere with apparently complete or close to complete coverage throughout (figure 13).

In Japan and most of the included U.S. States, other diseases are screened (figure 14). Data on coverage for these diseases are not given. In Europe this situation is rather homogeneous, including screening of hip disease.

Conclusion

Selected data on infant care have been presented for six European countries, seven American States, and Japan. The quality of the data is rather inhomogeneous.

Comparison of data between countries allows us to pinpoint main areas of concern as follows:

Organizational--Problems concern the still ongoing process of regionalization, as well as the number, size, and quality of neonatal intensive care units.

Medical--Evaluation of primary care systems.

Sociopolitical--Provision of day care, an existential problem for those mothers who have to go to work in order to make a living for their infants and themselves.

Table 1. Number of births per neonatal intensive care unit*

State (U.S.)	Number of births
California	20,135
Georgia	10,584
Michigan	7,349
Minnesota	8,343
Missouri	19,000
North Carolina	8,100
New York	5,833

*Birth institution with level III neonatal intensive care unit.

Table 2. Number of births per neonatal intensive care unit*

Country	Number of births
Denmark	18,666
England/Wales	18,738
Scotland	3,500
Federal Republic of Germany	30,000
Netherlands	18,500
Norway	5,750
Japan	3,639

*Birth institution with level III neonatal intensive care unit.

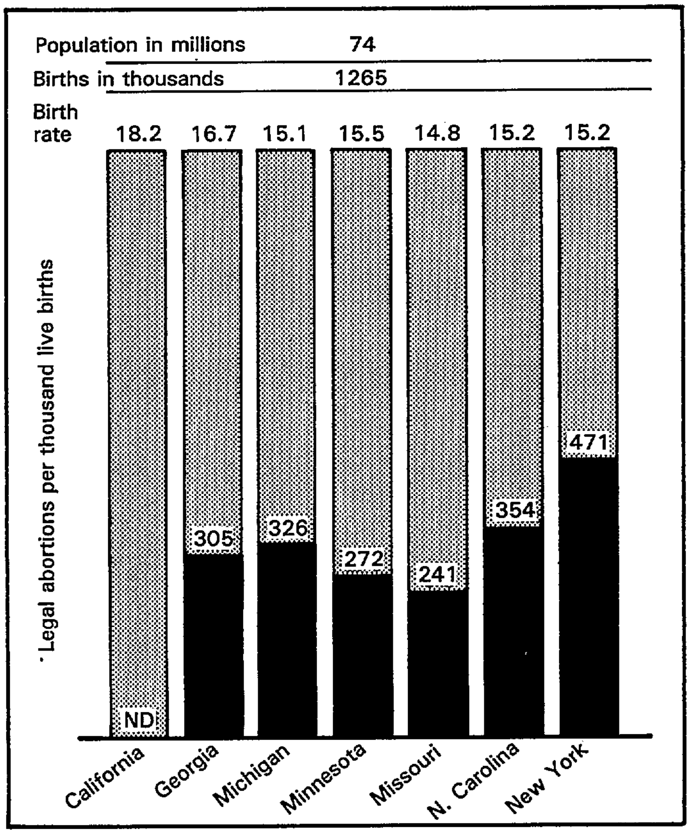

Figure 1. Statistical data on births, birth rate, and legal abortions for selected states: United States, 1988

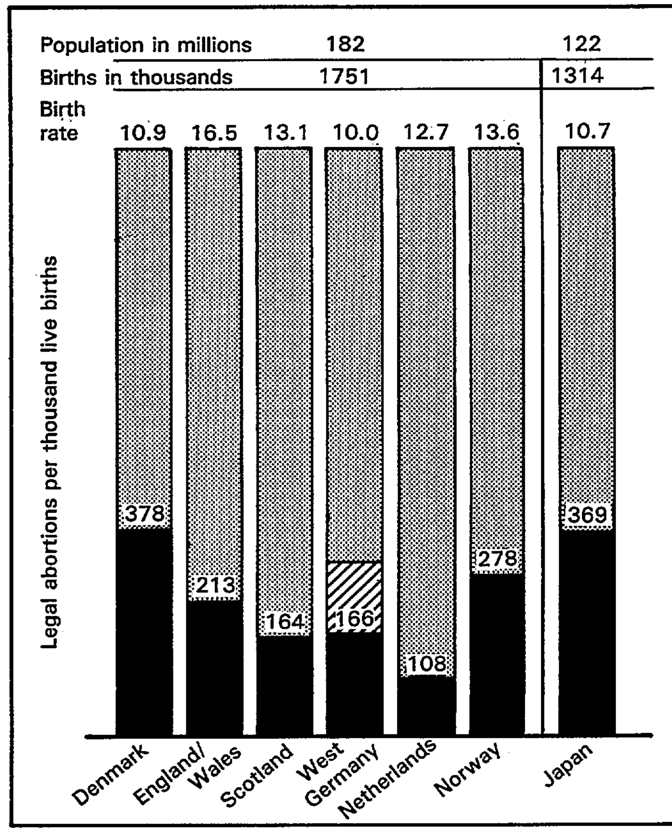

Figure 2. Statistical data on births, birth rate, and legal abortions: selected countries, 1988

Number of births

Country	Midwife	General practitioner	Obstetrician	State	Midwife	General practitioner	Obstetrician
Denmark	56	18.2	169	California	—	—	—
England and Wales	33	29.1	303	Georgia	1,176	1,039	195
Scotland	18	18.1	541	Michigan	—	—	—
West Germany	120	25.0	75	Minnesota	1,589	449	222
Netherland	185	31.0	231	Missouri	—	47	135
Norway	57	19.7	157	North Carolina	—	63	127
Japan	56	—	102	New York	799	79	147

Figure 3. Number of births per midwife, general practitioner, and obstetrician: selected countries and U.S. States, 1988

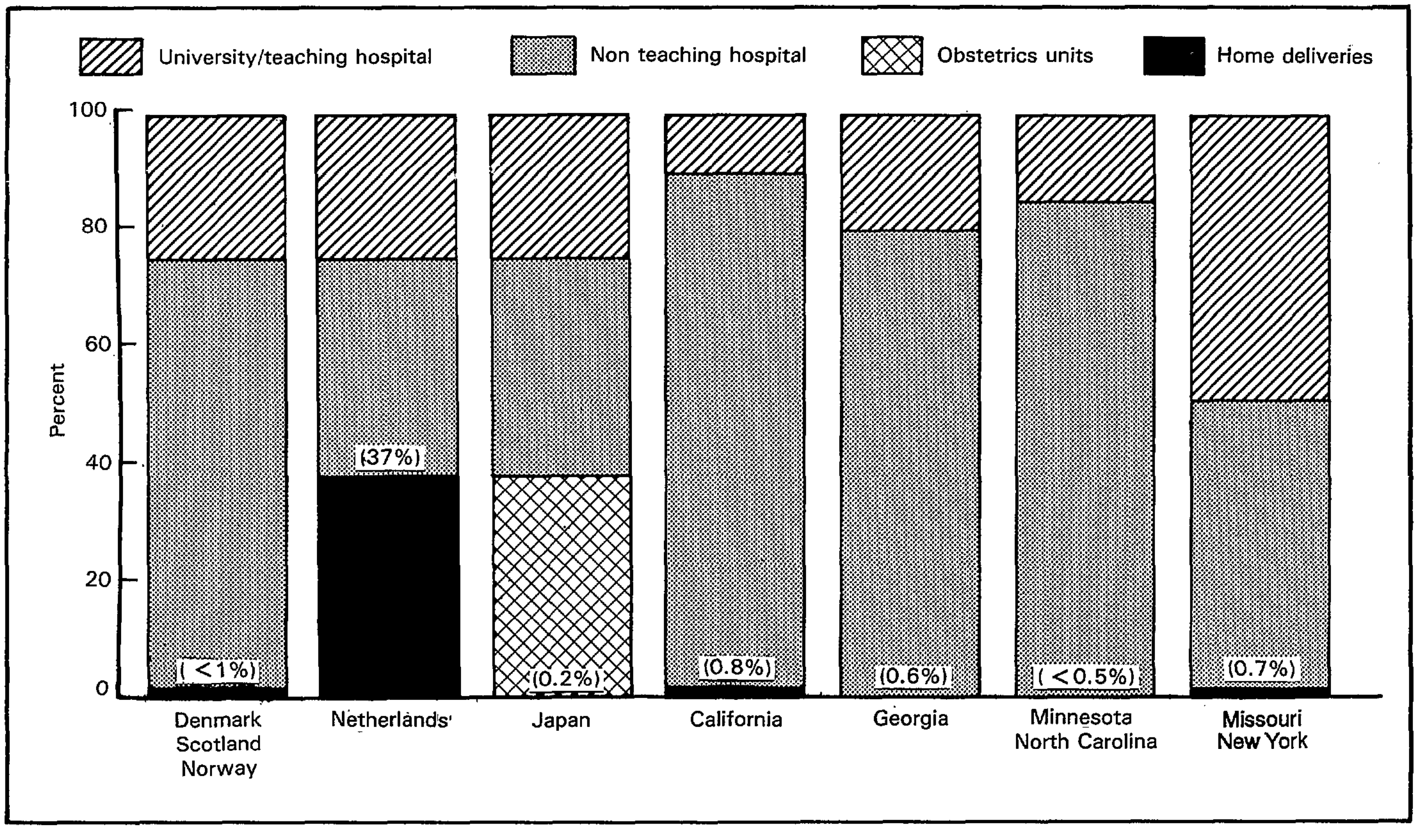

Figure 4. Percent distribution of births by place of delivery, including home deliveries: selected countries and U.S. States, 1988

State	California	Georgia	Michigan	Minnesota	Missouri	North Carolina	New York
Days in hospital	Varied	O 8 hrs	No data	2.8	No data	2	2.8–3.1
Home visit system	?	+	+	+	+	+	+
Who visits	–	–	–	–	–	–	–
When	–	–	–	–	–	–	–
Whom	Risks only	Risks only	Risks only	Risks only	Risks only	Risks only	Risks only
Coverage	?	?	?	10%	?	6.4%	6%

Figure 5. Post partum days in hospital and home visiting systems: selected U.S. States, 1988

Country	Denmark	England and Wales	Scotland	West Germany	Netherlands	Norway	Japan
Days in hospital	3	2+	4:2	6	O 4–12 hrs	5–6	7
Home visit system	?	+	+	+	+	+	+
Who visits	–	MW	–	PHN	MW / RN	–	PHN
When	–	2 wks	10th D	–	1st 2 wks	1 visit	–
Whom				Risk only			
Coverage	100%	100%	100%	?	100%	100%	27%

Figure 6. Post partum days in hospital and home visiting system: selected countries, 1988

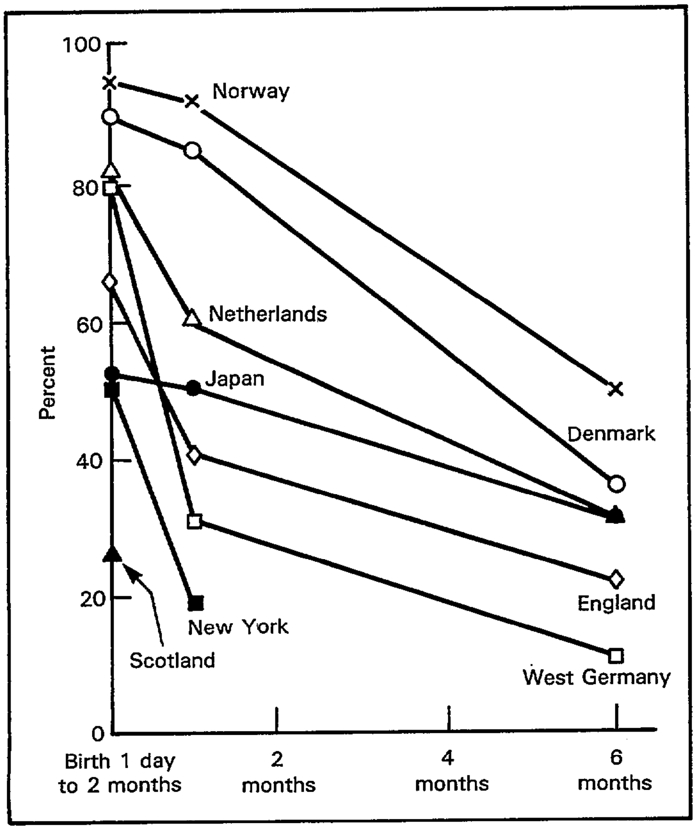

Figure 7. Frequency of breast feeding: selected countries and New York State, 1988

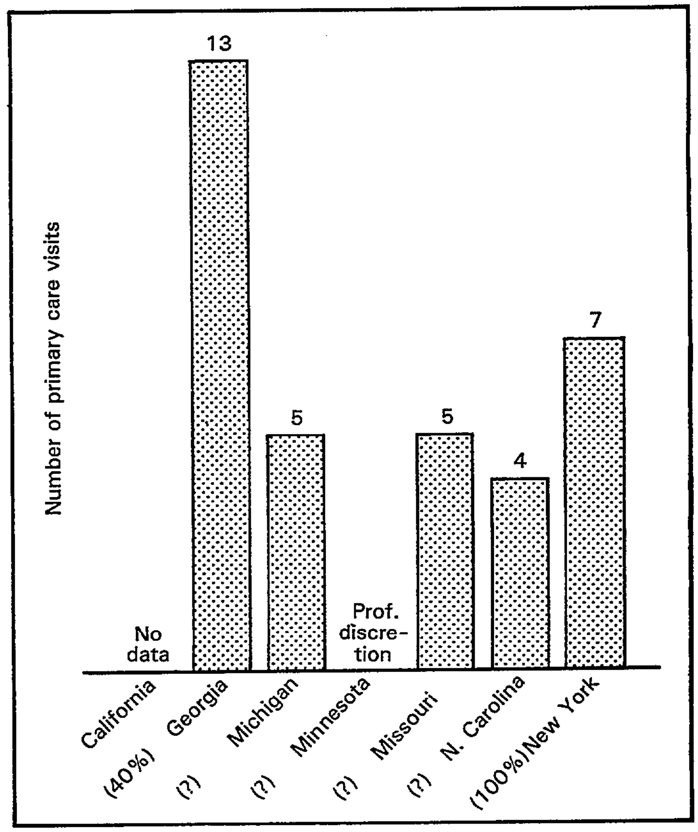

Figure 8. Recommended numbers of primary care visits in first year and their coverage by selected States: United States, 1988

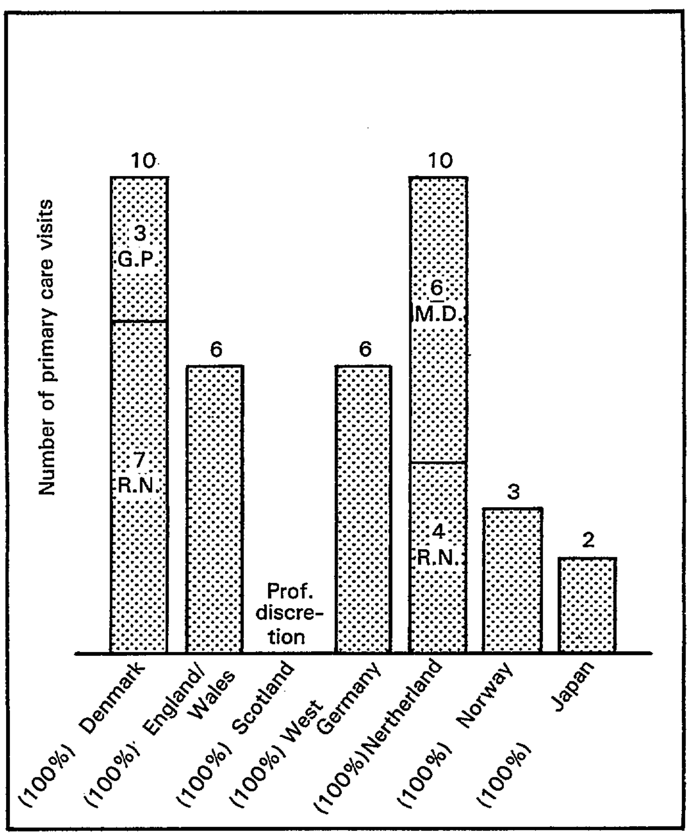

Figure 9. Recommended numbers of primary care visits in first year and their coverage: selected countries, 1988

Country	Silver nitrate Yes	Silver nitrate No	Alternative
Denmark		+	Observ
England and Wales		+	—
Scotland		+	—
West Germany	+	—	—
Netherland		+	Observ
Norway		+	—
Japan		+	Antibiot

State	Silver nitrate Yes	Silver nitrate No	Alternative
California	+		—
Georgia		+	Antibiot
Michigan	(+)		or Antibiot
Minnesota	+	—	—
Missouri	+	—	—
North Carolina	+	+	Antibiot
New York	(+)		or Antibiot

Figure 10. Use of eye drops post partum: selected countries and U.S. States, 1988

	State						
	California	Georgia	Michigan	Minnesota	Missouri	North Carolina	New York
Day care	+	O	+	+	O	+	
Provided by government	All			1.4%			
Employer	Options		'Some'	0.4%			
Private	Available		'Some'	71%			
% cost paid by mother	No data		?	77%		No data	

Figure 11. Day care for infants of working mothers by selected States: United States, 1988

	Country						
	Denmark	England and Wales	Scotland	West Germany	Netherland	Norway	Japan
Day care	+	+	O	+	+	+	+
Provided by government	100%	4%		2%	5%	5%	'Yes'
Employer		Few		?	5%	5%	
Private		23%		?	90%	90%	'Yes'
% cost paid by mother	33%	Varies		30–100%	30–100%	30–100%	No data

Figure 12. Day care for infants of working mothers: selected countries, 1988

	State						
	California	Georgia	Michigan	Minnesota	Missouri	North Carolina	New York
AFP	Elect %?		Select %?	?	?	Elect %?	
PKU	Select %?	>98%	>98%	>98%	Done %?	>98%	>98%
Hypothyroidism	Select %?	>98%	>98%	>98%	Done %?	>98%	>98%
Other defects	—	h	a,c,e,i	a,h	a,h	a,h,i	a,b,d,f,h

a. Galactosemia
b. Histidinemia
c. MSUD
d. Homocystinuria
e. Biotinidase def
f. Branched chain kethonuria
g. Cong ags
h. Hemoglobinopathy
i. Neuroblastoma

Figure 13. Screening for defects in pregnancy and after birth by selected States: United States, 1988

	Country						
	Denmark	England and Wales	Scotland	West Germany	Netherland	Norway	Japan
AFP	Survey	Elect	Elect 90%	Select ?	Select	Elect 'Risk'	Select 1–2%
PKU	>98%	>98%	>98%	>98%	>98%	>98%	>98%
Hypothyroidism	>98%	>98%	>98%	>98%	>98%	>98%	>98%
Other defects	No	No	No	(e)	No	No	a,b,c,d,g,i

a. Galactosemia
b. Histidinemia
c. MSUD
d. Homocystinuria
e. Biotinidase def
f. Branched chain kethonuria
g. Cong ags
h. Hemoglobinopathy
i. Neuroblastoma

Figure 14. Screening for defects in pregnancy and after birth: selected countries, 1988

Assurance of Quality of Perinatal Care

by Hans-Konrad Selbmann, M.D., and John Kiely, Ph.D.

Introduction

Perinatal and infant mortality are often used as main indicators of the quality of a health care delivery system. However, these indicators are influenced by:

- Social and medical risk factors women have before they become pregnant.
- Social and medical risk factors women acquire during their pregnancy, hospital stay, and neonatal phase.
- Social and medical risk factors newborns or infants get at birth or during their first year.
- The quality of the delivered perinatal care.

Throughout much of the world, quality assurance is considered to be part of the health care delivery process. In several countries such as the United States, the Federal Republic of Germany, and Spain specific laws exist making quality assurance activities mandatory for physicians, nurses, and hospitals. Quality assurance has become an important issue in the discussion of health services systems. Possible reasons for this are prevalent expectations among politicians that improvement in quality will reduce costs, change the critical attitude doctors have of their own performance, and also reduce demands from patients for the safety of their care.

The paradigm of quality assurance

Methodologically, the process of problem-oriented quality assurance follows a widely accepted paradigm comprising five steps and a loop (figure 1):

1. Standardized observation of the ongoing process of health care delivery.
2. Identification of problem areas (is it really a problem?) and setting of priorities (which problem should be analyzed first?).
3. Assessment of the quality of medical care by analyzing the problem using available data and knowledge and searching for potential solutions. (Sometimes this step needs a small medical care evaluation study.)
4. Implementation of the most appropriate measures in daily practice (for example, by changing the patient's or the physician's behavior).
5. Evaluation of the measures applied.

If the problem is solved others can then be approached. If the problem still exists another solution must be tried.

The way this paradigm is operationalized varies from country to country. However, the logic of the problem-solving process remains the same. In particular, one must always deal with two issues:

- Statistics alone cannot improve care. The individuals carrying out the quality assurance activities must find a way to help physicians solve the problems identified in steps 1 and 2.
- The last step--evaluating whether the problem has been solved--should never be missed in a quality assurance program.

Structure, process, and outcome of care

The most serious problem in quality assurance is the actual assessment of the quality itself (figure 2). In 1966 Avedis Donabedian (1) suggested that medical care could be conceptualized as consisting of three distinct aspects: structure, process, and outcome. Each of these can be evaluated separately. It makes sense theoretically that a good structure would lead to a good process of care and that together they would culminate in good outcome. However, many studies have shown that this is not always true in practice due to inappropriate criteria for measuring the quality of care. For example, it may be doubtful that the number of prenatal visits is a good measure of the process of prenatal care.

Examples of the structural aspects of quality include the accessibility of the hospital, the 24-hour availability of specific personnel and their professional qualifications, and the existence and condition of technical equipment (ultrasound, fetal monitoring, emergency laboratory, and so forth). The social and legal environments, which cannot be changed by the health care providers, also belong to structural conditions.

Evaluations of the quality of the process of care deal with the actions of the health care provider. Did the provider apply the correct diagnostic or therapeutic measures at the right time and in the right dosage? We have to realize that the patient-physician relationship--a part of the process quality--is very difficult to assess. So very often this area is neglected in quality assurance programs.

Within the scope of quality assurance, outcomes mean the aspects of a patient's health that can causally be attributed to medical care--in a positive or negative way. The rates of avoidable prematurity, disability, or mortality are good measures of outcome quality. That may not be true for the crude perinatal mortality rate.

How should we measure quality?

Usually quality will be measured by comparisons. The three most common types of comparisons are:

1. Comparing the actual care with standards, guidelines, or expectations.
2. Comparisons with past results from the same provider.
3. Comparisons with results from other hospitals or physicians.

In our view, the best choice among these three is the comparison with standards or expectations of good clinical practice, since past results or results from other providers may represent the norm but not the best possible care. The standards themselves--criteria lists and maps, decision algorithms, etc.--are ideally derived from comparative clinical trials and meta-analyses of existing trials or they are the results of different techniques for getting a scientific consensus. In any case, standards defined on a regional or national level should be accepted and if necessary adjusted by the applying physician or hospital.

Relationship between research and quality assurance

Research is a prerequisite of quality assurance since quality assurance can only be done when a medical practice has a solid scientific and empirical basis. Assuming that quality of care is measurable on a linear scale (figure 3) going from no care to maximal care, the optimal care is the best we can achieve with our known standards and under given structural conditions. Diminishing the area of not achievable care is the task of researchers by carrying out epidemiological studies, or health politicians by reallocating resources. To attain achievable care is the task of quality assurance programs (2).

Statistical information and tracers

Statistical information plays an important role during three steps of the quality assurance paradigm: the second step, the problem recognition step, and at the end, the evaluation step.

Statistical analyses of data collected routinely during the delivery of care may be used to present potential problems to obstetricians. Two examples of such problems would be an excessively high cesarean section rate or too many prescriptions for antibiotics. Routinely collected data can also be used to demonstrate the disappearance of problems after the introduction of new standards into the daily care delivery process.

An alternative approach to using hospital data is the use of tracers (figure 4). Tracers (3) are specific health care problems appropriate for assessing the quality of a whole hospital by focusing on only a few aspects of care. Examples of typical tracers in perinatal care are therapy for premature labor, management of breech presentations, indications for cesarean sections, care of premature babies, and care of multiple births.

Hospital-based perinatal surveys

Both alternatives are applied in the German hospital-based Perinatal Surveys (4). In other European countries like Belgium and Italy, similar surveys exist. Last but not least, the well- known Professional Activity Study, based in Ann Arbor, Michigan, uses the same procedure of data collection and presentation.

In the Federal Republic of Germany, more than 820 hospitals, approximately 80 percent of all obstetrical departments in the country, are participating on a voluntary basis in the annual survey. It is expected that the Perinatal Survey will soon become mandatory for all hospitals due to a new law on quality assurance.

For each newborn the hospitals fill in a questionnaire comprising about 100 items about pregnancy, delivery, and neonatal care up to the 7th day. Several programs for personal computers are now available to support the hospitals in collecting valid data, in writing discharge letters to the primary care physician, in preparing birth protocols, and in storing the data on diskettes. Questionnaires and diskettes will then be sent to 1 of 12 perinatal organization centers for a centralized statistical analysis.

The statistics the hospitals get back must be quality related, comprehensive, and understandable. Perhaps most important of all, this information should stimulate doctors to think about the quality of their own performance.

The perinatal organization centers produce statistics for each hospital forming a pyramid of information with hospital profiles at the top followed by different or other statistics. Figure 5 shows a part of the hospital profile for the tracer "Cesarean Section." The form of the distribution of the rates among the hospitals is divided into intervals with 0 being the lowest percent, followed by 10 percent, 25 percent, 50 percent (the median), 75 percent, 90 percent, and 100 percent being the highest. As it can be seen, the cesarean section rate varied from 0 to 34 percent in 1988. The data came from 165 Bavarian hospitals. The median was 15.1 percent and the average 15.2 percent. The X-bars mark the actual values of hospital A. They indicate that although the hospital uses a 100 percent standard indication for cesarean section for breech presentation of primiparae, its overall cesarean section rate is approximately one-half the average rate. One may ask why the profiles do not show ideal target rates, for example, the cesarean section rate should not be greater than 15 percent. The answer is that these target rates are not yet defined due to great fear of the hospitals that lawyers and insurance companies may misinterpret them. Statistics and profiles only offer a hint to the hospitals suggesting problem areas where special activities like medical care evaluations or peer reviews may be necessary.

Although the Perinatal Surveys are only hospital-based and not population-based in the Federal Republic of Germany, 98 percent of all deliveries take place in hospitals. Therefore, it is worthwhile to analyze the collected data. Time trends (figure 6) may be shown to the hospitals. This example shows that there was a notable increase in the proportion of premature births where a pediatrician was present during delivery. The other significant trend among premature births was a substantial increase in the cesarean section rate. This is the type of statistical feedback that may influence the decisionmaking process of obstetricians. Using the same information channels, other information like official health statistics or results of epidemiological studies may also be transferred to the health care providers.

Perinatal and infant mortality rates do not seem to be appropriate indicators for hospital-based quality assurance programs. In addition to the fact that the feedback of long-term outcomes to the hospital is often incomplete, both events are too rare to be handled statistically. The 1 to 11 deceased babies in a hospital with 1,000 births have to be analyzed case by case by an interdisciplinary peer group to distinguish between avoidable and unavoidable mortality.

Conclusion

From our experience, correct information that is easy to understand must be presented to the health care providers in order to stimulate the assurance of quality of perinatal care. The results of sophisticated statistical analyses like standardization or regression methods of any kind will not be accepted in every hospital.

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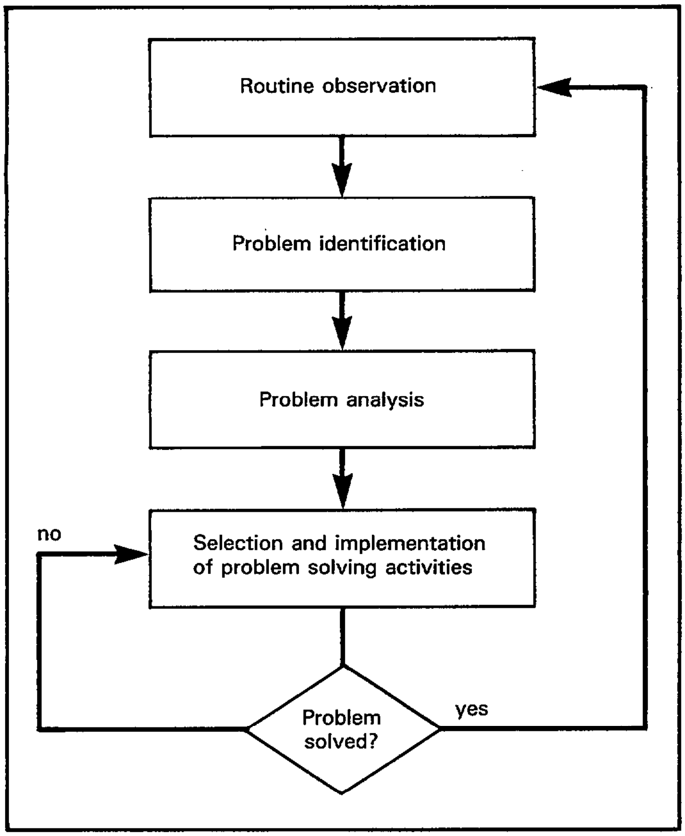

Figure 1. Paradigm of quality assurance

Structure:
- Accessibility of the hospital
- Availability of obstetricians and pediatricians
- Existence and condition of fetal monitoring devices

Process:
- Intensity of prenatal care
- Delivery mode
- Transfer to children's hospital

Outcome:
- Prematurity or small for gestational age
- Disability
- Mortinatality, neonatal or infant mortality

Figure 2. Aspects of quality (Donabedian 1966) and exemplary criteria for assessing the quality of perinatal care

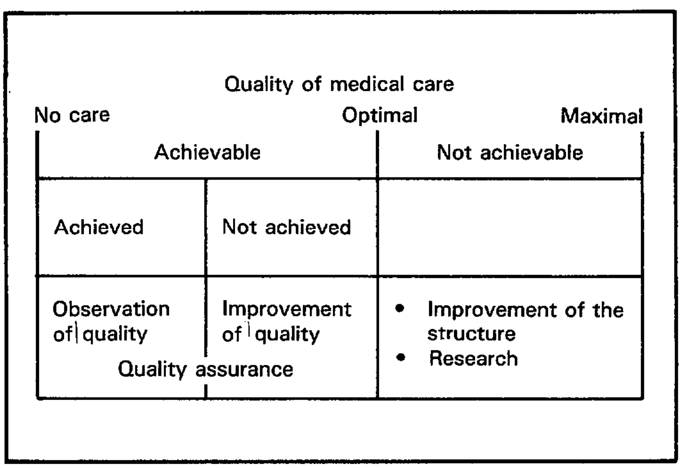

Figure 3. Relationship between quality assurance and research: (mod. Williamson, 1973)

Characteristics:

- Reflecting a major part of activities
- Well defined
- Frequent
- Variation in quality possible
- Standards of care available
- Little influence of nonmedical factors

Typical tracers in perinatal care:
Prenatal care: premature labor, late fetal death
Delivery: breech presentations, caesarean sections
Neonatal care: premature babies, multiple births

Figure 4. Characteristics of tracers: Kessner et al., 1973

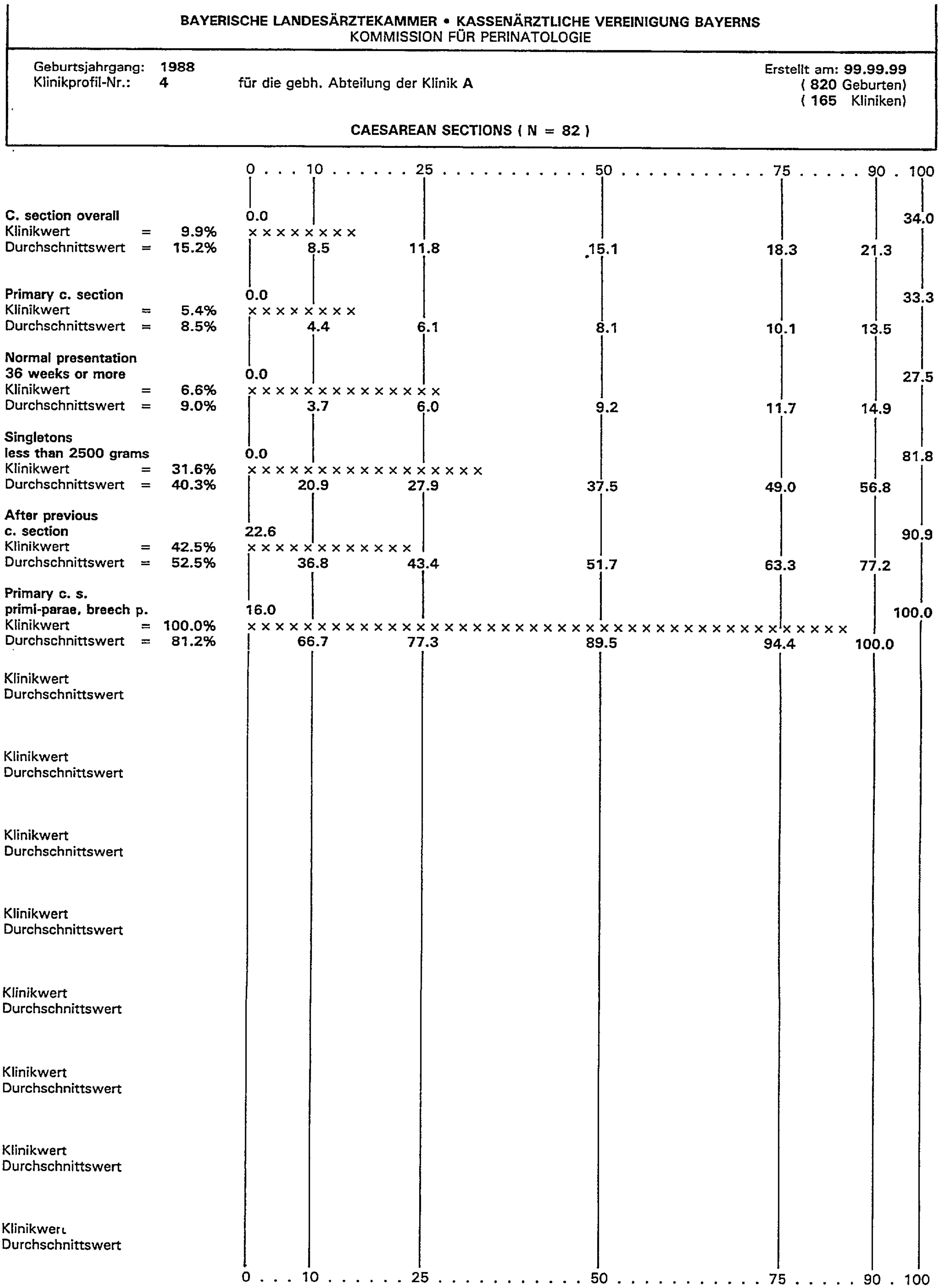

Figure 5. Hospital profile for caesarean section tracer. Baverian Perinatal Survey, Federal Republic of Germany.

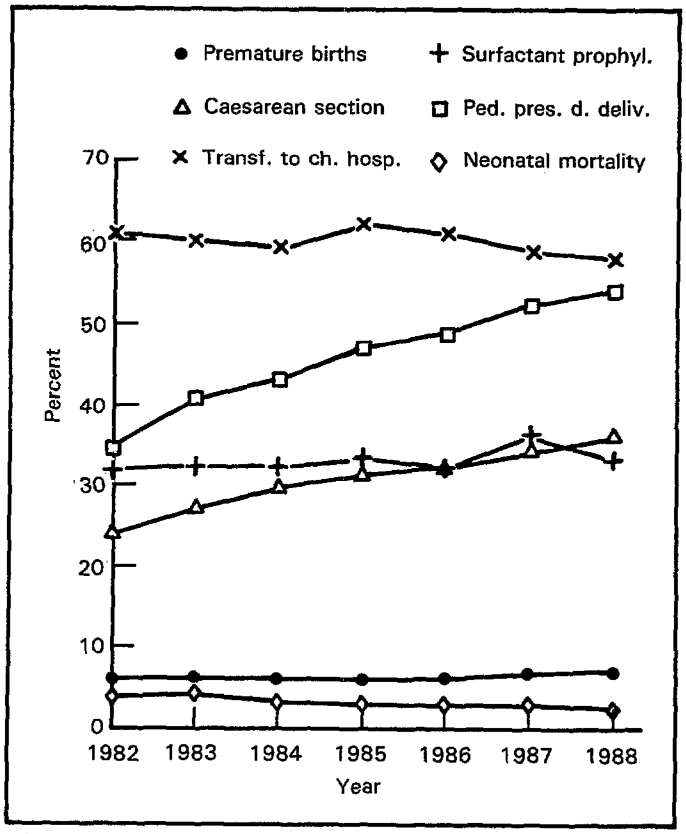

Figure 6. Premature births (less than 37 weeks) by methods of delivery, types of care, and pregnancy outcome: Federal Republic of Germany, 1982–88

Assurance of Quality of Perinatal Care:
The Viewpoint of the Epidemiologist

by John L. Kiely, Ph.D.

I am going to address the issue of perinatal care quality assurance from the viewpoint of an epidemiologist. As an epidemiologist, I am interested in developing tools for people in public health departments who are trying to institute surveillance programs that monitor perinatal care. The units of analyses in such surveillance programs are either hospitals or geographic areas. In other words, I am talking about the situation where a public health official wants to know about particular hospitals or geographic areas where perinatal care might be poor. Methods of perinatal surveillance at the population level are still in their infancy, so most of my discussion will focus on the questions that have to be asked before systems for monitoring care are set up.

Most of the countries represented at this meeting have made contributions to the development of methods of monitoring perinatal care at the population level. In Norway, Leiv Bakketeig and his colleagues have done quite a bit of research on birthweight-specific comparisons of hospitals' perinatal mortality rates (1,2). They have also used regional audits of perinatal deaths as a means of monitoring obstetric and neonatal care (3). Swedish pediatricians have pioneered in the use of population registries of cerebral palsy cases to monitor the effects of changes in perinatal care on neurological morbidity (4,5). The National Perinatal Epidemiology Unit in England has worked on developing perinatal audit as a tool for monitoring care (6), on using early neonatal seizures as a morbidity outcome in comparisons of care (7), and on birthweight-specific and birthweight-standardized comparisons of regional perinatal death rates (8-10). Epidemiologists and obstetricians in Scotland have developed a routine system for monitoring perinatal deaths that includes pediatric and pathological findings (11). In the United States there have been several birthweight-specific and birthweight-standardized comparisons of hospitals' perinatal mortality rates (12-16). In Germany, the Bavarian Perinatal Survey has been perhaps the most ambitious attempt at quality assurance of obstetric care for an entire region, especially since Dr. Selbmann and his colleagues have attempted to "feed back" data on structure and process, as well as outcome, to the participating obstetric departments (17).

Most attempts at perinatal care surveillance have been outcome-based. To be more specific, most such attempts have focused on perinatal deaths. This is unfortunate, since we are also interested in the structure and process of care. It is also inevitable, since information on perinatal deaths can be extracted from most vital registration systems, whereas information on structure and process can usually be obtained only from special studies.

What is the proper outcome for evaluating perinatal care at the population level?

This is the first question that should be asked by anyone who wishes to perform outcome-based surveillance of perinatal care. In the literature on this subject, five outcomes have been suggested as appropriate measures of the impact of care:

- Perinatal mortality
- Neonatal mortality
- Maternal morbidity
- Neonatal morbidity
- Long-term developmental outcomes

One of the first questions that comes up in discussions of the validity of mortality as an outcome measure is whether we should use perinatal mortality or neonatal mortality. In other words, what are the advantages and disadvantages of including late fetal deaths when we evaluate outcome?

There are some advantages to using perinatal mortality as an outcome and including late fetal deaths (stillbirths). First, it has been argued that late fetal deaths are more influenced by the effectiveness of third-trimester antepartum obstetric procedures than are neonatal deaths. Second, late fetal deaths may be more sensitive to prenatal care. Third, if perinatal mortality is used as an outcome, this avoids problems in comparing neonatal mortality rates due to different approaches to deciding whether a birth is a "live" birth or not.

Nevertheless, there are also disadvantages to including late fetal deaths as part of an outcome measure. We know that in the United States there is under-reporting of fetal deaths, and that the degree of under-reporting is different in different States, in different hospitals, and in different population groups. Another problem with using fetal death records is that a relatively high proportion of these records have missing or unknown birth weights. This makes it difficult to carry out birthweight-specific or birthweight-adjusted analyses when perinatal mortality is used as the outcome.

Given the deficiencies in reporting of late fetal deaths, I would make the following recommendations for outcome-based surveillance of perinatal care in the United States. First, neonatal death should be used as the mortality outcome in comparisons of hospitals or geographic areas. Second, State and local health departments should encourage more complete collection of information on late fetal deaths. This might pave the way toward valid perinatal mortality statistics in the future. Third, States that have not already done so should move toward reporting of all fetal losses, with no gestational age cutoff. The rationale for this recommendation comes from data for the six States that already require reporting of all fetal deaths. In these States, according to Kleinman, (18) the 1980 fetal death rate for whites (above 20 weeks gestation) was 33 percent above the comparable U.S. rate while the neonatal mortality rate in these States was only 3 percent above the comparable U.S. rate. Thus, it appears that registration completeness of fetal deaths of 20 weeks or more gestation is greater in these six States due to more complete reporting around 20 weeks gestation.

If we assume, therefore, that we are using neonatal death as the mortality outcome for perinatal surveillance, there are several questions that should be discussed before implementing a monitoring system:

1. Should multiple births be excluded?
2. Should the period of "neonatal" death be extended to the second or third month after birth? The rationale for this would be that neonatal intensive care results in longer survival for many sick newborns who end up dying in the postneonatal period.
3. Should there be a lowest birthweight cutoff? For example, should all births with weights under 500 grams be excluded?
4. Should congenital anomaly deaths be excluded?

With regard to this last question, the opinion of clinicians and others who speak from a biological point of view is that congenital anomaly deaths should always be excluded from any comparisons of hospitals or geographic areas because they are not affected by medical care. The problem with excluding congenital anomaly deaths, however, is that the ability to diagnose congenital anomalies in deaths differs across hospitals and across geographic areas. For example, the proportion of neonatal deaths due to congenital anomalies will generally be reported as higher in hospitals with high autopsy rates. Thus, when performing outcome-based monitoring of perinatal care, my recommendation is that congenital anomaly deaths should not be excluded from the numerator of death rates.

Birthweight standardization

Birthweight standardization (or adjustment) has generally been conceived as a simple method of adjusting for "case-mix." The theory is that social, economic, and behavioral factors mostly affect the birthweight distribution, and that weight-specific mortality is a reflection of perinatal medical care (figure 1). This theory is a simplification and there are some problems with it. It does, however, have some validity and it is the basis for comparisons of birthweight-specific mortality rates and birthweight-adjusted mortality rates.

One of the first questions that comes up in discussions of birthweight adjustment is whether it is important to adjust for other variables, such as race, sex, plurality, gestational age, or parity. In his attempts to measure the effectiveness of perinatal care in California, Williams (12,19) calculates an Indirectly Standardized Mortality Ratio (SMR) that adjusts for birth weight, ethnicity (white, black, and Spanish), sex, and plurality. In the construction of a perinatal "health care performance indicator" for use in Great Britain, Knox, Lancashire, and Armstrong (20) adjusted for birth weight, ethnicity, and parity. (They excluded multiple births.) There is a good clinical argument for adjusting for gestational age, but the completeness and quality of the gestation information on vital certificates is questionable (21).

There are some serious problems with birthweight standardization, and it is debatable whether the construction of a single summary measure for each hospital or for each geographic area can provide a valid index for comparisons. Evaluators of perinatal care should consider the following deficiencies of birthweight adjustment:

1. Standardization is most applicable when the populations being compared have the same relative risk (risk relative to a standard population) at each birth weight (21,22). However, for a given hospital or geographic area, weight-specific mortality ratios (relative risks) may differ across weight categories. In other words, in a group of hospitals or geographic areas, mortality patterns in babies with birth weights ≥2500 grams may not correlate with mortality patterns in low birthweight (<2500 grams) babies.
2. For a given hospital or area, the quality of medical care may differ across birthweight categories. Thus, it is possible that a hospital could concentrate on special care for tiny prematures, but be less prepared to care for sick full-term infants.
3. In the theory behind birthweight standardization, it is assumed that socioeconomic factors have little effect on birthweight-specific mortality. However, there is evidence that this assumption is not true. In babies with birth weights ≥2500 grams, mortality is affected by factors such as social class, maternal age, and parity (23-25).
4. Wilcox and Russell (26,27) have shown that standardizing for birth weight is biased against populations with heavier birth weights. This problem is dealt with in greater detail in a paper by Kleinman in these proceedings.[1]

If the decision is made to use birthweight standardization in a perinatal surveillance system, several decisions have to be made

- Whether to use direct or indirect standardization. (See reference 22, pp. 237-55.)
- What to use as the standard population.
- The degree of detail needed for birth weight categories.

For example, should one use 250-gram categories or 500-gram categories? This issue has been discussed by Madans et al. (13) and by Kleinman (21).

- Whether to analyze races separately.
- How to deal with the statistical instability of estimates. When calculating a standardized rate or SMR for a hospital or a small geographic area, the standard error around the estimate will often be large. This has to be taken into account in any attempt to monitor mortality rates. Kleinman (21) provides

[1]Kleinman, J. Implications of differences in birthweight distribution for comparisons of birthweight-specific mortality.

a practical method of calculating the standard error of the SMR. (See reference 21, equation 3, p. 148.) Williams (19) gives a different equation for the standard error of the SMR and suggests using this standard error in a Bayesian procedure to "shrink" individual SMR's toward the weighted mean of all SMR's in the analysis (which is designed to equal 1.00 or 100). Williams calls the result a "Bayes-adjusted Standardized Perinatal Mortality Ratio." (See reference 19, pp. 567-8.)

Obviously there are many factors to consider before using birthweight adjustment to compare neonatal mortality rates. I would make the following recommendations for implementing a neonatal mortality surveillance system at the population level:

1. Perform separate birthweight-adjusted evaluations above and below 2500 grams, resulting in two standardized indices.
2. In the United States: Perform separate evaluations for black and white births. The birthweight distributions and weight-specific mortality rates of blacks and whites are so disparate that they must be analyzed separately (21).
3. Exclude all births under 500 grams. This circumvents problems due to variation in reporting of live births weighing less than 500 grams.
4. Compare weight-specific rates whenever possible, since this is more informative than comparing adjusted rates.

What about measures of morbidity?

Obstetricians and neonatologists in industrialized countries are often more interested in morbidity than in mortality. So the question comes up: What morbidity outcomes could be used as measures of the effect of perinatal care on the population? Some suggestions have been made in the literature:

1. **Early neonatal seizures.** Dennis and Chalmers (7) have proposed that the frequency of neonatal convulsions occurring in full-term infants within 48 hours of birth may constitute an indicator of the quality of perinatal care.
2. **Post-asphyxial encephalopathy.** As an indicator of perinatal care, Field et al. (28) have suggested determining the number of newborns suffering grades II and III (significant) post-asphyxial encephalopathy (29). This syndrome can be easily diagnosed, since the occurrence of fits or persistent neurological abnormality is a minimum criteria for the diagnosis.
3. **Cerebral palsy.** During the 1970's, there was hope that registries of children with cerebral palsy could be used to monitor the effect of perinatal care on morbidity. Several investigators suggested that decreases in the rate of cerebral palsy, and especially in the rate of spastic diplegia, would indicate that the quality of care of high-risk infants was improving (4,30). The recent literature suggests that cerebral palsy is not very useful as an index of morbidity associated with perinatal care. There are two reasons for this. First, during the period when there were marked declines in perinatal mortality in much of the industrialized world, there was no consistent change in the cerebral palsy rate. Some population registries reported decreases, some reported increases, and in some the rate remained stationary (5,6, 31-33). Second, recent epidemiological studies have found little or no relationship between perinatal factors (such as asphyxia) and cerebral palsy (34,35).

Conclusion

I have been discussing attempts to develop outcome measures at the population level for monitoring or surveillance of perinatal care. This field is still in its infancy and advances are being made by trial and error.

Ultimately, the goal of these activities is to get to the point where we can "feed back" information to individual clinicians and they can use it to improve their performance.

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Medical Care and Service in Relation to Observed Differences in Outcomes in Denmark

by Finn Børlum Kristensen, M.D., Ph.D.

This paper addresses the question of observed differences in stillbirth rates and neonatal mortality between regions and between social groups in Denmark in relation to aspects of prenatal care.

Materials and methods

The study was based on the Danish Medical Birth Register (MBR), which covers all births to residents in Denmark (1). Through linkage between the national birth registration and the registration of causes of deaths, information on stillbirths and mortality in the first year of life was routinely recorded in the MBR. The material comprised 263,322 singleton births (263,041 with gestational age recorded) in the 1983-87 birth cohorts.

The MBR included information on the number of prenatal visits as the only registered information on prenatal care (1). The National Board of Health issues a recommended scheme of prenatal visits (2). On the basis of the recommended scheme and the length of gestation, an adequate number of visits can be defined that can be used for analysis of adequacy of the number of prenatal care visits.

Figure 1 shows that Denmark was divided into three large regions. A comparison was made between stillbirths and infant deaths among the three regions with Copenhagen and the eastern islands serving as baseline. The estimated risk ratio (RR) of Middle and Northern Jutland was 1.12 and differed significantly from the reference RR of 1 of Copenhagen and the eastern islands. This difference may to some extent be due to differences in prenatal intrapartum and pediatric care. Results of analyses of social differences in birth outcomes in Denmark were presented in another paper from this Symposium.[1]

Table 1 depicts a matrix for the definition of six adequacy groups. The matrix took gestational age at birth into account when determining the degree of adequacy of the number of visits in relation to the recommended scheme. The coding in the MBR did not allow the separation of cases with 0 visits recorded from cases where information was simply lacking. Group 1 included women with no visits recorded. Group 2 was a very mixed group. It included women who had made only one visit before delivery in week 31 and women who had made 6 visits before delivery after week 39. Groups 3, 4, and 5 ran parallel in the matrix and described different degrees of accordance with the recommended scheme. As outlined in the scheme, only women in groups 4 and above received an adequate number of visits.

Age, parity, county of residence, and social group are potential confounders of the association between each of them and birth outcomes. In order to control for confounding, a multiplicative Poisson model was used in the analysis (3,4).

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[1]Kristensen, F. Social gradients in birth outcomes in Denmark 1983-87.

Results

The following section will concentrate on prenatal care. Prenatal care in Denmark is shared among general practitioners, midwives, and maternity departments. The National Board of Health issues recommendations to the counties on the content of prenatal care (2). The counties are responsible for providing free prenatal and intrapartum care and developing their own prenatal programs on the basis of a recommended schedule from the National Board of Health. Table 2 shows the proposed schedule of prenatal visits up to week 40. It includes three visits to the general practitioner, a minimum of five visits to the midwife with an additional two visits as required, and one visit to a hospital department during weeks 16-18. This adds up to a recommended minimum of nine visits within the standard program irrespective of parity or risk. The pregnant woman can contact her general practitioner at any time, as is the case with other health problems, and she can be referred for extra visits in the outpatient clinic of the maternity department.

Figure 2 shows that the observed and estimated RR of stillbirth or neonatal death varied among the adequacy groups. The estimates on the basis of the model, which allowed control for age, parity, county of residence, and social group did not differ from the observed RRs. No visits or information recorded was associated with a high RR of death in group 1. This group consisted of 3,779 births and 133 deaths. Group 2 is a small, very mixed group and had an intermediate RR. It consisted of 4,847 births and 70 deaths. The RR decreased from 4 in group 3 with 9,886 births to 1 in group 5 with 103,444 births. Group 6 consisted of 88,573 births and had the same RR as group 5.

The differences in mortality among adequacy groups, regions, and social groups in Denmark led to the analysis of variations in adequacy of visits and mortality. Figure 3 depicts the frequency of no visits recorded and the frequency of an inadequate number of visits recorded in each of the 16 Danish counties. Inadequate number of visits was most frequent in the eastern parts of Denmark (to the left in the figure), with Copenhagen Municipality having a relatively high frequency of inadequate number of visits. Ribe County in the southwest had the lowest frequency--only one-third that of Copenhagen.

Figure 4 shows that an inadequate number of visits was most frequent in social group 4, which mainly consisted of babies with fathers who are unskilled and do manual labor. In group 2, which is a higher social group, an inadequate number of visits was only one-half as frequent.

Figure 5 shows that when the six levels of prenatal care adequacy were included in the multiplicative model, some changes occurred in estimated RRs of stillbirth or neonatal death in the 16 counties. This may indicate some influence of differences in prenatal care utilization patterns on outcomes in the counties. The metropolitan region (to the left in figure 5), which had the highest frequency of inadequate care, had an even lower estimated RR of stillbirth or neonatal death when pattern of prenatal care was taken into consideration. The opposite was the case with most of the western counties (to the right in figure 5), which had higher RRs when pattern of prenatal visits was included in the model.

Figure 6 shows that estimates of RR of stillbirth or neonatal death in the social groups changed very little when pattern of prenatal visits was introduced into the statistical model. This suggests that variation in utilization of prenatal visits between social groups scarcely accounts for any of the differences in mortality that were found between social groups.

Discussion

No clear-cut trend in mortality as a function of adequacy of the number of prenatal visits was found in figure 2. Group 2 included many babies born at or after term in the lower left corner of the matrix. This may have contributed to the "anomalous" RR of group 2. The number of visits is the only aspect of prenatal care that is recorded in the MBR. Many factors that may be associated with utilization of prenatal care may influence outcomes. Compliance with the prenatal care program may be strongly associated with a healthy lifestyle, and a lack of compliance may be associated with smoking and other inappropriate lifestyle elements. Because of these and other reservations, one should be very cautious about using the demonstrated association between inadequate care and mortality to infer an association between preventive and therapeutic measures in prenatal care and mortality.

Possibly, analysis of the content and quality of prenatal care visits and its association with outcomes would be more productive than nonexperimental analyses of the number of visits. More information on quality of prenatal care is strongly needed.

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Table 1. Matrix for the definition of 6 "adequacy" groups based on number of prenatal visits in relation to gestational age

Length of gestation (weeks)	Number of prenatal visits													
	0	1	2	3	4	5	6	7	8	9	10	11	12	13+
- 31	1	2	3	3	4	4	5	5	6	6	6	6	6	6
32 - 34	1	2	2	3	3	4	4	5	5	6	6	6	6	6
35 - 36	1	2	2	2	3	3	4	4	5	5	6	6	6	6
37	1	2	2	2	2	3	3	4	4	5	5	6	6	6
38 - 39	1	2	2	2	2	2	3	3	4	4	5	5	6	6
40 -	1	2	2	2	2	2	2	3	3	4	4	5	5	6

Table 2. Prenatal care program as outlined by the National Board of Health

	General Practice	Center of midwifery		Maternity department
		Recommended	Need	
Week of visit	E* 26 35	12 30 33 38 39	36 40	16-18

*Earliest week possible.

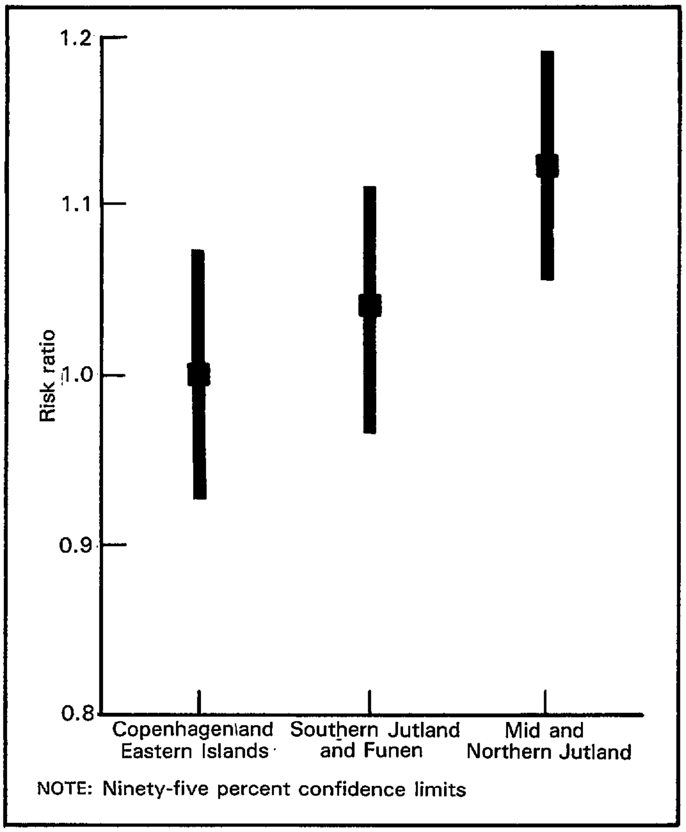

Figure 1. Risk ratio of stillbirth or infant death in three regions: Denmark, 1983–87

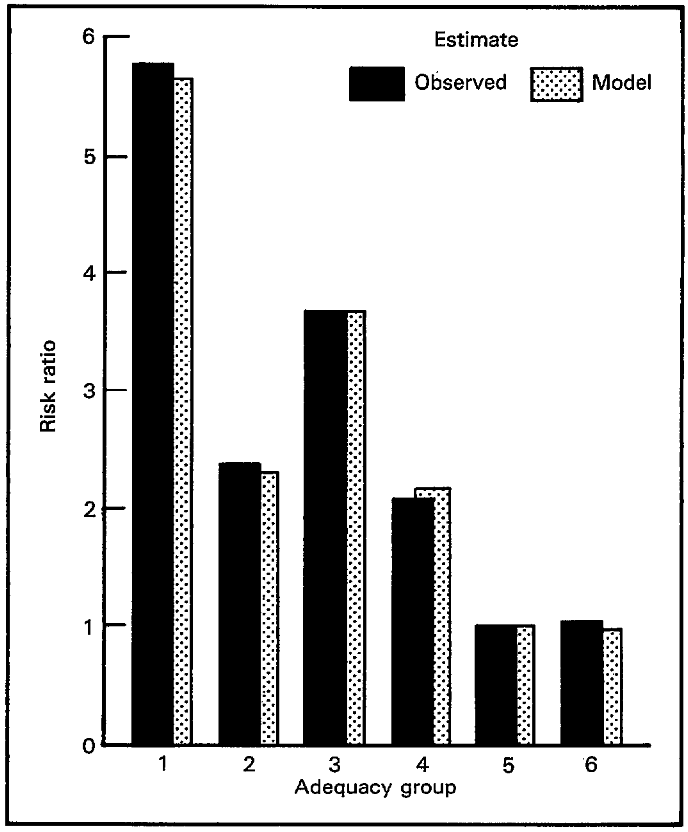

Figure 2. Association between adequacy of number of visits and stillbirth or neonatal death in singletons with known gestational age: Denmark, 1983–87

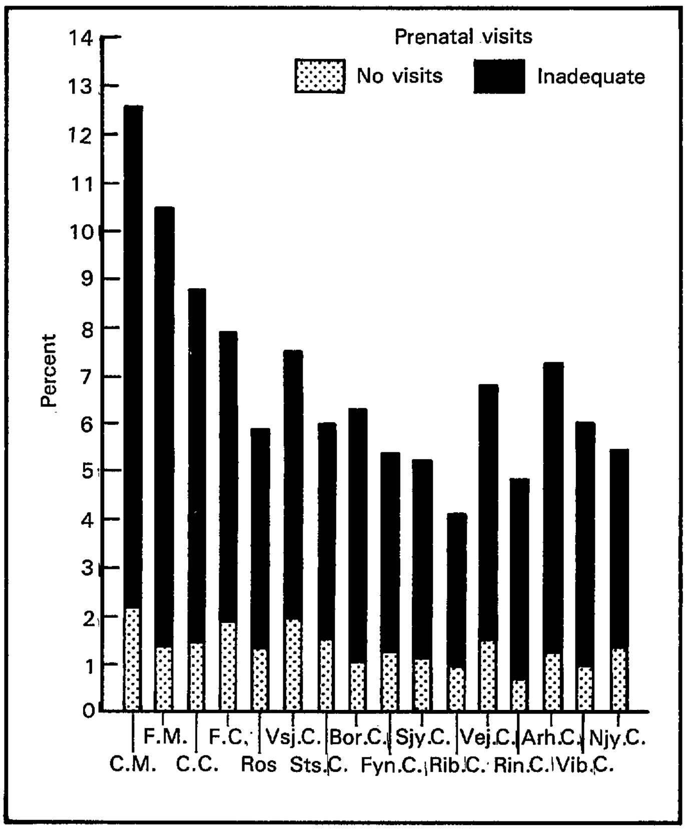

Figure 3. Percent of women with inadequate number of prenatal visits by county: Denmark, 1983–87

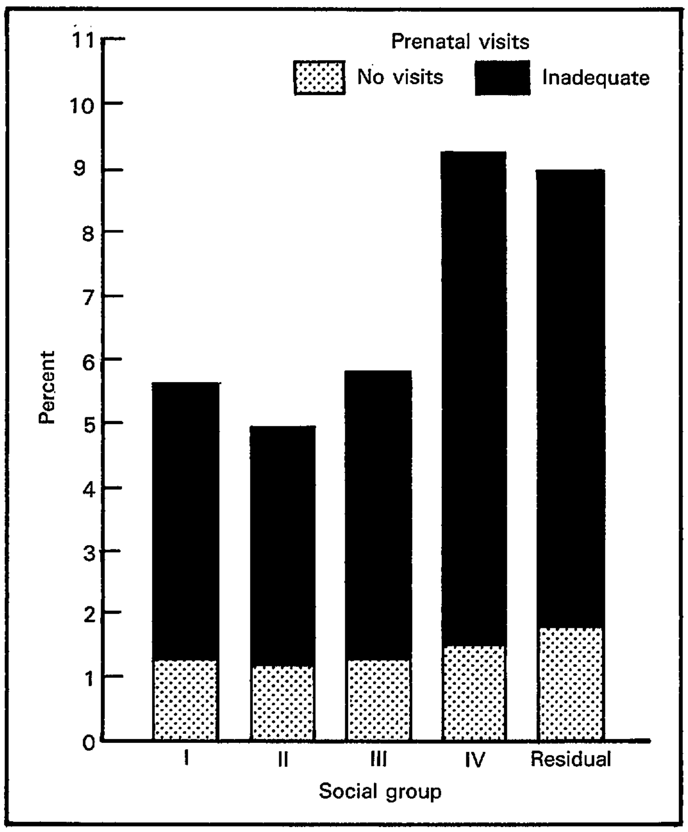

Figure 4. Percent of women with inadequate number of prenatal visits by social groups: Denmark, 1983–87

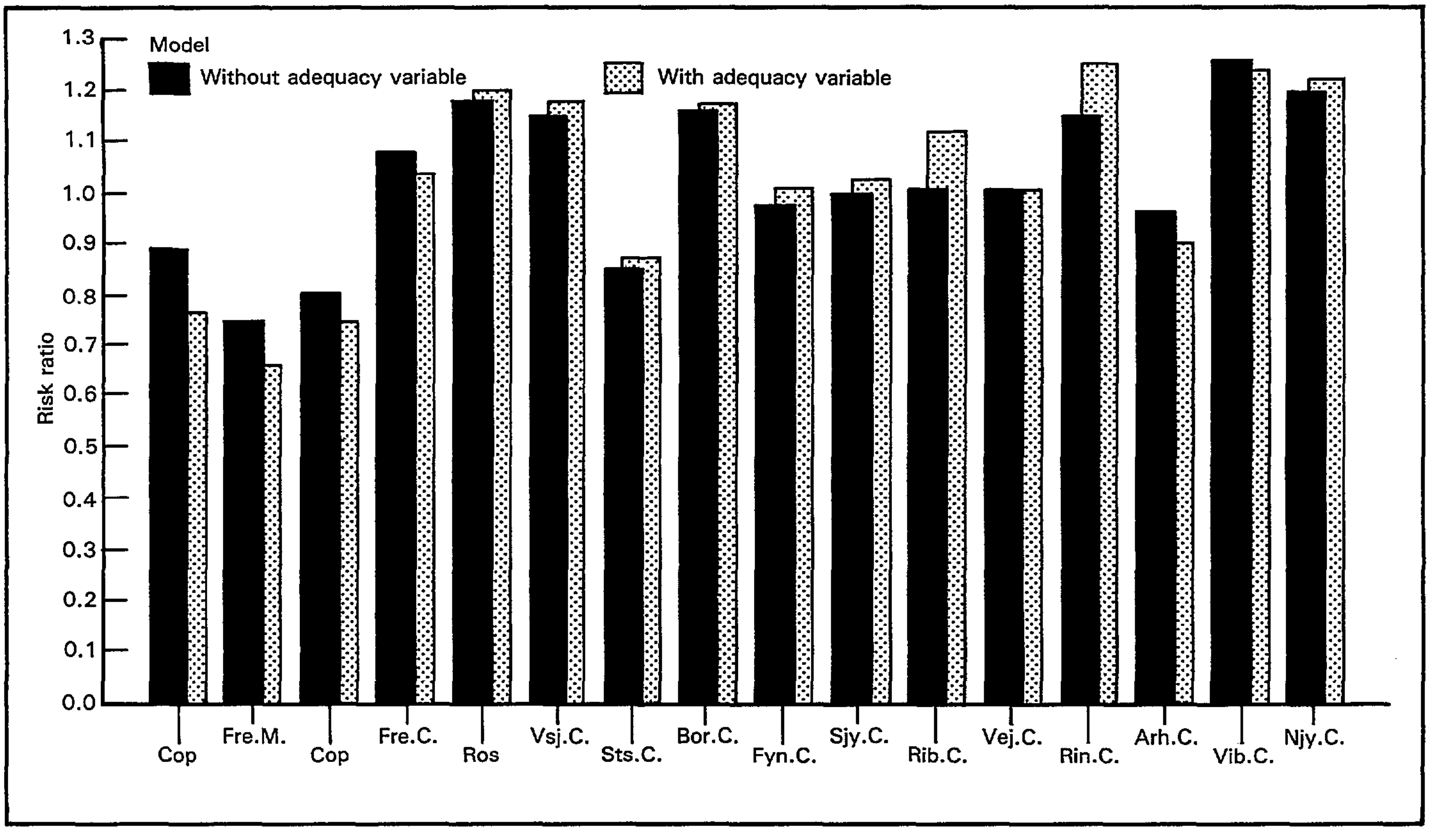

Figure 5. Risk ratio of stillbirth or neonatal death by county: Denmark, 1983–87

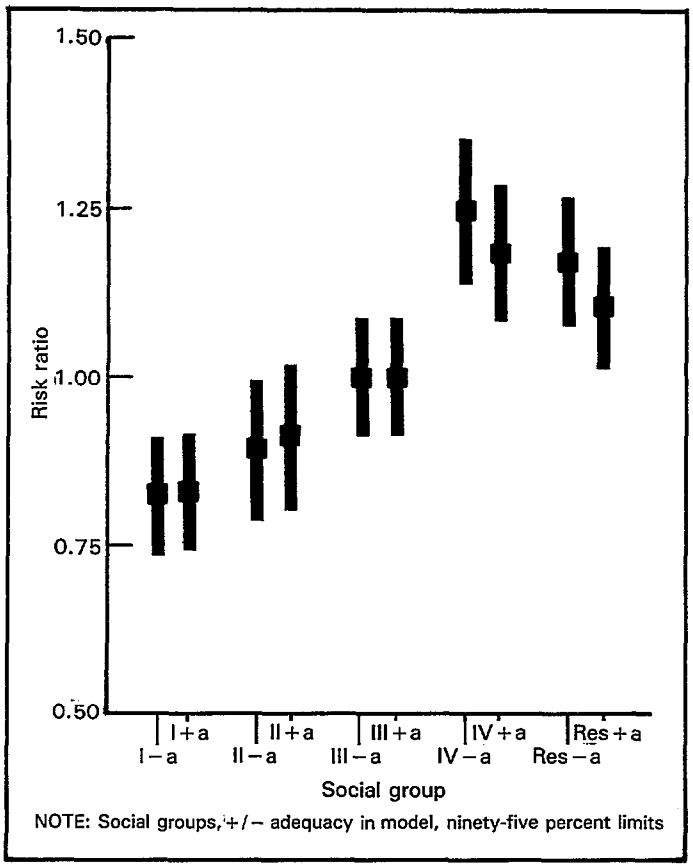

Figure 6. Risk ratio of stillbirth and neonatal death by social groups: Denmark, 1983–87

Medical Care and Services in Relation to Observed Differences in Outcome: Antenatal Care in the East End of Glasgow

by Gillian McIlwaine, M.D.

Thank you very much for inviting me to take part in this important international symposium on perinatal and infant mortality.

In the Western World, the death of a mother or her infant during the perinatal period is now fortunately a rare event, and crude rates have very little meaning. It was not always so. One of my heroes was Sir Dugald Baird, a famous Scottish obstetrician who started his career in the hospital where I am now based--the Glasgow Royal Maternity Hospital--which serves the women of the east end of Glasgow (said to be one of the most deprived areas of Europe).

In the 1920's, many women died from hemorrhaging during pregnancy and childbirth. I am told that in 1930 Baird succeeded in persuading the Board of Governors to give these women blood from public volunteers. The result was dramatic--only 4 women died from hemorrhaging in the following year instead of the expected 100 women.

The effects of medical care on obstetric practice were more easily demonstrated in those days when mortality rates were high. It is now more difficult, but what I hope to do is to mention briefly recent Scottish antenatal studies, and show how they have influenced practice by describing the current services offered to the women of the east end of Glasgow. Glasgow has a population of around one million and is the largest city in Scotland. It made its wealth from shipbuilding and heavy industry, much of which has now gone, leaving much unemployment and social disadvantage.

In Britain, antenatal care is provided in the hospital by obstetricians and midwives and in the community by general practitioners. Theoretically, care is shared, but in reality there is often little communication between these groups. The pattern of care was laid down by the Ministry of Health in 1929 (1) and in many places has not changed. There are on average 12 to 14 visits made up of monthly visits to 28 weeks of pregnancy, fortnightly visits to 36 weeks, and weekly until delivery.

Two Scottish studies have recently questioned the relevance of providing early 20th century care for the women of today. Hall and Chng (2), in a retrospective review of the case records of 2,184 women, concluded that "our investigation has demonstrated some of the deficiencies in a mass approach to antenatal screening, which precludes the consideration of the needs of each pregnant woman." They recommended a reduced number of routine visits, which would retain the benefits of antenatal care while allowing more time for first visits and for those with special needs.

At the same time in Edinburgh, Parboosingh and Kerr (3) developed a community-based antenatal program tailored to the needs of the individual. Women with no complications had fewer visits, for example, four visits for a primigravida and three visits for a multigravida. The results of the study were dramatic when compared with the findings of a study done 5 years ago when the care was hospital-based. The default rate was reduced from 16 percent to 1 percent; attendance before 16 weeks gestation rose from 63 percent to 95 percent, and the number of antenatal inpatient days per woman fell from 0.5 to 0.01. The perinatal mortality rate, which was higher than the national average at the beginning of the research period, fell to one-half the national average thereafter.

Shortly after these results were published, a working group of the Royal College of Obstetricians and Gynecologists recommended in its report that: antenatal care centered in the community should be developed more widely; midwives should provide care as part of the obstetrician and general practitioner team; and the pattern of care should be tailored to the needs of each woman (4).

A study done in Glasgow demonstrated that many women wished to attend community antenatal clinics (5). The results of a randomized trial of delivery of care in either the hospital or in the community, with the same team providing care in both settings, showed that there were no differences in obstetric outcomes. On the other hand, the women attending the community clinic found it more convenient and cheaper in terms of travel costs. They also saw fewer clinic attendants (6).

That was the background on which an integrated pattern of care was being planned for the women of the East end of Glasgow. As I have said, the area is characterized by high unemployment (27 percent overall with some areas having rates as high as 70 percent) and considerable social deprivation. The opening of eight health centers--where groups of general practitioners were based--made it possible to develop an integrated service, with midwives from the maternity hospital working in the community with general practitioners and one consultant from the hospital linking with one health center, thus making it possible for integrated patterns of care to develop. Women received care either at the hospital or in the community.

There are on average 2,500 pregnancies each year in the Eastern District, and information was obtained from a random sample of 1,848 area residents delivering at the Royal Maternity Hospital. Of the 911 primigravida, only 48 percent were married, 43 percent shared a house with someone other than their partner (frequently parents), and 53 percent smoked, a fifth of whom smoked more than 20 cigarettes per day. Of these women, 88 percent left school at or before the minimum leaving age and 42 percent were entirely dependent on State benefits as their sole source of income (7).

Susan Williams, a research midwife, recently reviewed the community antenatal service in the East end (8). She obtained information from 583 women, a subset of the study mentioned above, who booked during the middle of the study period. The basic characteristics of these women did not differ from those of the total study population. Of this group, 25 percent received all of their care at the hospital. The remainder received the majority of their care in the community: midwife only clinics (30 percent); general practitioner only clinics (35 percent); general practitioner plus midwife (18 percent); and obstetrician plus midwife (17 percent).

The outcomes looked at as well as perinatal mortality were accessibility, continuity of care, and satisfaction with the service. The vast majority of women found the clinics accessible, but when comparing traveling and waiting time, the community service was more satisfactory. Women also saw fewer clinic attendants in the community. When views about satisfaction were considered, no difference was found between those attending the hospital and those attending the community clinics. While 76 percent of women found the service satisfactory, only 49 percent felt their questions had been answered. The vast majority of women felt that the birth and postnatal stay were better or as expected. Women were equally divided as to whether they preferred hospital or community care.

The crude perinatal mortality rate has improved dramatically in both the Eastern District and the rest of the City. Between 1975 and 1979 the Eastern District rate was 22.1 per 1,000 compared with 18.5; during the next 5 years when the community program began, the rate fell to 13.8 compared with 11.2; and for the last few years, it has been 10.6 compared with 9.8 per 1,000 total births for the rest of the City. Considering that the low birthweight rate is 10 percent and the illegitimacy rate is 45 percent, we must be pleased with the improvement but we are not in a position to say how much was a result of the community program. We can state, however, that these studies have highlighted a need for a flexible approach to the delivery of care, as well as the importance of an integrated service and the opportunity for choice for the woman.

I am very conscious also that we do not have definite answers about the benefit of antenatal care. Cochrane has described antenatal care as a multiphasic screening program that has never been evaluated (9).

To answer the questions, Who should provide antenatal care? Where? How often? and What are the benefits? a randomized controlled trial is required. In order to obtain a large enough sample, it would have to be a multicenter study. Such a study has been discussed at a previous ICE Working Group. Following that meeting, I queried all the obstetricians (126) in Scotland about such a proposal. Over 90 percent responded enthusiastically, but it became clear that we do not know what the current service comprises. A multicenter descriptive study, funded by the Chief Scientist's Organization of the Scottish Home and Health Department, is therefore taking place at the moment and is likely to be the first phase, to be followed in the near future by a randomized trial.

This International Collaborative Effort has not only made it possible for statistical comparisons to be made, but it has also stimulated research ideas that, at this stage, are being undertaken in one country but will hopefully be of benefit to others.

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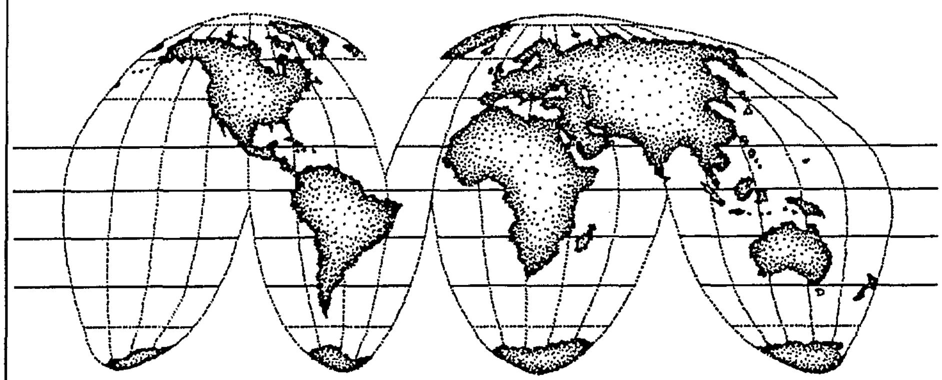

Relation of Cultural and Social Factors to Pregnancy Outcomes

Social Gradients in Birth Outcomes in Denmark 1983-87

by Finn Børlum Kristensen, M.D., Ph.D., Lisbeth B. Knudsen, M.S., and Flemming Mac, M.Sc.

Introduction

The decline in perinatal mortality, which was observed in Denmark in the 1960's and 1970's, stagnated in the 1980's at a level that is not quite satisfactory when compared to outcomes in, for example, Sweden and Japan. In the 1980's the low birthweight rate varied between 5 and 6 percent, the perinatal mortality rate varied around 8.5 per 1,000, and infant mortality was about 8 per 1,000.

This paper addresses the questions: Are there social and occupational differences in birth outcomes in the relatively homogeneous Danish society--a society that offers free access to prenatal care, hospital care, birth assistance, and maternity leave? Can a search for social differences provide insights leading to improvements and better results?

Material and methods

The study was based on the Danish Medical Birth Register (MBR), which covers all births to residents in Denmark, and the Danish Register of Congenital Malformations, which includes malformations in fetal deaths after 16 weeks of pregnancy and malformations diagnosed during the first year of life (1).

Through linkage between the national birth registry and the registration of causes of deaths, information on stillbirths and mortality in the first year of life was routinely recorded in the MBR. Both registers included information on mother's and father's occupation irrespective of marital status. Occupational information was derived from birth certificates and was coded in accordance with the International Standard Classification of Occupation. The material comprised 263,322 single babies (263,041 with gestational age recorded) in the 1983-87 birth cohorts.

On the basis of the father's occupation, the material was divided into four social classes comprising about 20 percent of the births each and a residual group including about 25 percent of the births.

Analyses of the MBR have shown that the parent couple's social group, when based on a single variable indicating occupation, was best described by the father's occupation because the father's occupation in the vast majority of cases is at the same or higher level than the mother's in the social hierarchy. Social group I consisted of university graduates, managers, teachers, technicians, and other groups. Social group II consisted of clerks, typists, assistants in social and health services, some skilled workers and other groups. Social group III consisted of manual workers--mostly skilled, subordinates in service trades, and other groups. Social group IV consisted of manual workers, mostly unskilled or unemployed with no trade registered. The residual group consisted of babies with fathers with unknown occupation or an occupation that was difficult to place in a social hierarchy.

Babies of fathers who were university graduates were chosen as the comparison group for the study of nonoptimal birth outcomes. This group was characterized by having a very low frequency of nonoptimal outcomes and consisting of more than 20,000 births in 1983-87. The social groups were compared with this "baseline" group. Multiplicative Poisson models were employed in the analysis of mortality in order to control for potential confounding (2,3). Expected frequencies of a number of outcomes were estimated with the multiplicative model, so that expected frequencies were controlled for differences in age, parity, and county of residence composition. The overall frequency of the outcomes for all groups together was similar to the observed frequency. Thus the estimates illustrated what would be the frequency of the outcomes in the social groups, if they had the same distribution on covariates as university graduates.

Results

Table 1 shows social groups and pregnancy outcomes in Danish birth cohorts of singleton babies for the years 1983 to 1987. The total number of stillbirths was 1,161, and the number of infant deaths was 1,893. The crude stillbirth rates varied from 3.1 per 1,000 in social group I to 5.7 in social group IV, and infant mortality rates varied from 5.6 in social group I to 9.1 in social group IV.

Figure 1 shows estimated risk ratios (RR) of stillbirth and infant death for social groups in the 1983-87 cohort, with social group I as a baseline. The vertical axis has a maximum value of 2. The estimates were controlled for differences in age, parity, and county of residence between social groups. A social gradient was obvious, with social group IV having an estimated RR of 1.6, which was markedly different from those of the other groups.

Figure 2 shows the RR of stillbirth for the social groups. Note that the scale on the vertical axis has a maximum of 2.5; the same pattern as in figure 1 is seen with a distinct social gradient. The estimated RR was 1.9 in social group IV.

Figure 3 depicts RRs of death in the first week of life of live born single babies. The vertical scale has a maximum of 1.5. The RRs were closer to 1 but a trend was still observable. When birthweight groups were included in the multiplicative model, no statistically significant differences in early neonatal mortality could be found between social groups.

Figure 4 shows RRs of death after the first week of life but before the first birthday in single babies. The vertical scale has a maximum of 2.5. Social group II did not differ from social group I, and social group III had only a moderately increased risk. This contrasts with the estimated RR of social group IV, which was 1.8.

Figure 5 depicts the estimated percentage of low birth weight in single live born babies divided into the baseline and "excess" percentage in each of the social groups. The lower baseline segments of the columns differed only slightly between groups. The upper excess segments of the columns varied considerably between the social groups. Even within social group I the 60 percent who were not university graduates contributed to an overall excess of one-third of a percent. The low birthweight percentage in social group IV was 2.5 percent above the baseline.

Figure 6 shows that the excess estimated percentage of preterm birth in the social groups was less than was the case with low birth weight, both relatively and in percentage terms.

As shown in figure 7, social group IV had the largest estimated excess percentage of congenital malformations (excluding congenital luxation of the hip) in live born single babies, when compared with babies whose fathers were university graduates.

Figure 8 shows the estimated frequency of stillbirths in single babies by social group. The stillbirth rate varied from 3.1 per 1,000 in social group I to 5.7 per 1,000 in social group IV. The excess stillbirth rate in social group IV was about double the rate for university graduates.

Figure 9 shows that there was practically no excess infant mortality in social groups I and II. This means that about two- thirds of babies who did not belong to those two groups experienced all of the excess infant mortality. Social group IV experienced more than one-half of the excess infant mortality.

Discussion

This study has shown that social differences in estimated RRs of late fetal or infant death were indeed present in Denmark. The differences were largest for the risk of stillbirth and infant death after the first week of life. The results suggest that hospital intrapartum and early neonatal care or other factors may have reduced the influence of factors that are associated with social groups on mortality during the first week. The factors that produced social differences in mortality seemed to have more influence during pregnancy and after the first week of life. The residual group in figure 3 had the highest estimated RR in the early neonatal period. This may partly be a consequence of underregistration of father's occupation under dramatic circumstances in the delivery room in cases that lead to early neonatal death.

Estimated baseline infant mortality increased only slightly from social group I to social group IV in figure 9. This suggests that the composition of social group IV as to age, parity, and county of residence contributed very little to the differences in estimated infant mortality that were found between social groups.

The results of the study indicate that attention still has to be paid to social differences in Denmark. Special interest should be paid to social group IV. Probably a large proportion of the differences was caused by living conditions, work conditions, education, and, not least, lifestyle. However, "social drift" between generations also may have contributed (4). Babies are born into one of the social groups but the parents may have been born in another social group and be in the present group because of the influence of factors like presence or lack of disease, congenital potentials, and environmental influence in a broad sense. Contributions from lifestyle, environment, and inheritance to the causation of nonoptimal outcomes are mingled in a complex manner.

No matter how large the potentially preventable fractions of the excess nonoptimal birth outcomes are, the results point to the need for critical assessment of how we get the best results out of our efforts in maternal and child care in Denmark. We may obtain better results in the future if we concentrate more on social classes III and IV.

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Table 1. Social groups and pregnancy outcomes in Danish birth cohorts of singleton babies, 1983-87

Social group	Live born infants	Still-births	Infant deaths	Mortality per 1,000 Still-birth	Mortality per 1,000 Infant
I	53,244	167	300	3.1	5.6
II	37,633	146	224	3.9	6.0
III	59,219	244	416	4.1	7.0
IV	51,796	295	469	5.7	9.1
Residual	61,149	309	484	5.0	7.9
Total	263,041	1,161	1,893	4.4	7.2

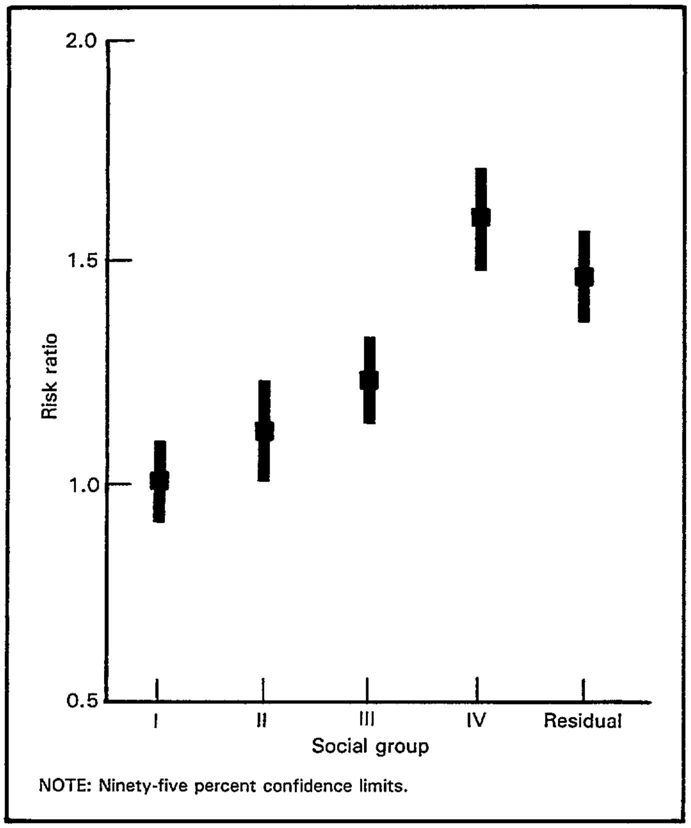

Figure 1. Risk ratio of stillbirth or infant death for singleton infants, by social group: Denmark, 1983–87

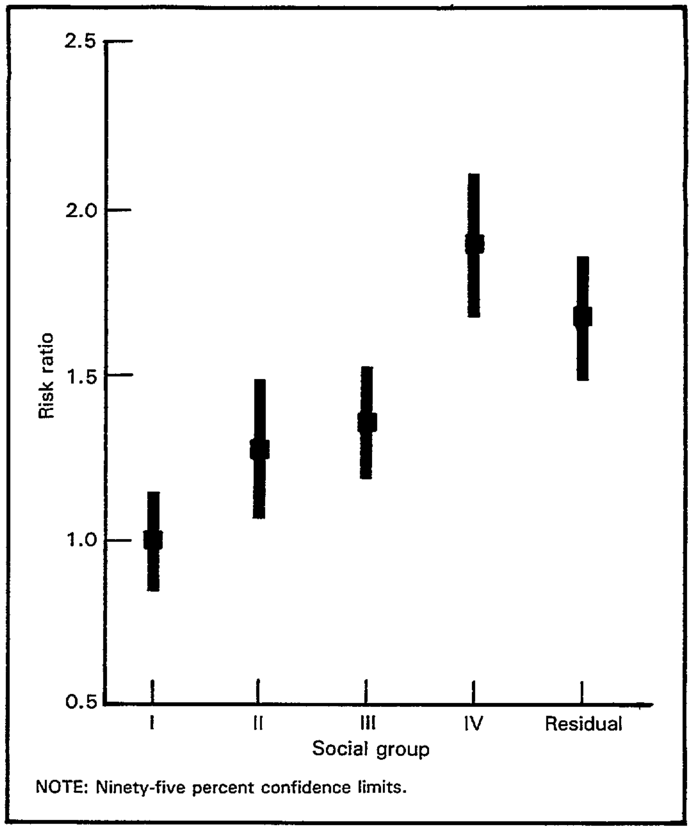

Figure 2. Risk ratio of stillbirth for singleton infants, by social group: Denmark, 1983–87

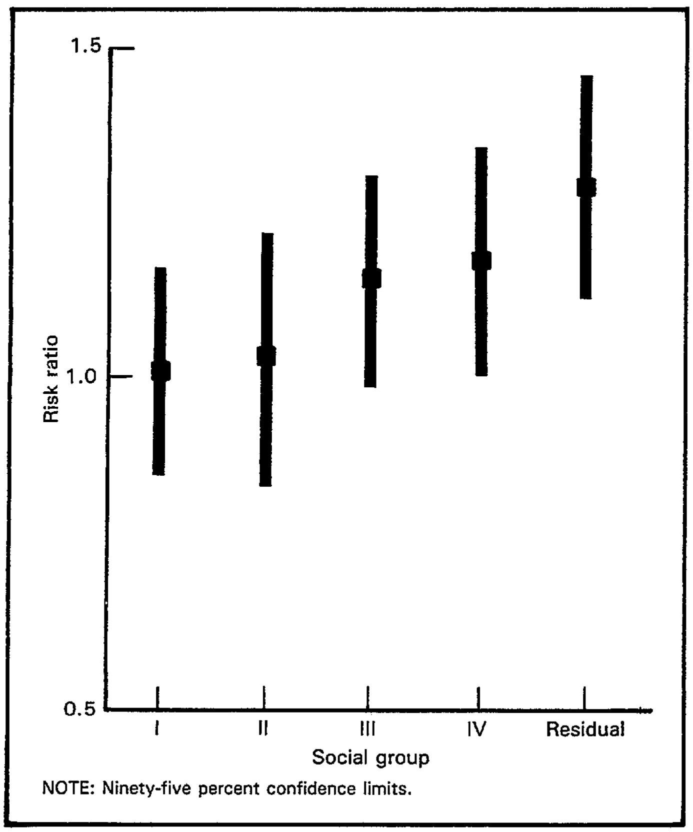

Figure 3. Risk ratio of early neonatal death for singleton infants, by social group: Denmark, 1983–87

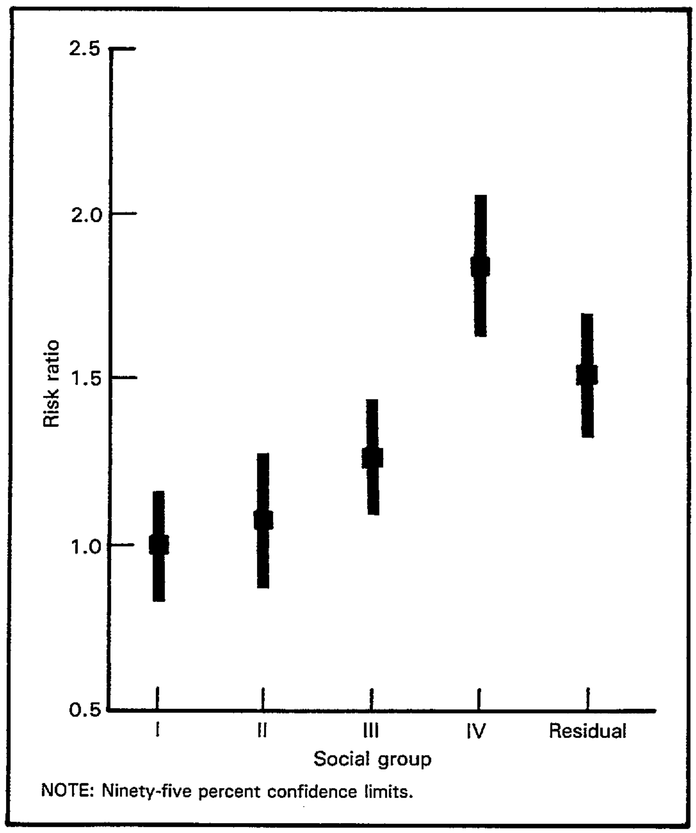

Figure 4. Risk ratio of late neonatal or postneonatal death for singleton infants, by social group: Denmark, 1983–87

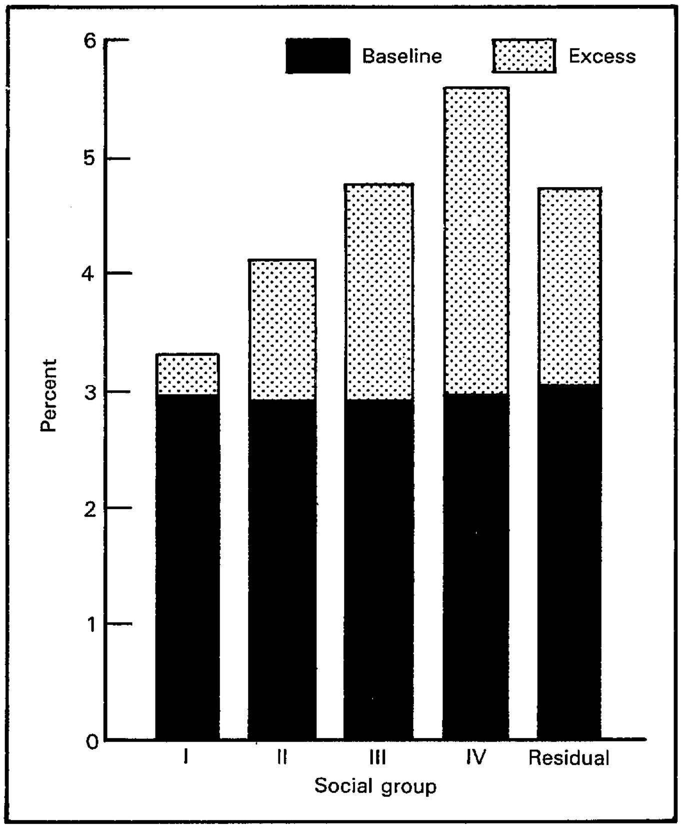

Figure 5. Percent low birth weight for singleton infants by social group: Denmark, 1983–87

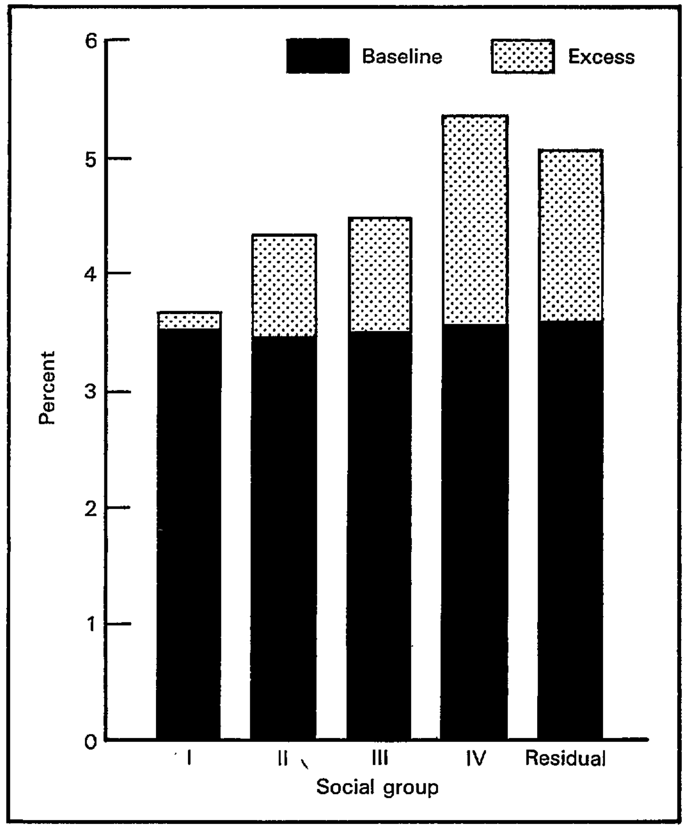

Figure 6. Percent preterm deliveries for singleton infants by social group: Denmark, 1983–87

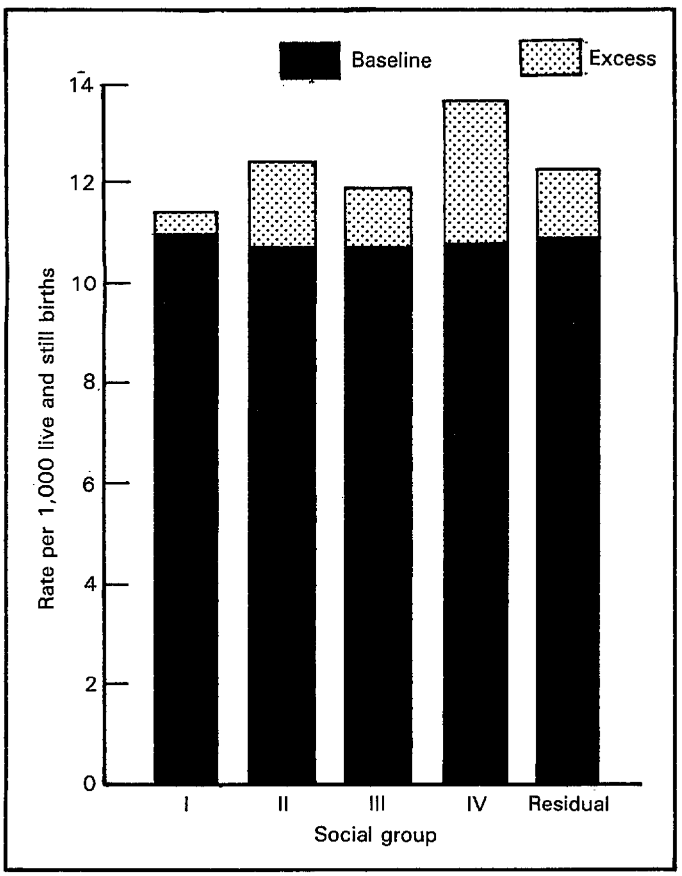

Figure 7. Congenital malformation rate for singleton infants by social group: Denmark, 1983–87

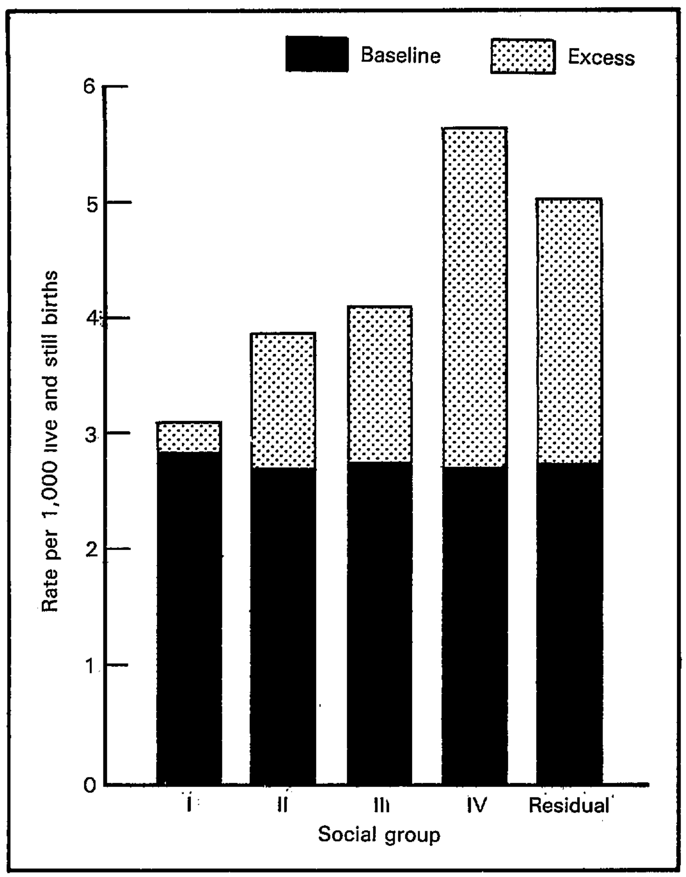

Figure 8. Stillbirth rate for singleton infants by social group: Denmark, 1983–87

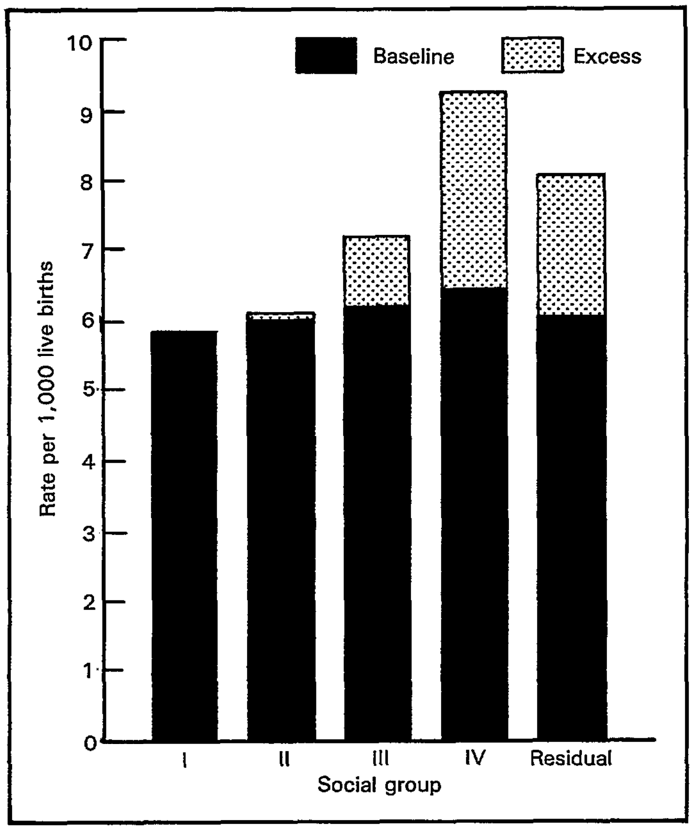

Figure 9. Infant mortality rates for singleton infants by social group: Denmark, 1983–87

Sociodemographic Influences of Migrant Workers Populations on Infant Mortality in the Federal Republic of Germany

by Eberhard Schmidt, M.D., Ursula Scharnagel,
Christian Petrich, M.D., and Max Limbacher

Introduction

Beginning in the 1950's, Germany has attracted a considerable number of immigrants. They have come as migrant workers from mostly Southern European countries, mainly from the Mediterranean area. At present there are 4,490,000 migrant workers and their families in Germany, which has a total population of 60 million inhabitants. Of the 677,000 infants born in 1988 in Germany, 73,000 were born to foreign parents (10.8 percent). Out of these about 60,000 were born to migrant workers. On the average, every 9th child, and in certain areas like the state of North Rhine-Westphalia, almost every 4th child born is a migrant worker's baby.

Although the countries that these people come from are in close vicinity to each other, their populations differ greatly in their sociocultural traditions and thus in their ability to adapt to their new environment. The greatest problems are encountered with the Turkish population. Problems are reflected in their attitudes toward medical services, especially toward primary care of pregnant women and during infancy.

Data presented here have been received from the Federal Office of Statistics for the whole of West Germany. The more detailed analysis is based on data from the State Office in North Rhine-Westphalia, which is the most populated German state, with 16.9 million persons or 27 percent of the total population of West Germany and 149,000 births per year.

Data for the Federal Republic of Germany

Within the mostly Mediterranean population in Germany, which came as migrant workers, the Turkish group quickly became the largest group, whereas the numbers of Italians, Greeks, Spanish, and Yugoslavians soon leveled off (figure 1).

The immigration to the Federal Republic had a varying impact on different German states, depending on their economic structure and attractiveness for migrant workers (figure 2). This figure shows the percentage distribution of the German population versus the migrant worker population throughout the various German states. Due to certain economic factors, some states carry an overload of migrant worker immigration.

What are the sociodemographic consequences visible in official statistics in Germany in relation to migrant workers?

Migrant workers have more children than German families. In contrast to immigrants from central Europe, children born out of wedlock are rare in the migrant worker population. This rate was 2.6 percent among the Turkish population, 3.4 percent among the Greek population, and 7 percent among the Dutch and British foreigners in the Federal Republic.

Infant mortality in each of the 11 German states has declined at roughly the same pace in recent decades, the difference between the highest and the lowest state rates remaining at almost exactly 35 percent over these years (figure 3). Throughout the years North Rhine-Westphalia, a densely populated state with certain inherent sociopolitical problems, stayed around the 9th position.

The same becomes evident when looking at perinatal mortality (figure 4). The percentage of difference between maximum and minimum has narrowed from 35 percent in 1980 to 25 percent in 1988. Here also North Rhine-Westphalia is ranked 8th among the states. Within 7 years Bavaria has moved to position No. 1, attributable to a special perinatal surveillance system.

Infant mortality in the migrant worker population has been systematically included in official statistics since the 1970's (figure 5). It has always surpassed the German figure. The difference became aggravated in the mid-1980's and is narrowing now, but still remains 25 percent above the current German figure.

The difference in perinatal mortality has always been a little more pronounced throughout the years, also reaching a maximum in the mid-1980's, when German rates went down a little faster than those of migrant workers' children (figure 6). The gap between the two is closing but a difference of about 24 percent still exists.

Data from North Rhine-Westphalia with special regard to the Turkish population

Two 3-year periods were compared, 1975-77 and 1986-88 (table 1). Among the different countries of origin, the Turkish population is the largest and demonstrates the most homogeneous set of problems in regard to their sociocultural adaptation to the host country. This analysis is based on the Turkish infant population in comparison to the German infant population.

Birthweight-specific infant mortality shows identical figures for both groups in both periods for birth weight below 1500 grams (table 2). However, looking at birth weights between 1500 and 2500 grams, there are elevated mortality figures in the Turkish group--pronounced in 1975-77 and persisting but much reduced in 1986-88. For the 1975-77 interval, these differences are significant. The reasons for the higher mortality in the intermediate low birthweight groups of Turkish children can only be speculated upon at present.

Age-specific infant mortality rates for both groups in both periods show no substantial differences between the two national groups (figure 7). Please note that stillbirths are not included in this data set.

In figure 8, cause-specific infant mortality in the two groups was compared using four cause categories:

- infections
- congenital anomalies
- perinatal conditions
- others

Please note the almost complete disappearance of cause group I. Cause group II provides evidence for a continuous difference in congenital malformations, which has become even more pronounced in the Turkish population during the period 1986-88.

The difference in mortality due to congenital anomalies is significant for the time period 1986-88 (table 3). The true odds ratio may even be higher since high maternal age, a known risk factor, is higher in the German than in the Turkish population. At present we cannot analyze these interdependencies further since birth and death data have not been linked.

The data so far indicate a disadvantage for the migrant worker population for specific aspects of infant mortality such as:

- increased losses of infants weighing between 1500 and 2500 grams; and

- a possible excess in congenital malformations.

Both groups are small in number and cannot be significant contributors to the persistent excess in infant mortality in the Turkish population.

Let us then go back to the age-specific mortality in North Rhine-Westphalia, this time including stillbirths, which are not included in the table on age-specific mortality.

It is evident that in all aspects of infant mortality of live births, the unfavorable figures for migrant worker populations have improved over time. Data for stillbirths, however, behave differently (figure 9). There has always been an excess in stillbirths in the migrant worker population, and there is no evidence of a decrease in recent years in the stillbirth rate for this population group.

This confirms the findings of regional statistics, which show poor participation of this group in primary care of pregnancy. Permanent improvements are being made in primary care programs to overcome the special sociocultural barriers that are at work here, and to ensure that this population group makes use of available perinatal services.

Conclusion

Migrant worker populations in the Federal Republic of Germany have a higher mortality than the German population, and the Turkish population is at special risk.

Factors identified for further action are:

- higher mortality in birth weight groups 1500 to 2500 grams;
- excess rate of congenital malformation; and
- higher stillbirth rate.

One of the main methodological handicaps preventing further clarification is the lack of linkage of birth and death data, which we consider absolutely mandatory for further analysis.

Table 1. North Rhine-Westphalia infant populations

	1975-77	
	Turkish	German
Infant births	45,083	404,344
Infant deaths	1,089	7,675
	1986-88	
	Turkish	German
Infant births	36,429	468,945
Infant deaths	407	4,318

Table 2. Birthweight-specific mortality, North Rhine-Westphalia

	1975-77							
	Turkish				German			
Birth weight (kilos)	≤1.0	-1.5	-2.0	-2.5	≤1.0	-1.5	-2.0	-2.5
Percent	0.3	0.6	1.1	3.3	0.3	0.5	1.2	4.1
Mortality rate	95.5	57.0	24.5	6.9	97.0	55.5	17.5	4.8
	1986-88							
	Turkish				German			
Birth weight (kilos)	≤1.0	-1.5	-2.0	-2.5	≤1.0	-1.5	-2.0	-2.5
Percent	0.3	0.6	1.1	3.6	0.3	0.5	1.2	4.0
Mortality rate	63.0	22.0	5.0	3.0	62.0	20.0	5.2	1.6

Table 3. Cause-specific infant mortality, North Rhine-Westphalia

Cause	1975-77		1986-88	
	Congenital anomaly	Others	Congenital anomaly	Others
Turkish	223	866	120	287
German	1,425	6,250	1,041	3,277
Odds ratio	1.13		1.32	
95% confidence interval	0.96 - 1.33		1.05 - 1.66	

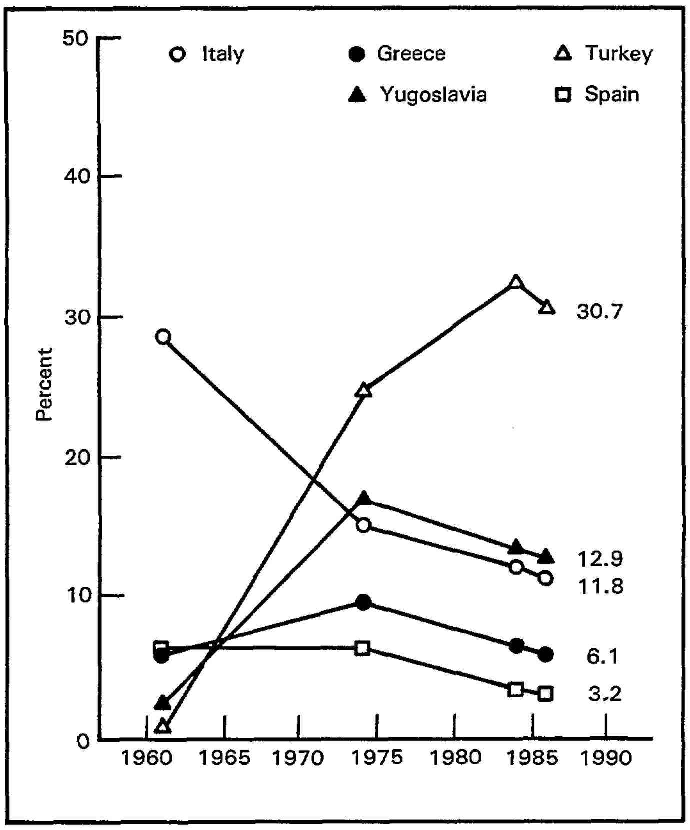

Figure 1. Percent distribution of migrant workers by nationality: West Germany, 1960–86

		1980		1988
Maximum	SAAR	15.6	SAAR	10.0
Minimum	BW	10.4	BW	6.4
NRW		14.8		8.4

Figure 3. Infant mortality for selected States: West Germany, 1980 and 1988

		1980		1988
Maximum	SAAR	15.8	SAAR	7.9
Minimum	S.HOL	10.0	BAV	6.0
NRW		12.7		6.8

Figure 4. Perinatal mortality for selected States: West Germany, 1980 and 1988

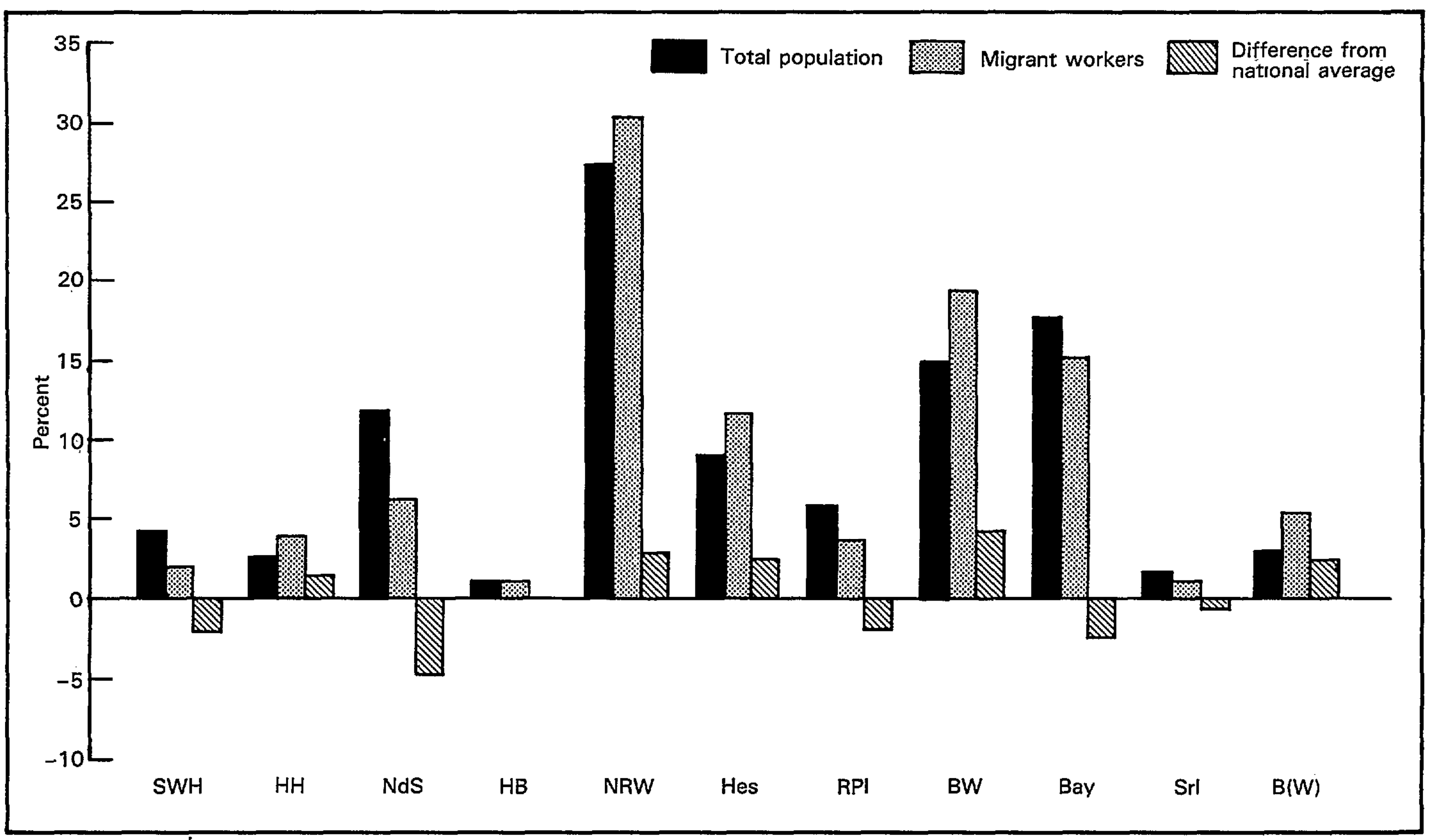

Figure 2. Percent of migrant workers versus total population in the States of West Germany

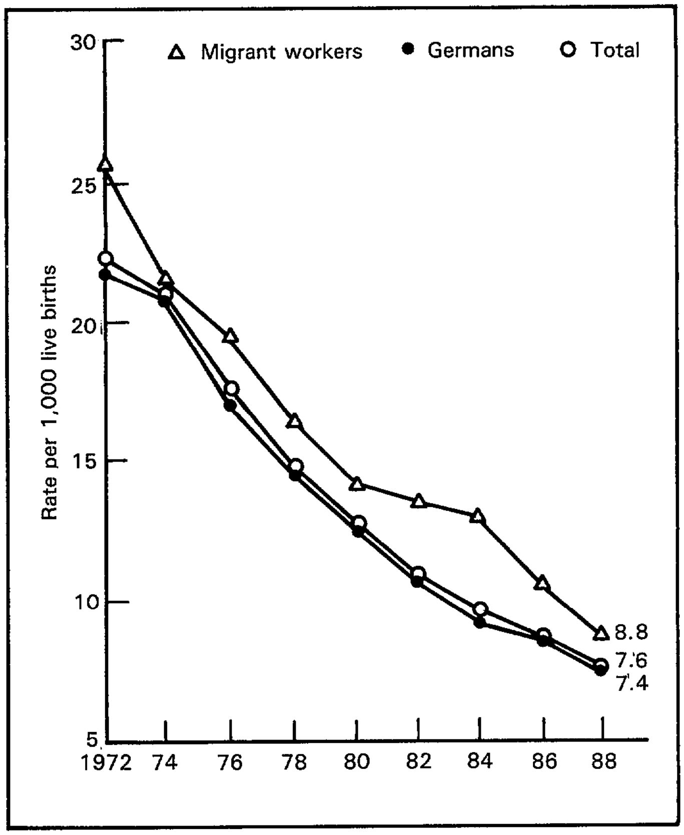

Figure 5. Infant mortality rate by nationality: West Germany, 1972–88

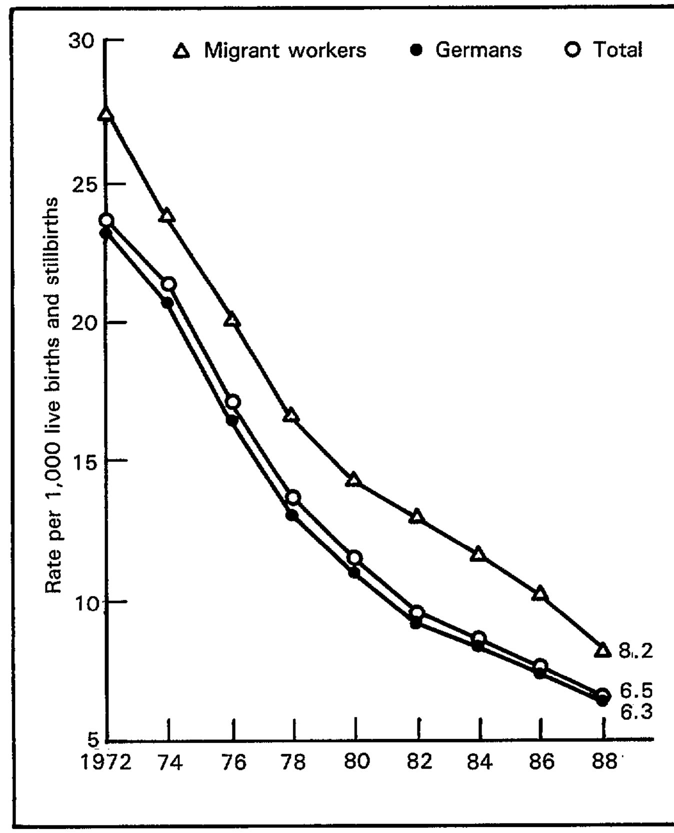

Figure 6. Perinatal mortality rate by nationality: West Germany, 1972–88

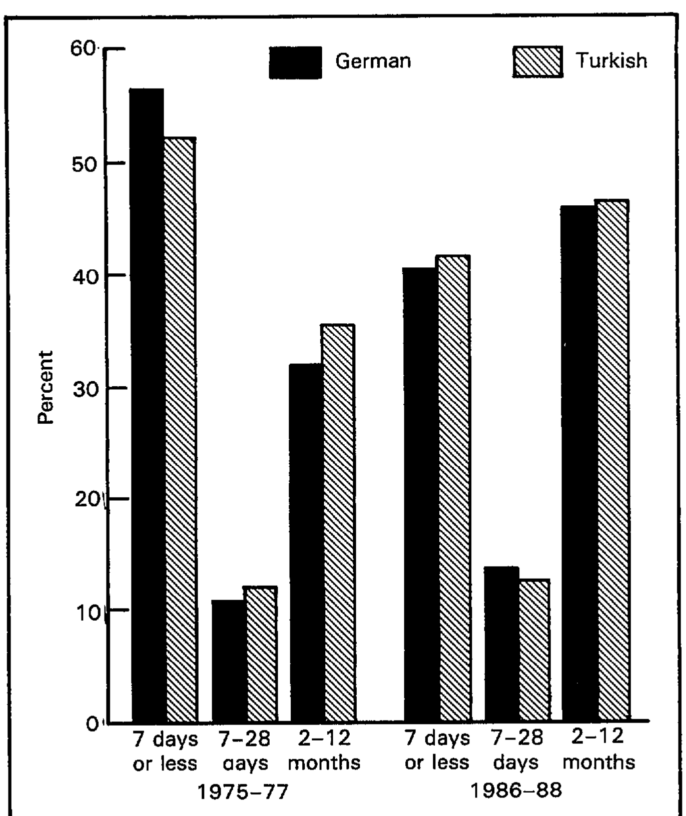

Figure 7. Percent distribution of infant deaths by age at death and nationality: West Germany, 1975–77 and 1986–88

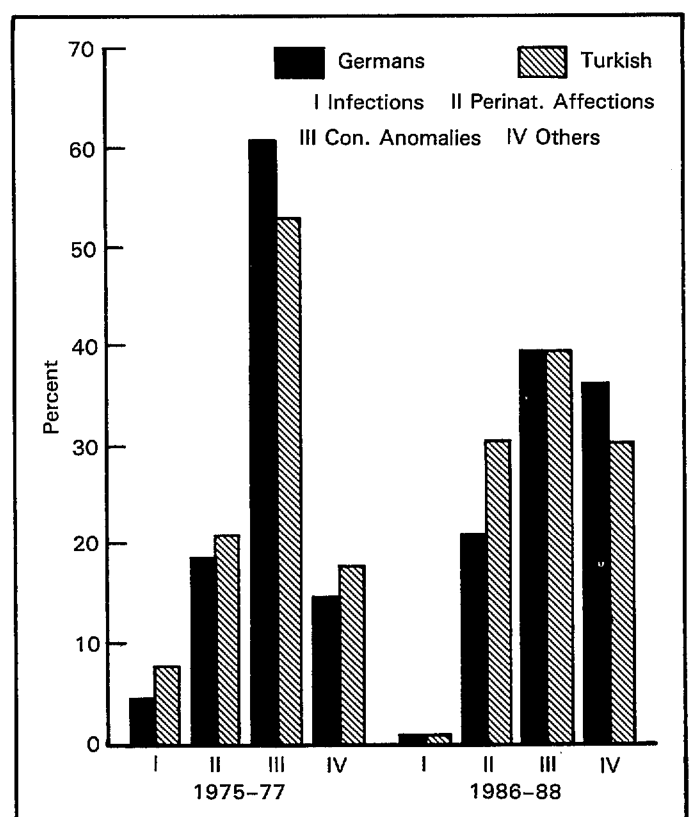

Figure 8. Percent distribution of infant deaths by selected causes of death and nationality in North-Rhine Westphalia: West Germany, 1975–77 and 1986–88

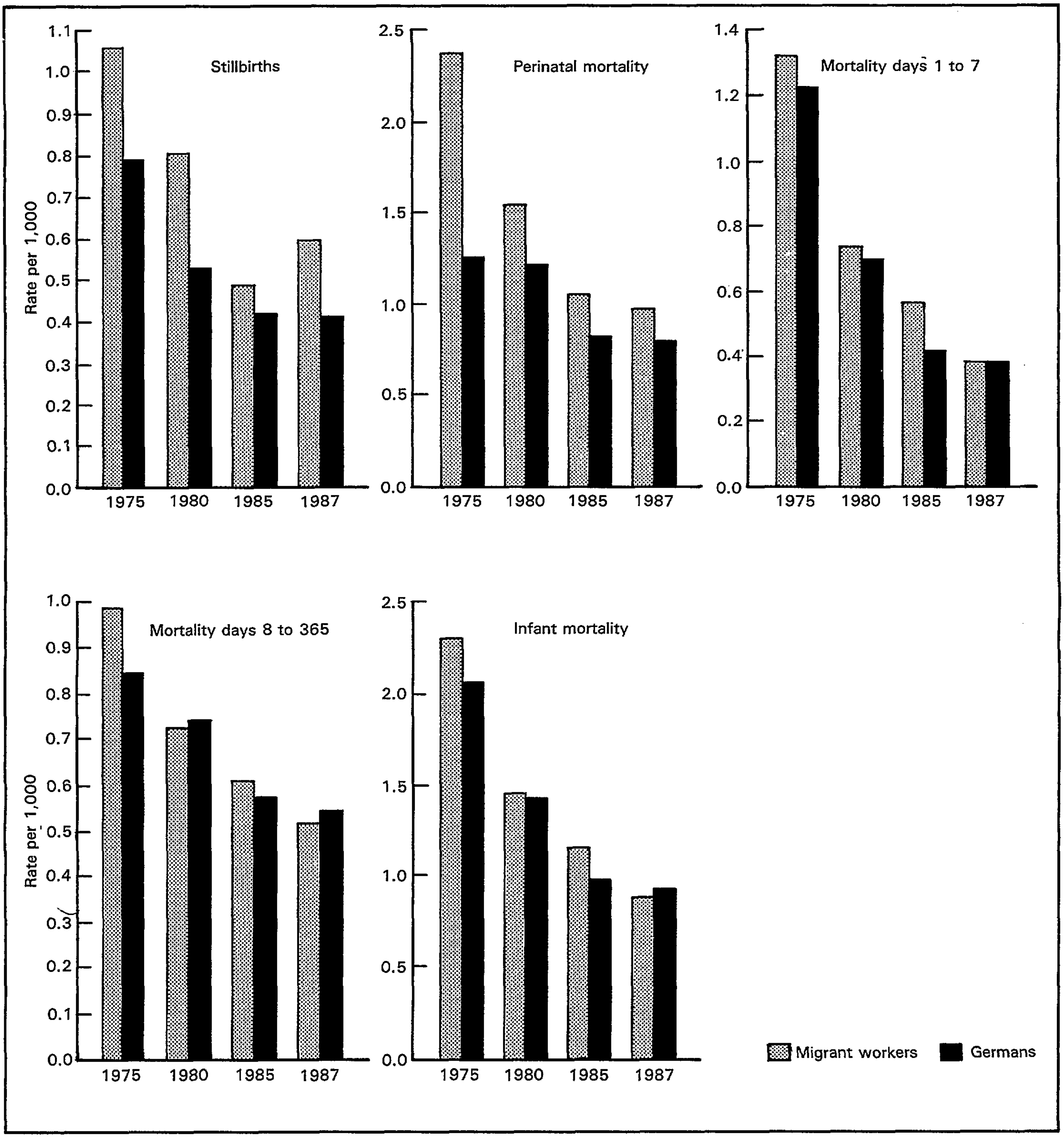

Figure 9. Fetal and infant mortality measures for Germans and migrant workers in North-Rhine Westphalia: West Germany, 1975–87

Sociodemographic Postneonatal Mortality Differentials Among Good Birthweight Infants of Different Religious Groups in Israel

by Vita Barell, M.A., Pnina Zadka, M.P.H., Ayala Lusky, B.Sc., and Angela Chetrit, B.Sc.

The purpose of this report is to investigate the effect of social and cultural factors in postneonatal mortality among the different Israeli religious groups. We will show that religion in Israel is a proxy for socioeconomic and cultural differences among populations, and that the impact of these factors tends to be strongest at the late fetal and at the postneonatal periods.

The population of Israel is composed of four major religious groups: the majority are Jews, 80 percent of the population; 16 percent are Moslem; 2.5 percent are Christian; and 1.5 percent are Druze. This non-Jewish segment of the Israeli population is mainly Arab. The Christians are an intermediate group, between the Jews and the Moslems or Druze, in their social structure as well as in their demographic composition, as is reflected in their educational and fertility levels. The Christians living in Israel are heterogeneous and there are significant numbers of European as well as Arab origin.

Of the 97,000 infants born alive annually in Israel, 76 percent are Jews, about 20 percent are Moslem, and about 2 percent each are Druze and Christian (figure 1). These populations differ in the distribution of demographic, socioeconomic, and other factors known to be associated with infant mortality.

The following analyses are based on the 390,000 births that occurred during 1981-84. Computerized files of infant deaths for the years 1981-85 were matched with their corresponding birth files, and 99.5 percent of the deaths were successfully matched.

Particular attention will be paid to postneonatal deaths among good birthweight infants. This is based on the potential preventability of many of the deaths among infants weighing 2500 grams or more at birth and surviving the neonatal period.

Fertility

There are considerable differences in fertility among the religious groups (figure 2). The Moslems have the highest fertility rates, similar to that of the Druze and very different from that of the Christians and the Jews.

Examination of the infant mortality rates (IMR) in these heterogeneous religious groups (table 1) shows that in 1981-84, Moslems and Druze had similar mortality rates (22 per 1,000), the Christian rates were intermediate (16 per 1,000), and approached the lowest, Jewish rates (11 per 1,000). In 1987 the pattern was similar, but at much lower levels.

Breakdown of the IMR into neonatal and postneonatal components and inclusion of fetal deaths highlight the major differences in mortality among the religious groups (figure 3). Inspection of age at death shows the major disparities between the rate ratio (RR) of Moslems and Jews, for example, among late fetal deaths (RR=2.6) and in the postneonatal period (RR=3.1).

The decline in infant mortality over time has been proportionally similar among the different religious subgroups in Israel, and all have achieved about a 70 percent decrease since the mid-1950's (figure 4). The rate ratio of non-Jewish groups to Jews has not changed over the years and remained about 2.0 for Moslems and Druze and about 1.5 for Christians.

Birth weight

The proportion of births weighing less than 2.5 kilograms is 7.4 percent for Jewish and about 6.5 percent for non-Jewish live births (figure 5). However, this difference in low birth weight (LBW) between the religious groups is a function of differences in birth order distributions, with a higher proportion of first-order births among the Jews. There were only minor differences in the proportion of LBW infants when controlled for birth order.

Within the last decade there has been an increase in the proportion of LBW live births in all religious groups and almost all birth orders, in contrast to the trend observed in most countries. The increase has been concentrated in the 2.0- to 2.4-kilogram range.

IMR of good birthweight (GBW) infants 1977-84

Among the Jews, mortality of GBW infants of 2500 grams or more has reached a plateau at about 4 per 1,000 (figure 6). Among non-Jewish groups, the rate ranges from twice as high among the Christians to four times as high for Moslems and Druze.

Neonatal mortality of GBW infants 1977-84

Neonatal mortality rates of GBW infants are low among all groups (figure 7). The main difference in mortality among GBW lies in the postneonatal period.

GBW postneonatal mortality 1977-84

Postneonatal mortality (figure 8) among Jewish GBW infants was 2.4 per 1,000, for Christians 4.7, and for Moslems and Druze about 8.5. The rates in each of the religious groups are stable. The rate ratio of GBW mortality for Moslem and Druze to the Jews approaches 4.

As stated earlier, the main difference between the religious groups lies in the fetal death rate and the postneonatal deaths of GBW infants. Because of a relatively high level of incomplete data on sociodemographic factors among the fetal deaths in 1981-84, the evaluation of differences in mortality and in risk factors among the religious groups will be limited to the postneonatal GBW infants.

Risk factors

The risk factors for mortality are not evenly distributed among the populations (figure 9). The differences between the groups tend to be due to greater proportions of high risk births and, to a lesser extent, to higher mortality rates within each risk group.

The study was limited to the risk factors that are registered on the birth notification. Information such as accessibility to health care, quality of care, and utilization of health services are not available here. Education was the only social risk factor that was studied, as birth notification information on occupation was poor. Parental educational level has been used therefore as a proxy for socioeconomic status.

Additional risk factors presented are maternal age, birth order, and sex of infant. Some reservations must be made about the number of births and deaths in some of the populations. In the study period there were about 7,000 GBW births among the Druze and Christians and about 50 deaths of GBW infants. Therefore, some of the results are subject to random fluctuation.

Maternal education

Maternal education is generally considered not only a proxy for social class but also a determinant in infant care-giving practices.

There is considerable disparity in maternal educational attainment among the different religious groups in Israel (table 2). In 1981-84 more than 70 percent of the mothers of Druze and Moslem infants had less than 9 years of education, compared with 29 percent of the Christians and 10 percent of the Jews. One in four of the Moslem mothers had no formal education. Low education was a risk factor for postneonatal mortality among GBW Moslem, Druze, and Jewish infants. Within detailed groups of educational level (data not shown), there was a rate ratio of about 2 in most groups, as compared to about 3.5 for total postneonatal mortality of GBW infants. The Moslem rate decreases by 30 percent to 6.1 per 1,000 when adjusting for the distribution of the Jewish maternal education. It should be noted that although there was an increase in parental schooling in all religious groups over the previous 4-year period, the gap in educational level between Jews and non-Jews has widened, as the increase in schooling is more rapid among Jews and Christians than among Moslems and Druze.

Paternal education

Moslem and Druze fathers tended to be better educated than the mothers, while among Christians and Jews there was less difference in the distribution of mother's and father's schooling (table 3). Generally, the impact of increased paternal education on reduction of postneonatal mortality was similar to the impact of increased maternal education.

Both parents' education

There was concordance of educational level of both parents among Jews, Christians, and Moslems (table 4). The majority of infants born to Christians and Jews had both parents with more than 9 years of schooling; among more than one-half of the Moslem infants, both parents had less than 9 years of schooling.

Among most of the religious groups, the highest postneonatal mortality occurred, as expected, when both parents had less than 9 years of education (table 5). Among the Moslems and Druze, low paternal education had more of an impact on postneonatal death than did low maternal education, while among Christians and Jews maternal schooling had more impact. The effect of high educational level of both parents is unclear, as only the Moslems show a reduction in postneonatal mortality.

Maternal age

The optimal maternal ages for childbearing are 25-34. The average proportion of young mothers less than 20 among the Moslems was about 7 percent in 1981-84, more than 2.5 times greater than among the Jews (2.6 percent) (table 6). Among the Jews the mortality rates were highest among young mothers. Infants of older Jewish mothers are not at higher risk than the average. Postneonatal mortality risk for non-Jewish GBW infants was greatest among mothers 35+ years, with a rate more than four times higher than among the Jews. As maternal age is highly correlated with education, the high risk among non-Jewish older mothers could be a confounding effect of education (or vice versa). It must be noted that, over time, the proportion of older mothers 35+ has decreased among non-Jews, while among the Jewish infants the proportion of mothers 35+ has increased.

Birth order

There is a very large difference in the birth order distribution between the Jews and non-Jews, with a more than 2.5 times higher proportion of 4+ parity among the Moslems than among the Jews (table 7).

The lowest postneonatal mortality in all Israeli religious groups is found among first-order births, but the differential in rates is greatest among these infants in opposition to the pattern expected by mother's age.

Gender

All non-Jewish groups show higher postneonatal mortality among the females; the only group with the expected pattern in developed countries are the Jews (table 8). Moslem and Druze GBW males have three times the risk of dying of Jewish males, while the females have almost five times the risk. The difference is smaller among the Christians.

Cause of death

The major causes of postneonatal death among Moslem and Druze GBW infants were infectious disease (figure 10). Among Jews and Christians, deaths were more uniformly distributed between infections, malformations, and ill-defined conditions (including sudden infant death syndrome--SIDS). Moslems had more than double the rates of Jews for malformations and ill-defined conditions. But for infectious disease mortality, the rate for Moslem and Druze infants was six times higher than that of Jews and three times the rate for Christians. It must be noted that there has been a great reduction in infectious disease mortality among non-Jews in the past decade, contributing significantly to their reduction in postneonatal mortality.

The highest malformation rate was among the GBW Moslems (2.0 per 1,000 postneonatally). The excess malformations among all non-Jews are related to the high rates of consanguinity among Israeli Arab populations, as well as poor compliance with prenatal diagnostic services and resistance to termination of pregnancies of affected fetuses.

Multiplicity of risk factors

Figure 11 shows that one of the major differences among the religious groups in Israel is the number of high risk factors within each family. Twenty-nine percent of the Moslem infants had only 0-1 risk factors as compared with 63 percent of the Christians and 82 percent of the Jews.

Generally, as the number of risk factors increased, the postneonatal mortality rate tended to increase as well (figure 12). At equal risk levels, however, the non-Jewish rate still tended to be more than twice as high.

Discussion

We have shown that non-Jews in Israel are highly heterogeneous and the differences in fertility and in mortality tend to reflect socioeconomic differences and the different risk factor distribution between them. Postneonatal mortality among GBW infants has reached a plateau in Israel in the last decade, about 2 per 1,000 live births for Jews, 5 for Christians, and 8-9 for Moslems and Druze. The unexplained increased proportion of low birth weight in all religious groups in Israel resulted in a leftward shift of the birthweight curves and more 2.5-2.9 kilo births in the GBW range. This may be partially responsible for the plateau in GBW postneonatal mortality, despite a reduction in risk factors.

The comparatively lower mortality rate ratio among infants of mothers at similar educational levels among the religious groups indicates that the different distribution in education levels may be a major key to the differential in postneonatal mortality of GBW infants. Christians, the intermediate group between Jews and other non-Jews in educational levels, are also intermediate with respect to their infant mortality levels. The fact that the increase in educational attainment is more rapid among Jews and Christians prevents the narrowing of existing gaps.

The main differences in infant and perinatal mortality are concentrated in late fetal deaths and in postneonatal mortality of GBW live births, suggesting that free obstetric care in hospitals (covered by national insurance with a special grant offered to deliveries in hospitals) may have helped reduce the gap in neonatal mortality but does not prevent the gaps between the populations. Financial constraints do not play a significant part in receiving equitable health care. Essentially free antenatal care for pregnant women and postnatal preventive care for infants is available at widely distributed local mother and child health clinics. An essential element in obtaining antenatal and postnatal care is personal knowledge and motivation and a positive attitude toward health care and health care services. Cultural attitudes may also affect utilization, as reflected in gender differences in relative risk of postneonatal death.

The religious groups in Israel are very different social groups living one beside the other in one country. The differences among them are not only in the usual sociodemographic variables but in separate and autonomic cultures, each with a unique social structure. These differences are difficult to translate into operatively measurable variables or risk factors.

The period prevalence data for the following 3-year period, 1985-87, indicates continuing reductions in infant mortality in all population groups (figure 13). The main differentials remain after the first month of life but there is some indication that the gap is decreasing. Hopefully, investigation of the distribution and behavior of risk factors, identification of targets amenable to change, and appropriate health service intervention will reduce the differentials even more, while reducing infant mortality throughout the country.

Table 1. Mortality rates by age at death and religion, all birth weights: 1981-84

Religion	Live births	Mortality rate per 1,000			
		IMR	Neonatal	Post-neonatal	Still-births
Total	387,069	13.6	8.7	4.9	5.8
All non-Jews	94,018	20.7	10.9	9.8	8.5
Moslems	73,343	22.1	11.6	10.5	11.4
Druze	7,451*	21.9	11.0	10.9	6.0
Christians	7,563	15.7	9.0	6.7	4.4
Jews	293,051	11.4	8.0	3.4	4.4

*Excluding Druze Israeli residents from the Golan Heights.

Table 2. Percent distribution of births and postneonatal mortality by maternal education and religion, GBW infants (≥2500 gm)

Population group	Maternal education			
	Live births (percent)		Postneonatal mortality rates per 1,000 LB	
	0-8 years	9+ years	0-8 years	9+ years
Moslems	70.1	26.6	9.2	7.0
Druze	80.8	18.3	8.3	7.6
Christians	28.6	70.0	4.5	4.9
Jews	10.0	87.1	3.7	2.2

Table 3. Percent distribution of births and postneonatal mortality by paternal education and religion, GBW infants (≥2500 gm)

Population group	Paternal education: Live births (percent) 0-8 years	Live births (percent) 9+ years	Postneonatal mortality rates per 1,000 LB 0-8 years	Postneonatal mortality rates per 1,000 LB 9+ years
Moslems	61.1	35.4	9.6	7.0
Druze	47.5	51.8	9.1	7.1
Christians	34.5	63.7	3.3	5.6
Jews	11.1	84.2	3.4	2.2

Table 4. Percent distribution of births and postneonatal mortality by educational level of both parents and religion, GBW infants (≥2500 gm)

Population group	Both parents: years of schooling: Live births (percent) 0-8 years	Live births (percent) 9+ years	Postneonatal mortality rates per 1,000 LB 0-8 years	Postneonatal mortality rates per 1,000 LB 9+ years
Moslems	53.2	19.0	9.8	6.7
Druze	42.5	16.1	9.5	8.1
Christians	18.9	54.0	4.5	5.8
Jews	5.5	78.9	4.1	2.2

Table 5. Postneonatal mortality by parental educational level and religion, GBW infants (≥2500 gm)

Education by religion	Mother	Father	Both parents
0-8 years of schooling:			
Moslems	9.2	9.6	9.8
Druze	8.3	9.1	9.5
Christians	4.5	3.3	4.5
Jews	3.7	3.4	4.1
9+ years of schooling:			
Moslems	7.0	7.0	6.7
Druze	7.6	7.1	8.1
Christians	4.9	5.6	5.8
Jews	2.2	2.2	2.2

Table 6. Percent distribution of births and postneonatal mortality by maternal age (high risk) and religion, GBW infants (≥2500 gm)

Population group	Maternal age: Live births (percent)		Maternal age: Postneonatal mortality rates per 1,000 LB	
	<20 years	≥35 years	<20 years	≥35 years
Moslems	7.2	13.5	8.7	10.7
Druze	8.4	13.0	(8.4)	12.7
Christians	3.2	8.8	(0.0)	3.2
Jews	2.6	11.4	4.1	2.5

( ) Based on less than 500 births.

Table 7. Percent distribution of births and postneonatal mortality by birth order (high risk) and religion, GBW infants (≥2500 gm)

Population group	Maternal age			
	Live births (percent)		Postneonatal mortality rates per 1,000 LB	
	1	4+	1	4+
Moslems	19.5	48.3	6.7	9.2
Druze	20.1	44.9	5.1	9.3
Christians	27.8	25.2	1.5	6.3
Jews	29.0	18.3	1.7	3.3

Table 8. Postneonatal mortality by sex of newborn and religion, GBW infants (≥2500 gm)

Population group	Rates per 1,000 LB		
	Male	Female	Rate ratio
Moslems	7.8	9.6	0.8
Druze	8.1	8.2	1.0
Christians	3.9	5.6	0.7
Jews	2.5	2.2	1.1

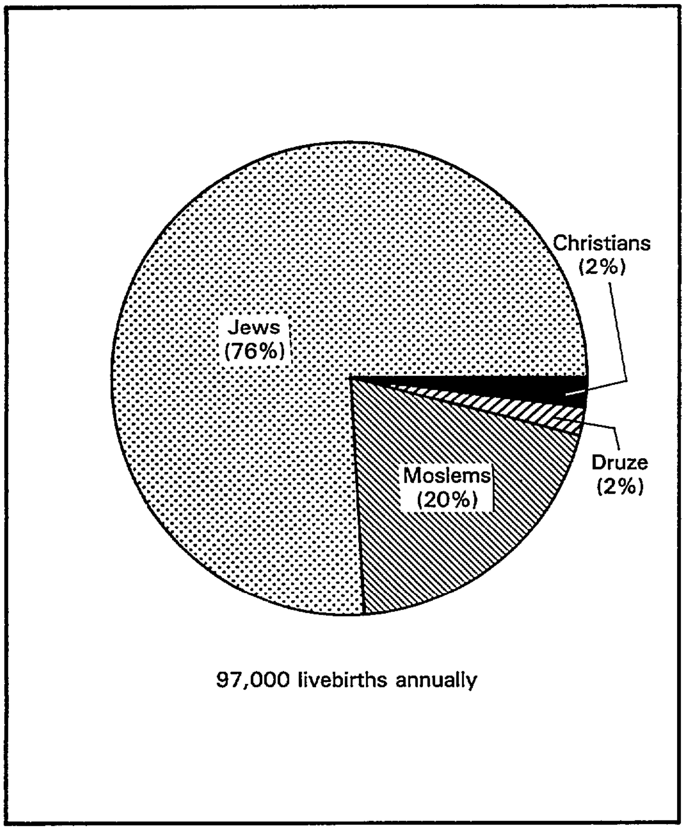

Figure 1. Percent distribution of live births by religion: Israel, 1981–84

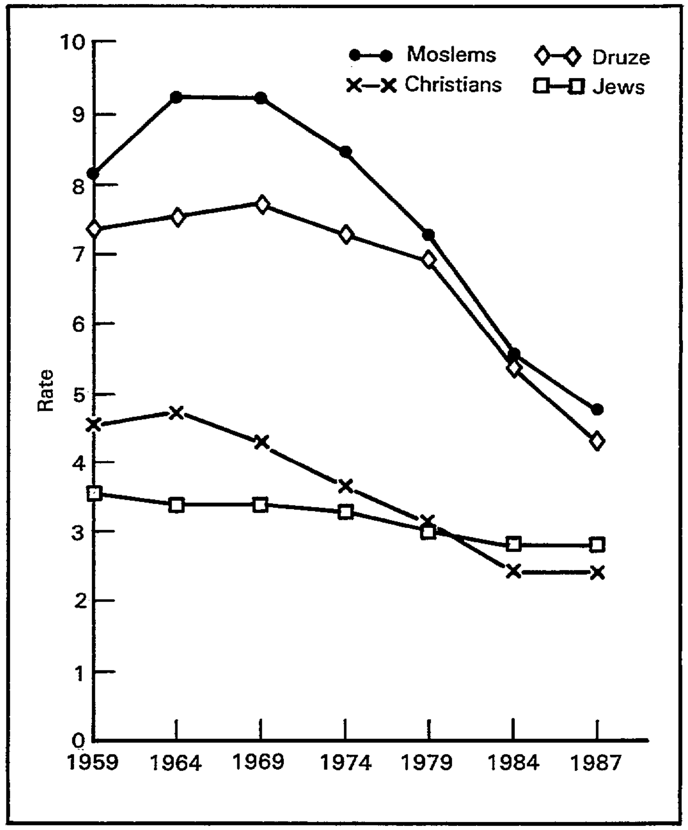

Figure 2. Total fertility rate by religion: Israel, 1959–87

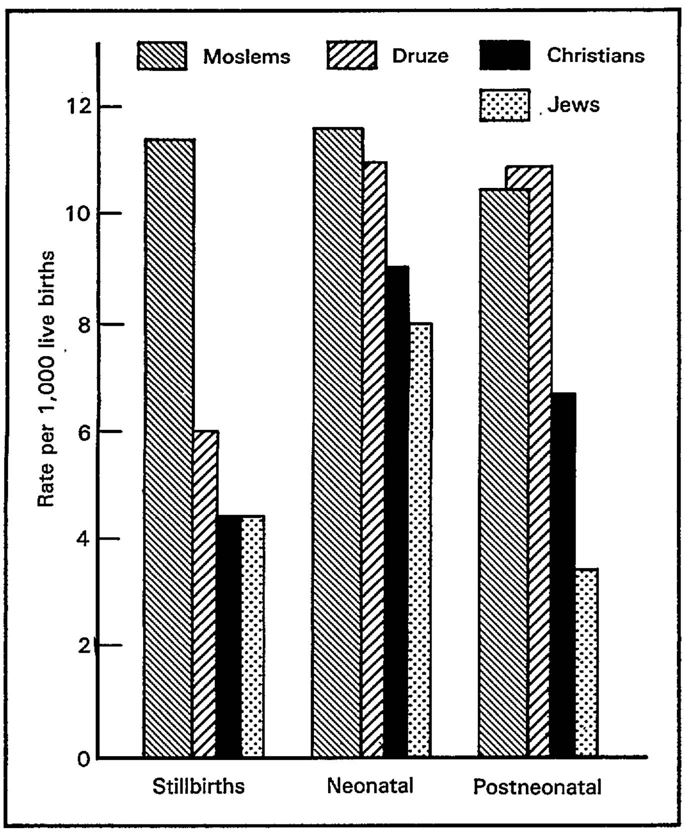

Figure 3. Fetal and infant mortality rates by religion: Israel, 1981–84

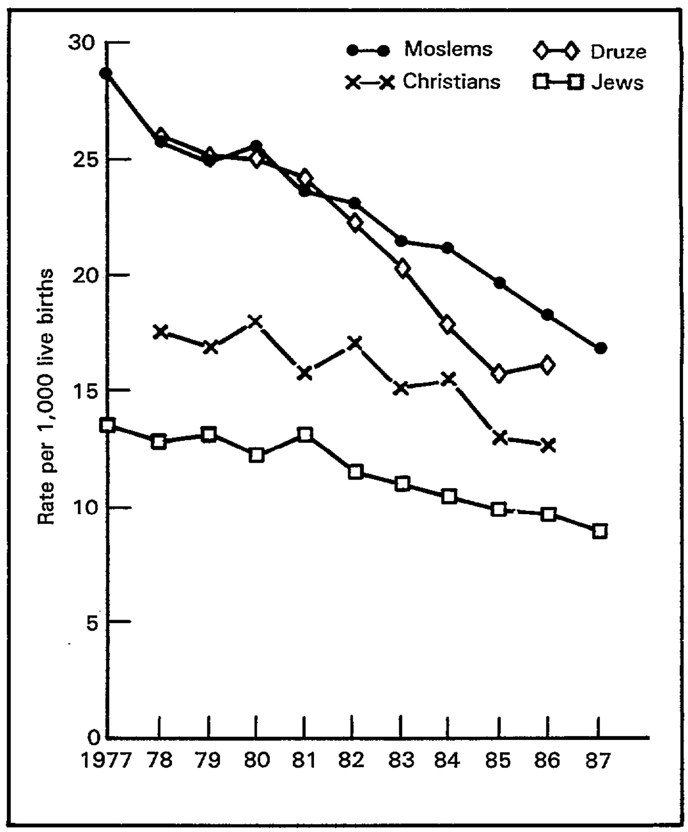

Figure 4. Infant mortality rate by religion: Israel, 1977–87

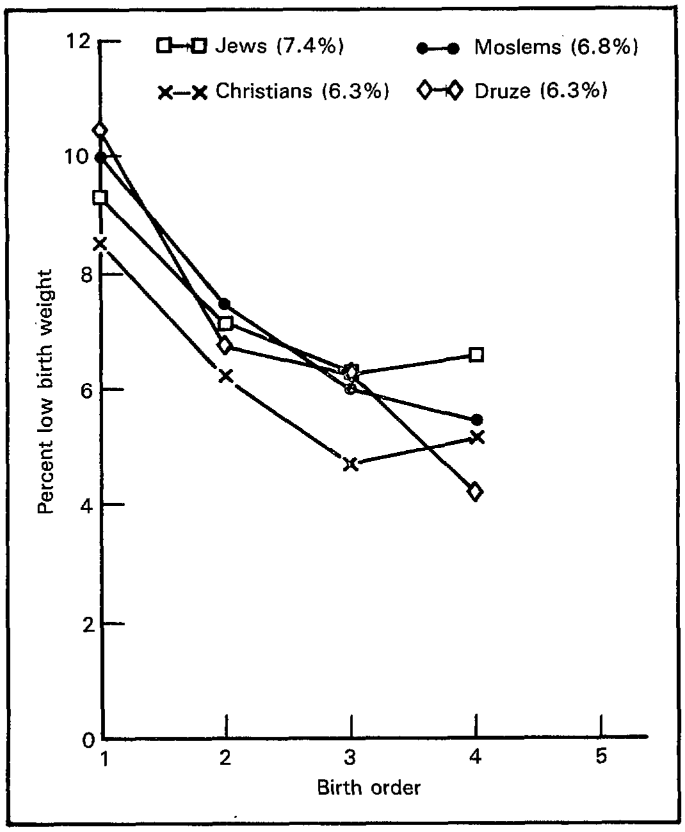

Figure 5. Percent low birth weight by birth order and religion, Israel

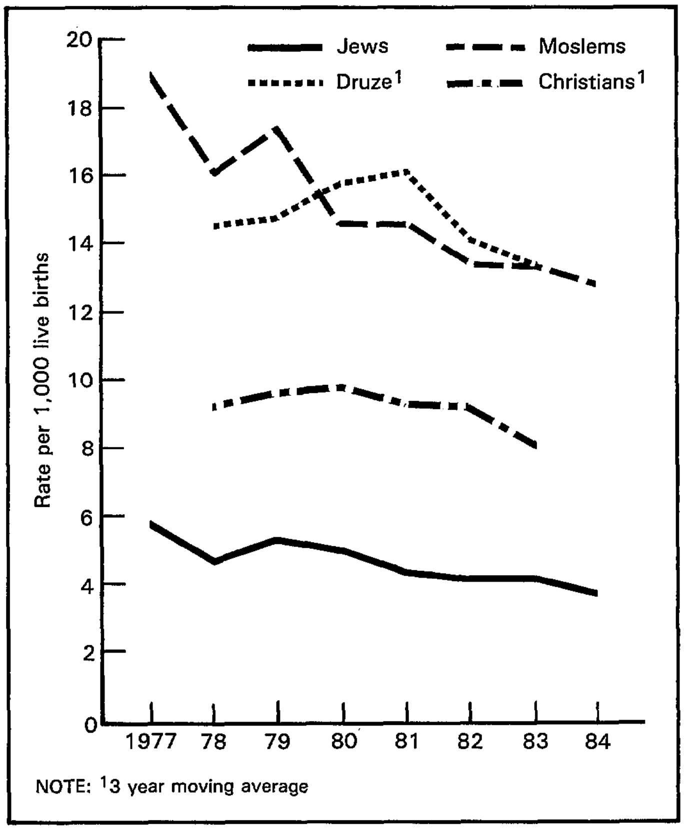

Figure 6. Infant mortality by religion: Israel, 1977–84. For infants with birth weight of 2.5 kg and above (GBW).

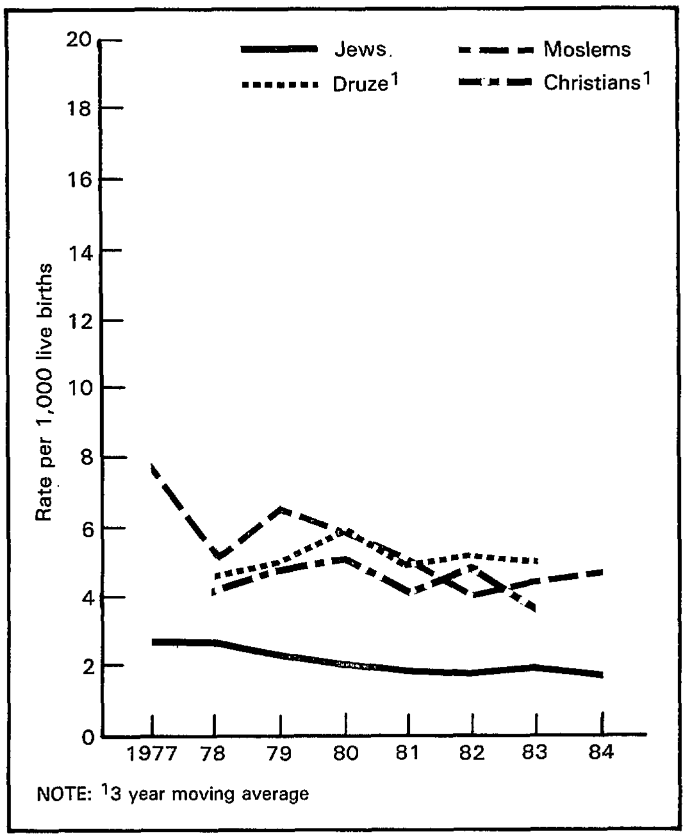

Figure 7. Neonatal mortality by religion: Israel, 1977–87. For infants with birth weight of 2.5 kg and above (GBW).

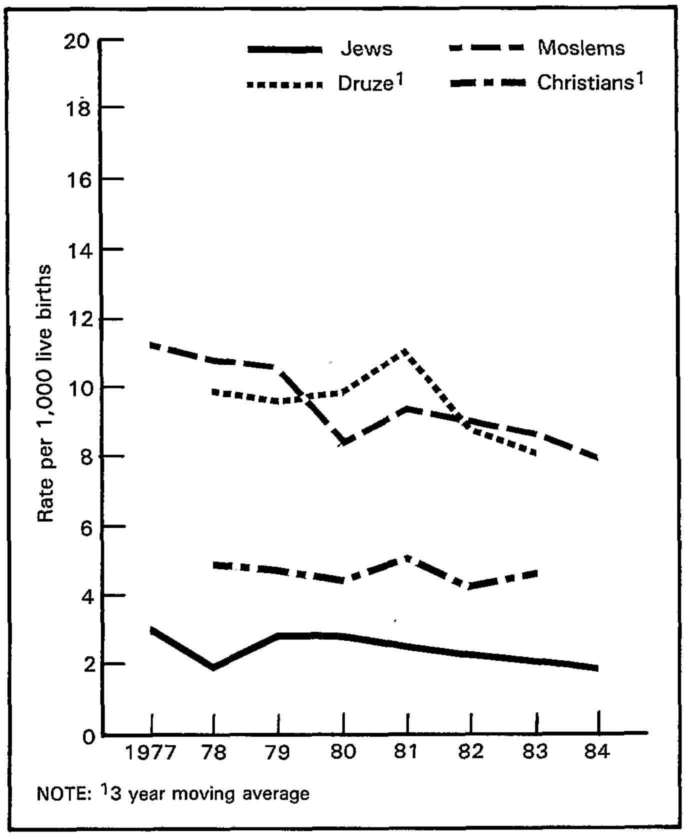

Figure 8. Postneonatal mortality by religion: Israel, 1977–87. For infants with birth weight of 2.5 kg and above (GBW).

- Mother's education
- Father's education
- Joint parental education
- Maternal age
- Birth order
- Sex of infant

Figure 9. Risk factors

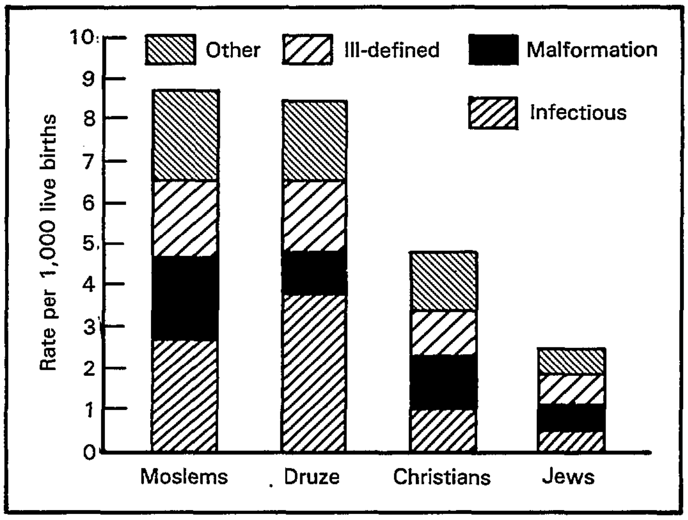

Figure 10. Postneonatal mortality rates by cause of death and religion: Israel, 1981–84. For infants with birth weight of 2.5 kg or more (GBW).

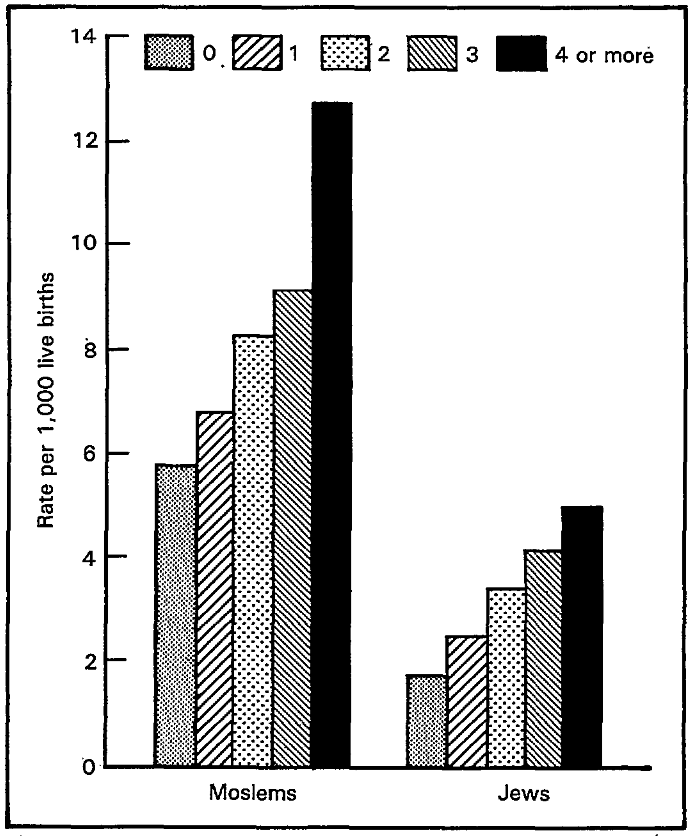

Figure 12. Postneonatal mortality rate by number of risk factors and religion: Israel, 1981–84

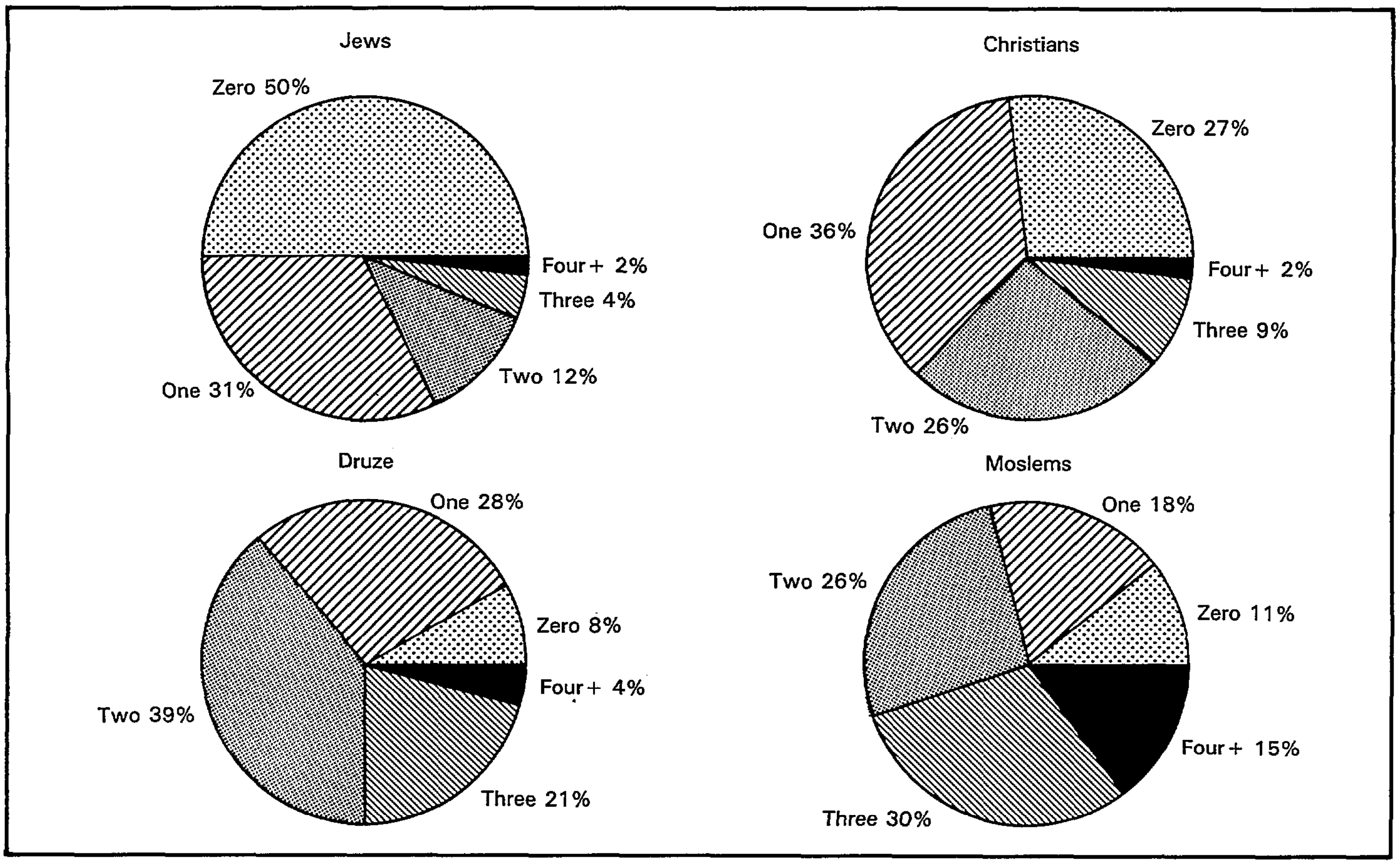

Figure 11. Percent distribution of number of risk factors by religion: Israel, 1981–84

Effects of Social Factors on Pregnancy Outcomes Including Birth Weight, Perinatal Mortality, and Infant Mortality in Norway, 1979-82

by Leiv S. Bakketeig, M.D., Annett Arntzen, M.A., and Per Magnus, M.D.

In this presentation we will examine in a population of Norwegian births the associations between the parent's socioeconomic status, maternal and paternal education, and outcomes of pregnancy, such as birth weight and mortality (perinatal and postneonatal).

Material

The analysis is based on information collected on all births in Norway during the 4-year period, 1979-82, a total of 206,449 births. Since 1967, civic and medical information has been collected on all births in Norway (live births and fetal deaths aged 16 weeks or more), and the information is kept at the Medical Birth Registry. In order to obtain information on variables not available in the Medical Birth Registry, such as parental education, occupation, and other socioeconomic factors, a record linkage was carried out based on the 11-digit personal ID-number attached to each child and its parents. Information from the Medical Birth Registry, the Death Registry, and from the 1980 census were linked. Both of the latter data sets were made available through the Central Bureau of Statistics.

This linkage implies that the socioeconomic conditions, including parental education as of November 1980, were applied to mothers who gave birth during the 4 calendar years 1979-82, approximately 2 years prior to and 2 years after the census. Our last census was in 1980 and therefore this is the reason for using nearly 10-year-old births as the basis for this analysis.

Results

Table 1 shows perinatal and postneonatal mortality by socioeconomic status (SES) based on father's occupation. Perinatal and postneonatal mortality rates are at their lowest for births in the highest socioeconomic group (SES group 1). We noticed that the highest mortality rates were in the group where the father of the child is unknown or unreported. This group of children is mostly born to unmarried mothers or the father's occupation was not traceable in the census. For postneonatal mortality the rate is more than 60 percent higher in the lowest social class as compared with the highest one, as shown in table 2.

Table 3 shows the association between the level of paternal education and perinatal and postneonatal mortality. The rates are expressed as relative to the rates for births to fathers with the highest education level (>12 years). There appears to be a gradient with the education level for mortality rates. For postneonatal mortality the rate is 50 percent higher for fathers with the minimum years of schooling.

In table 4 similar relationships are shown between education and mortality rates, but this time the focus is on the mother's education. Again strong associations emerge. Particularly, one notices the relatively high postneonatal mortality in the group in which the mother has minimum years of schooling, namely 80 percent higher mortality as compared with mothers with the highest level of education.

Let us then combine mother's and father's education and examine the association between the combinations of parental education and mortality. Let us first choose relative perinatal mortality as the outcome variable.

Table 5 shows that in the group where the father as well as the mother have a low education level, perinatal mortality is 1.8 times higher compared with the group where both parents have the highest education. When looking at births grouped by mother's level of education (horizontally in the table) the mortality in general drops as the education level of the father increases. Looking at the relationship vertically, the table shows that where the father has either the lowest or the intermediate level of education, there seems to be no association with the mother's level of education. However, when the father has the highest education level, mortality tends to drop with increasing maternal education.

In table 6 a similar relationship is shown for postneonatal mortality. However, here we notice that maternal education seems to carry more weight than does paternal education.

The tables presented so far are crude ones. They are based on all births, singletons and multiples; all parity groups; and all maternal ages, unmarried as well as married mothers. However, stratified analysis has demonstrated that the overall patterns stay the same. For example, focusing on a subsample of mothers having their first singleton birth, the relative mortality rates associated with social class, maternal and paternal education, and combinations of parental levels of education are much the same as the results shown here, and the associations tend to be even stronger.

Then, how do these relationships between social variables and mortality operate? We certainly have a long way to go in order to answer this question. But we do know how closely linked birth weight is with perinatal mortality in particular. Therefore, let us examine the association between parental education and birth weight.

In table 7 the average birth weight is shown for births to parents with the highest level of education. The average weight was 3575 grams. For each combination of parental education, the difference in average birth weight from the reference group mentioned above is shown. Where both parents have the lower level of education, the average birth weight was 122 grams lower. When one studies the table and the pattern of differences in birth weight more closely, one is struck by the similarities with the patterns in the two mortality tables previously shown.

A similar relationship is displayed in table 8 where instead of average birth weight the proportions of low birth weight (that is birth weight below 2500 grams) are given for each combination of parental education. Again, the same basic pattern seems to emerge. We notice, for example, that the proportion of low birthweight births is 5.4 percent when both parents have the lower level of education as compared with 2.9 percent where both parents have more than 12 years of schooling. Given the fact that birth weight is the strongest predictor of perinatal and infant mortality, these observations lend support to the hypothesis that the association between social factors and perinatal and infant mortality is to a major extent mediated through an association with birth weight.

Finally, in order to quantitate the importance of some biological and social variables we have applied a logistic regression analysis using birth weight as the dependant variable (birth weight below 2500 grams or birth weight 2500 grams or more). Independent variables are paternal and maternal SES groups (SES group 1, SES groups 2 and 3, and SES group 4), maternal and paternal education (<9 years, 10-12 years, and 12 years), and maternal age (20 years, 20-25 years, and 25 years) and parity (0 and 1+).

The results from this analysis are shown in the next two tables (tables 9 and 10). As shown in table 9, among the factors parity and maternal age, parity had the greatest impact: the proportion of low birthweight births was reduced by 20 percent from the first to later births (OR=0.80).

Table 10 shows that among the social factors, paternal and maternal education had an equal impact on the risk of a low birthweight birth (OR=0.88 and 0.87, respectively, where father and mother had an education >12 years). Maternal SES groups 2 and 3 combined increased the risk of low birthweight birth by 10 percent. There was no significant separate contribution by SES group based on father's occupation.

Conclusion

In conclusion, adverse pregnancy outcomes like perinatal and infant deaths as well as low birth weight are closely associated with social variables like parental education and socioeconomic group. It is of importance to notice that the impact of the father's education is at least of the same magnitude as that of the mother's education. And where both parents have the minimum years of schooling, the risk of adverse outcomes is 50 to 80 percent greater than when both parents have higher education.

These observations call for further research into the associations between social variables and health and what actually lies behind them. This area of research will most likely become an important part of perinatal epidemiology in the years to come.

Table 1. Perinatal and postneonatal mortality by socioeconomic status (father), Norway, 1979-82

SES group	Number of births	Mortality rates (per 1,000) Perinatal	Postneonatal
1	44,834	9.0	2.3
2	25,669	10.1	3.3
3	69,251	10.8	3.2
4	25,954	9.8	3.7
Unknown	40,741	33.6	4.2
Total	206,449	14.7	3.3

Table 2. Relative perinatal and postneonatal mortality by socioeconomic status (father), Norway, 1979-82

SES group	Relative mortality Perinatal	Postneonatal
1	1.0	1.0
2	1.1	1.4
3	1.2	1.4
4	1.1	1.6
Unknown	3.7	1.8

Table 3. Relative perinatal and postneonatal mortality by paternal education

Father's education (yrs.)	Number of births	Relative mortality rates	
		Perinatal	Postneonatal
≤9	36,634	1.4	1.5
10-12	76,423	1.2	1.2
>12	43,722	1.0	1.0
Unknown	49,670	(3.7)	(1.6)

Table 4. Relative perinatal and postneonatal mortality by maternal education

Mother's education (yrs.)	Number of births	Relative mortality rates	
		Perinatal	Postneonatal
≤9	45,997	1.5	1.8
10-12	99,976	1.2	1.3
>12	37,115	1.0	1.0
Unknown	23,361	(1.3)	(1.2)

Table 5. Relative perinatal mortality by parental education

		Father's education (yrs.)		
		≤9	10-12	>12
Mother's education (yrs.)	≤9	1.8	1.5	1.3
	10-12	1.5	1.3	1.3
	>12	1.6	1.5	1.0

Table 6. Relative postneonatal mortality by parental education

		Father's education (yrs.)		
		≤9	10-12	>12
Mother's education (yrs.)	≤9	1.5	1.5	1.6
	10-12	1.6	1.3	0.9
	>12	1.0	0.9	1.0

Table 7. Average birth weight by parental education (differences in grams from "optimal" weight)

		Father's education (yrs.)		
		≤9	10-12	>12
Mother's education (yrs.)	≤9	-122	- 84	- 51
	10-12	- 71	- 50	- 17
	> 12	- 25	- 25	3575 gms

Table 8. Percent of low birthweight births (<2500 grams) by parental education

		Father's education (yrs.)		
		≤9	10-12	>12
Mother's education (yrs.)	≤9	5.4	4.3	3.6
	10-12	4.4	3.7	3.4
	>12	4.6	3.5	2.9

Table 9. Biological factors and low birth weight logistic regression

Factor	OR	95% C.L.
Parity		
0	1.00	
1+	.80	.78- .83
Maternal age		
<20	1.00	
20-35	.85	.80- .91
>35	1.26	1.16-1.37

Table 10. Social factors and low birth weight--logistic regression

Factor	OR	95% C.L.
Paternal education (yrs.)		
≤9	1.00	
10-12	.96	.93-1.00
>12	.88	.84- .93
Maternal education (yrs.)		
≤9	1.00	
10-12	.91	.85-.96
>12	.87	.80-.94
SES (maternal)		
SES 1	1.00	
SES 2 + 3	1.10	1.05-1.15
SES 4	.99	.91-1.08

Effects of Socioeconomic Factors on Late Fetal and Infant Mortality in Sweden

by Sven Cnattingius, M.D. and Bengt Haglund, D.M.Sc.

The association between socioeconomic factors and pregnancy outcome has been known for a long time. The first Swedish investigation in this area was conducted in Stockholm during the 1920's. Postneonatal mortality was eight times higher if the family's yearly income was under 4,000 Swedish crowns as compared with a yearly income above 10,000 Swedish crowns. Regarding neonatal mortality, low income families were twice as likely to lose their child during the first month as compared with those with a high income (1).

Socioeconomic differences and pregnancy outcome in Sweden in the 1970's were studied by Ericson et al. (2). Despite increased incidence of low birthweight infants in the less favored socioeconomic group, there were no differences in perinatal mortality.

The study presented here is based on births from 1985 and 1986 registered in the Swedish birth registry. Information regarding social class is derived from 1985 census data. The linkage between the two registries is based on the mother's personal identification number. During the study period, 192,979 single births were reported to the birth register. The late fetal death rate was 3.4 per 1,000, while neonatal and postneonatal death rates were 3.2 and 2.1 per 1,000, respectively (table 1).

In Sweden, socioeconomic status (SES) can be assessed according to the SES of the woman, man, or family. We preferred family SES because many women do not belong to the work force during this part of life. Family SES is assessed according to the highest SES in the family. Socioeconomic status was divided into the following categories: women not in the working force; blue-collar workers--unskilled and skilled; white-collar workers--low, intermediate, and high level; self-employed; farmers; and nonclassifiable employees.

Rates of stillbirths were below 3 per 1,000 births among children of intermediate level white-collar workers, farmers, and nonclassifiable employees. Stillbirth rates were above 4 per 1,000 births among children born to women not in the work force and unskilled blue-collar workers. Also, neonatal mortality rates were low among infants of intermediate level white-collar workers and farmers. Higher rates were obtained primarily among infants born to women not in the work force, blue-collar workers, and higher level white-collar workers. Postneonatal mortality rates were low among infants of self-employed, intermediate, or high level white-collar workers. Higher rates were obtained among infants born to women not in the work force, among nonemployees, and nonclassifiable employees, but rates also were high for other groups, i.e., farmers and blue-collar workers.

When analyzing other differences between the socioeconomic groups, we found that women not in the work force, self-employed, and nonclassifiable employees, were heterogeneous with regard to other sociodemographic factors (i.e., maternal age, parity, family situation, and smoking habits). Probably, these relatively small groups include low risk as well as high risk women. These groups (and the small farmer group) were therefore excluded from further analyses.

Maternal smoking is reported to be associated with increased risks for late fetal death and infant death in Sweden (3,4). Smoking during pregnancy is reported to be more common in lower social classes. Thus, when studying socioeconomic differences in pregnancy outcome, smoking may act as a confounder through which at least some of the effects of social class on pregnancy outcome are mediated. We therefore cross tabulated smoking against social class. Table 2 shows that smoking habits varied between different socioeconomic groups, ranging from 42 percent smokers among non-skilled blue-collar workers to 14 percent among high level white-collar workers.

The crude relative risk (RR) of late fetal death, as shown in table 3, was highest for unskilled blue-collar workers (RR=1.8). Using logistic regression analysis, the risk estimate increased to 2.0 when adjustments were made for age and parity. Adjusting for the possible effects of smoking, in addition to age and parity, decreased the relative risk to 1.8. Significant adjusted relative risks for late fetal death were also obtained for skilled blue-collar workers and low level white-collar workers (RR=1.4, respectively).

Regarding neonatal death, significant adjusted relative risks were obtained for skilled and unskilled blue-collar workers and high level white-collar workers (RR=1.5). When studying postneonatal death rates, only slight differences in mortality rates were found, and none of these reached statistical significance.

In summary, in Sweden today the greatest effect of socioeconomic status is on late fetal mortality rather than on mortality in the first year of life. In sharp contrast with the previously quoted Swedish study from the 1920's, only slight differences in postneonatal death rates were obtained. This is also in contrast with other studies in which social class has been reported to be strongly associated primarily with postneonatal death rates (5). The postneonatal death rate is relatively low in Sweden, and the relative contribution of congenital malformations is relatively high. Further study of socioeconomic differences in infant mortality should consider not only differences in time of death but also differences in causes of death between socioeconomic groups.

Acknowledgment. We are indebted to Anders Ericson, Director, and Jan Gunnarskog, programmer, at the National Board of Health and Welfare, for providing data for this investigation.

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Table 1. Late fetal death and infant mortality by socioeconomic status of the family; Sweden 1985-86, single births

	Number of births	Stillbirth N	Stillbirth per 1,000	Infant mortality: Neonatal N	Infant mortality: Neonatal per 1,000	Infant mortality: Postneonatal N	Infant mortality: Postneonatal per 1,000
Not in working force	9,096	39	4.3	37	4.1	36	4.0
Blue-collar workers:							
- unskilled	37,192	171	4.6	127	3.4	76	2.1
- skilled	40,420	132	3.3	144	3.6	91	2.3
White-collar workers:							
- low level	22,204	81	3.6	68	3.1	41	1.9
- intermediate	38,944	100	2.6	98	2.5	58	1.5
- high level	25,234	77	3.1	98	3.9	38	1.5
Self-employed	7,994	33	4.1	25	3.1	11	1.4
Farmers	3,526	8	2.3	9	2.6	9	2.6
Not classifiable employees	7,648	16	2.1	12	1.6	31	4.1
Information not available	721	2	2.8	4	5.6	4	5.6
Total	192,979	659	3.4	622	3.2	395	2.1

Table 2. Smoking habits and socioeconomic status of the family

	Percent daily smokers
Blue-collar workers:	
- unskilled	42
- skilled	35
White-collar workers:	
- low level	30
- intermediate	18
- high level	14

Table 3. Pregnancy outcome by socioeconomic status of the family. Single births in Sweden, 1985-86

	Death rate per 1,000	Crude RR	Age and parity adjusted RR	Age, parity, and smoking adjusted RR	95% CI
		--- Late fetal death ---			
Blue-collar workers					
- unskilled	4.6	1.8	2.0	1.8	1.4-2.4
- skilled	3.3	1.3	1.4	1.4	1.0-1.8
White-collar workers					
- low level	3.6	1.4	1.4	1.4	1.0-1.9
- intermediate	2.6	1.0	1.0	1.0	
- high level	3.1	1.2	1.1	1.1	0.8-1.5
		--- Neonatal death ---			
Blue-collar workers					
- unskilled	3.4	1.4	1.5	1.5	1.1-2.0
- skilled	3.6	1.4	1.5	1.5	1.1-2.0
White-collar workers					
- low level	3.1	1.2	1.3	1.3	0.9-1.8
- intermediate	2.5	1.0	1.0	1.0	
- high level	3.9	1.5	1.5	1.5	1.1-2.1
		--- Postneonatal death ---			
Blue-collar workers					
- unskilled	2.1	1.4	1.2	1.2	0.8-1.8
- skilled	2.3	1.5	1.4	1.3	0.9-1.9
White-collar workers					
- low level	1.9	1.2	1.2	1.3	0.8-1.9
- intermediate	1.5	1.0	1.0	1.0	
- high level	1.5	1.0	1.0	1.0	0.7-1.6

Relationship of Cultural and Social Factors to Pregnancy Outcomes in England and Wales

by Beverley J. Botting, B.Sc., and Alison J. Macfarlane, B.A., Dip.Stat.

Abstract

Data from England and Wales that link information collected at the registration of an infant death together with that collected at the infant's birth registration were used to examine infant mortality rates according to the father's social class, the mother's country of birth, the parents' marital status, and where in England and Wales the parents lived, and to examine the relationship of these variables with birth weight.

Introduction

Since 1975 the Office of Population Censuses and Surveys (OPCS) has linked death records of infants dying under 1 year of age with their corresponding birth records, thereby providing information on a variety of social and biological factors relating to the infants who died and to their families. Information on many variables--including the mother's age, her marital status, where she lives, the number of previous children born within marriage (parity), parents' countries of birth, and birth weight--is available from the birth records. Death records provide information on causes of death and the parents' occupation from which the social class is derived.

The social class classification used has six main categories. The first three, social classes I, II, and IIIN, are non-manual groups, moving from social class I (which includes professional groups such as doctors) to social class IIIN (which includes those working in shops and similar occupations). The remaining classes are social class IIIM, which includes the manual skilled occupations; social class IV, which includes the semiskilled manual occupations; and social class V, which includes the unskilled manual occupations.

Within England and Wales there are approximately 650,000 live births, 6,000 infant deaths, and 3,000 stillbirths each year. Infant mortality rates are raised among children of some social and demographic subgroups of the population. This paper will consider how infant mortality rates are associated with the father's social class, the mother's country of birth, the parents' marital status, and where the parents lived (separately and in combination), and the relationship of these variables with birth weight. Of course, these characteristics are not independent of each other.

Birth weight

The 1946 National Birth Survey (1), the 1958 British Perinatal Mortality Survey (2), and the 1970 British Births Survey (3) all showed associations between low birth weight and a number of demographic and socioeconomic factors. Since these special cohort studies, based on relatively small numbers of children, were carried out, birthweight data have become available routinely for nearly all births and infant deaths in England and Wales.

A system for recording birth weight for stillbirths has been in operation for over 20 years. OPCS has obtained birthweight information for live births since 1975 through the cooperation of district health authorities. The completeness of birthweight recording on live births improved consistently from 1975 and has been nearly complete since 1983. In 1987 nonstatement of birth weight was less than one-tenth of 1 percent for live births, 1 percent for stillbirths, 4 percent for early neonatal deaths, 2 percent for late neonatal deaths (deaths at ages between 7 and 27 days), and less than one-half of 1 percent for postneonatal deaths. Since some babies dying soon after birth are never weighed, it is likely that this group may include an excess of low birthweight babies. It is not possible to test this hypothesis by analyzing these births by gestation because gestation is not collected at live birth registration. It is collected for stillbirths.

An infant's chance of survival is closely associated with its birth weight. As shown in figure 1, in 1987 over a quarter of all babies born live in England and Wales weighing under 1500 grams died in the first 28 days of life, compared with less than 2 per 1,000 live born babies weighing 3000 grams or more.

Figure 2 shows the birthweight distribution of live births, stillbirths, and early neonatal deaths (deaths at less than 7 days after live birth) in 1987. Over one-half of babies dying in the first week of life weighed less than 1500 grams compared with less than one-third of stillbirths and only 1 percent of live births. The birthweight distribution for stillbirths is, however, distorted by the 28 week gestation criterion for stillbirths. Babies delivered dead before 28 completed weeks gestation may have birth weights higher than those of some live births but are not currently legally registrable in England and Wales and hence do not appear in OPCS statistics. All live births are registrable irrespective of birth weight and gestation. The association between birth weight and mortality is very strong during the first year of life, but, as would be expected, it decreases with increasing age.

Social class

For deaths in infancy of babies born inside marriage there are marked persistent and statistically significant social class differences based upon the occupation of the father, but as shown in figure 3, the differences decreased between 1979 and 1986. The ratio in mortality between social class V (non-skilled occupations) and social class I (professional occupations) is largest for postneonatal deaths.

The decrease in overall postneonatal mortality in the 1970's was associated with a sharp decline in the social class differentials (4). There was a change in the OPCS occupational classification in 1979, since which time, as shown in figure 4, there has been a small decrease in the differentials. Among children of married couples, the postneonatal mortality rate is low for social classes I, II, and IIIN, and increases progressively through social classes IIIM, IV and V. The postneonatal mortality rate among children whose father's social class was classified as other (mainly students, military personnel, and those who have never had a job) is higher than for social class V.

Marital status

Figure 5 illustrates the recent rise in the proportion of births occurring outside marriage and also indicates the proportion of those that were registered jointly by both parents. In recent years there have been changes in the distribution of births by marital status in England and Wales. Children born outside marriage can be registered jointly by both parents or by their mother alone, but for these children the father's details can only be given on the birth registration documents if the father is present at the registration. The proportion of live births that were to married parents decreased rapidly from 91 percent in 1975 to 74 percent in 1988. The proportion of all births that were registered by the mother alone increased from 5 to 8 percent during the same period, but the largest increase was the proportion of births outside marriage registered jointly by both parents--from 4 to 18 percent. There were more live births outside marriage in 1988 (177,000) than in any previous year.

Some 68 percent of births outside marriage in 1987 were jointly registered and in 70 percent of these cases the mother and father gave the same address as their usual place of residence. These figures suggest that at least one-half of the children born outside marriage during 1987 had parents who were living together in a stable relationship.

There were increases between 1986 and 1987 in the numbers and proportions of births outside marriage for women in all age groups. Nearly three out of four births to teenage women in 1987 occurred outside marriage, almost double the proportion 10 years earlier. The largest increase, however, was for women aged 20-24; 31 percent of births to women in this age group occurred outside marriage in 1987, more than three times the proportion in 1977.

The recent increase in the number of children born outside marriage (registered by the father and mother together or by the mother alone) makes it important to consider whether there has been a change in the social and economic conditions associated with being born to unmarried parents.

Infant mortality is strongly associated with the marital status of parents and also with the different types of birth registration outside marriage, with the highest rates for infants of single women who register the child alone. For example, considering the years 1987 and 1988 combined, the infant mortality rate for infants born inside marriage was 8.0 per 1,000 live births; for infants born outside marriage whose birth was registered by both parents giving the same address, the rate was 11.0, about 38 percent higher; for babies born outside marriage registered by both parents who gave different addresses, the rate was only slightly higher at 11.3; and for babies born outside marriage registered by the mother alone the infant mortality rate was 14.3, over 70 percent higher than for babies born within marriage.

Marital status and social class

Children born outside marriage who are registered jointly by both parents have postneonatal mortality rates on average 1 1/2 times higher than those of children of married parents of the same social class. The differential among children of fathers whose social class is classified as "other" is even higher. For postneonatal mortality rates the ratio between social class V and social class I is less marked among the jointly registered children of unmarried parents than among children of married couples. This may be a result of small numbers or may reflect a smaller association between the social class of the father and the living conditions of the children of unmarried parents. It may also reflect the different social class distributions of the parents of children born inside or outside marriage.

Unmarried fathers who were present at the registration of their child's birth have a different social class distribution to that of married fathers. In 1988, as shown in figure 6, only 15 percent of jointly registered children born outside marriage had fathers in social classes I and II compared with 32 percent of the children of married couples. In part, the different social class distribution is a result of the different age structure of the two groups.

As a proxy for standardization to take into account this different age structure, figure 7 examines one age group (25-29), comparing the mean birth weight for those babies born inside marriage and those outside marriage registered jointly by both parents. For all social classes the mean birth weight is higher for those born inside marriage.

Country of birth

Another variable known to be associated with differences in birthweight is the mother's country of birth (5). In England and Wales approximately 10 percent of births are to women who were born outside England and Wales. Country of birth is increasingly becoming a poor indicator of ethnic origin for births in England and Wales. Identification of a child's ethnicity by mother's country of birth, although the only practical method in present circumstances, under-represents the numbers of black and Asian mothers as it classifies second-generation immigrant mothers as UK born rather than foreign born. In addition, while many women of Afro-Caribbean ethnic origin and an increasing proportion of women of Asian ethnic origin were born in England and Wales, very few women born in India or Africa are of European descent.

This is not yet a serious difficulty in the case of mothers of Asian origin, since the majority of these women entered this country in the 1970's and 1980's as young adults. Only a small proportion of Asian women born in England and Wales had therefore reached the age of 20 by the mid-1980's. However, the majority of Asian women now entering the childbearing ages are UK born; consequently their births, as a proportion of all births to Asian women, will rise rapidly. On the other hand, most immigration from the Caribbean occurred in the 1950's and 1960's. UK born Afro-Caribbean mothers therefore account for a sizable proportion of all births to those of Afro-Caribbean origin. Therefore, the following analysis covers Asian births in England and Wales fairly comprehensively, but for Caribbeans it excludes many births to Afro-Caribbean women.

Figure 8 shows trends in infant mortality rates during the period 1975-85 in terms of 3-year moving averages. Data for women born in India and Bangladesh and in East and West Africa have been aggregated because in the earlier years data were not available separately for these countries. Infant mortality fell in all groups over the decade. By the mid-1980's the excess mortality for infants of Indian, Bangladeshi, and African born women seen during the 1970's had virtually disappeared. Infant mortality among infants of Caribbean and Pakistani mothers declined at almost the same rate as in the UK group; their excess over the UK group (72 percent for Pakistanis and 35 percent for Caribbeans) remained virtually unchanged over the 10-year period.

The differences in infant mortality by mother's country of birth for the period 1982-85 combined are given in figure 9. Differences in levels of mortality between the country of birth groups showed considerable variation according to the age at death. The differences were generally larger in the neonatal period than in the postneonatal period and not always in the same direction. Whereas all groups of infant deaths to immigrant mothers showed excess neonatal mortality over the indigenous population, this was not the case with postneonatal mortality.

For infants of Indian, Bangladeshi, and East African born mothers excess mortality in the neonatal period was counterbalanced by lower mortality in the postneonatal period, which resulted in levels of infant mortality that were similar to those for the indigenous population. For infants of Pakistani, West African, and Caribbean mothers overall infant mortality was raised well above the level for the UK group and, therefore, also above the rates for infants of Indian, Bangladeshi, and East African mothers. At every stage of infancy, however, mortality for infants of Pakistani mothers was significantly higher than the rates prevailing for the UK group and also for all other countries of birth groups. This pattern was apparent throughout the 1975-85 decade.

Country of birth and birth weight

Figure 10 shows that there are differences in the birthweight distributions of babies born to mothers of different countries of birth, with the highest proportion of low birthweight live births (less than 2500 grams) being recorded for mothers born in East Africa. Indian, Bangladeshi, and East African mothers had much higher proportions of babies weighing under 3000 grams (43 to 48 percent) than the UK group (25 percent).

Women born in Pakistan had a higher proportion of babies weighing over 3000 grams compared with other groups from the Indian subcontinent but a lower proportion than the UK group. Birth weights for infants of West African and Caribbean mothers were lower than in the UK group but higher than in Asian groups.

These results have been confirmed in a number of local studies (6-11). For example, an early study showed that babies born to women from the West Indies were on average of lower birth weight than those whose parents were born in Britain, even after adjusting for the mothers' heights and parities. A further study showed that women of Asian ethnic origin in higher socioeconomic groups tended to have babies of lower average birth weight than women of European ethnic origin (10). It also showed that babies born to Asian women in the higher socioeconomic groups had lower mortality than those born to less affluent women of Asian ethnic origin (11).

Of course, birth weight cannot be considered in isolation from gestational age, but gestational age is not collected at the registration of live births in England and Wales. Figure 11 is taken from hospital discharge data. It cannot, therefore, be used to calculate mortality rates but it does provide an opportunity to examine gestational age data by country of birth. The collection of these data ceased in 1985.

The mean gestational age is given together with a 95 percent confidence interval for each country of birth group. For most groups born outside the UK the confidence intervals are very wide, which reflects the small numbers of births.

Returning to mortality data, there were interesting differences in birthweight-specific infant mortality between some country of birth groups. Considering the neonatal and postneonatal components separately, at birth weights under 3000 grams neonatal mortality rates were lower for infants of Indian, Bangladeshi, and East African mothers than for the UK group, even though overall neonatal mortality was significantly higher for infants of these immigrant groups. Weight for weight, however, infants of women born in Pakistan had markedly higher neonatal rates compared with the UK group and other infants with mothers from the Indian subcontinent.

Postneonatal mortality also showed an association (although less marked than neonatal mortality) with birth weight, with the highest mortality in all groups at birth weights under 2500 grams. Infants of Indian, Bangladeshi, and East African mothers had lower postneonatal mortality than the UK group at every birth weight, but infants of Pakistani mothers again showed markedly higher rates than the UK and other Asian groups throughout. Infants of Caribbean and West African mothers had higher postneonatal mortality at birth weights under 2500 grams; this pattern was generally reversed at higher birth weights.

Country of birth and social class

As shown earlier, in England and Wales neonatal, postneonatal, and infant mortality vary with social class, the rates rising from social class I to social class V. The rates for the various country of birth groups were analyzed by social class to determine if country of birth groups show similar differences and if mortality differences between country of birth groups could be explained by differences in social class composition.

Social class differences in infant mortality were evident in all country of birth groups, with mortality generally rising from social class I to V. Interclass variation in mortality was generally greater for immigrant groups than for the UK group. Infant mortality in social classes IIIN, IIIM, and IV was particularly high among infants of Caribbean and Pakistani women, and in social class V among infants of West African and Pakistani women.

One-half of births to Caribbean women during 1982-85 took place outside marriage, but there was no difference in infant mortality between those born inside and those born outside marriage.

The populations from different countries of birth have different social class distributions to the indigenous population. Figure 12 shows infant mortality ratios for the different country of birth groups, standardized for social class. Rates for women born in the United Kingdom were used as the standard. Standardization has little effect on the direction and magnitude of mortality differences between the groups. After standardization for social class, infant mortality was still significantly higher for infants of Caribbean and Pakistani mothers than for other infants. Differences in the social class composition of the various immigrant groups explain only a relatively small part of the observed intergroup variation in mortality.

Geographical differences

Within England and Wales there are clear geographical patterns in infant mortality (12). For National Health Service purposes, England is divided into 14 Regional Health Authorities (RHA's), with each RHA and Wales then divided into between 8 and 22 District Health Authorities (DHA's).

During 1983-85 all RHA's in the south of England had neonatal mortality rates below that of England and Wales. The rates for most northern RHA's and Wales were noticeably above the national level. Differences in postneonatal mortality rates between northern and southern RHA's disappeared in the mid-1970's (figure 13) and have remained at similar but fluctuating levels since.

An RHA can encompass a wide variety of different urban and rural areas and have populations with different social class and country of birth distributions. Therefore, it is useful to analyze data for the smaller areas of the DHA's.

Due to the relatively small number of deaths in each DHA in England and in Wales, apparently large differences in mortality between areas may occur by chance. Crude infant mortality rates for DHA's ranged from 6.0 to 13.2 per 1,000 live births for the period 1983-85. This spread of rates is much larger than that for RHA's that ranged from 8.6 to 10.9. This reflects the greater variability arising from the much smaller number of deaths and the much more marked differences between the socioeconomic characteristics of the populations of the DHA's. These can, in their turn, affect the birthweight distribution of live births in each DHA. It is also possible that there are local differences in the quality and accessibility of health care available in pregnancy, in labor, and in the postnatal period. Analyses which have included both socioeconomic factors and indicators of the provision of health care have found that the outcome of pregnancy in terms of mortality and the incidence of low birth weight is more closely associated statistically with provision of health care (13-15).

DHA's may have relatively high mortality at one point in the birthweight distribution but not elsewhere. Differences in birthweight-specific mortality rates have practical implications for monitoring and planning maternity services. In addition, a higher mortality rate among very low birthweight births has very different implications from a higher rate among heavier babies, when seeking ways to reduce mortality.

Infant mortality rates for different birthweight groups and for all weights combined were examined separately for each DHA in England and each management unit in Wales (for convenience, management units in Wales were referred to as DHA's in this analysis). For each birthweight group 95 percent confidence intervals (based on the normal approximation to the binomial distribution) were calculated by applying the England and Wales rates to the number of live births in each DHA. DHA's whose rates lay outside these confidence intervals, either above or below, were identified. At this probability level it would be expected that 5 percent, or 11 out of each set of 216 rates, would lie outside the interval, if the difference were attributed to chance alone. The resulting data for births of all birth weights are shown in figure 14, together with the England and Wales rate and the 95 percent confidence intervals.

For all babies, irrespective of birth weight, 22 DHA's had crude infant mortality rates that lay above the upper end of the confidence interval and 17 had rates that lay below the lower end. These 39 areas outside the interval are more than the 11 that would be expected by chance.

Geographical differences by country of birth

Immigrants to England and Wales have tended to cluster in particular areas. It is reasonable, therefore, to expect that areas with a high proportion of women from the New Commonwealth and Pakistan will have different birthweight distributions to other areas.

As seen earlier, during the period 1983-85 the highest infant mortality rates in England and Wales were among babies whose mothers were born in Pakistan or Bangladesh. These differences persisted across birthweight categories but not always when cross-tabulated by RHA of mother's residence. In most RHA's, however, infant mortality rates were highest for infants of Pakistani mothers.

Differences in infant mortality were more marked at the DHA level. The various immigrant groups were generally concentrated in specific DHA's. Examining data for 1983-85 showed that in DHA's with the highest immigrant infant mortality rates, the immigrant community was predominantly of Pakistani origin. In areas with low rates for infants of immigrant mothers, the predominant groups generally but not always were of Indian and East African origin.

Figure 14 shows that in 13 of the 22 DHA's with rates above the upper end of the interval, more than 10 percent of mothers had been born in the New Commonwealth or Pakistan. In the DHA's with rates below the lower end of the interval, the percentage of mothers born in the New Commonwealth or Pakistan did not exceed 8 percent and it only exceeded 5 percent in seven DHA's. Similarly, analysis by social class derived from the father's occupation shows that 20 of the 22 DHA's with high infant mortality rates had 20 percent or more of fathers in social classes IV and V combined, whereas of the 17 DHA's with low rates only 4 DHA's had more than 20 percent of fathers in these classes.

This analysis also confirmed the existence of infant mortality gradients by social class and country of birth of mothers within the different birthweight groups. Babies weighing under 1500 grams at birth had a higher risk of death in DHA's where there was a high proportion of fathers in social classes IV and V. In the higher weight groups mortality was lower in DHA's with a low proportion of fathers in social classes IV and V. For births over 2500 grams, infant mortality rates were low for areas with low proportions of mothers born in the New Commonwealth and Pakistan.

Summary and conclusion

When the rate of decrease in infant mortality rates slowed down during the 1980's in England and Wales, it was natural to wonder if a "biological limit" had been reached from which further reductions would not be possible at the present level of scientific development. This question can be answered in part by the presence of differentials. Even after the reductions observed over the previous decade, differentials in the infant mortality rate still existed in England and Wales in 1988. The presence of differentials in mortality rates implies that there is potential for further reduction.

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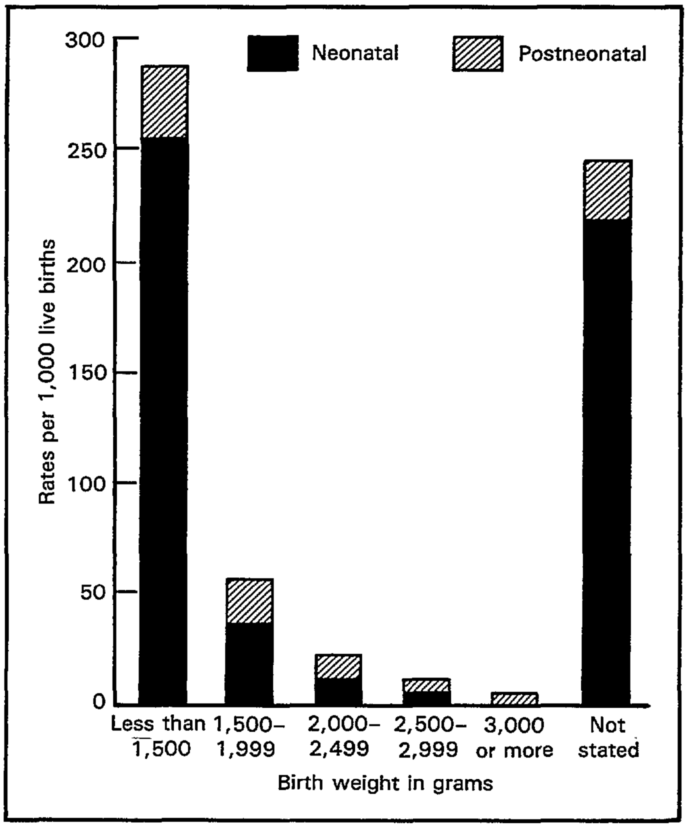

Figure 1. Neonatal and postneonatal mortality rates by birth weight: England and Wales, 1987

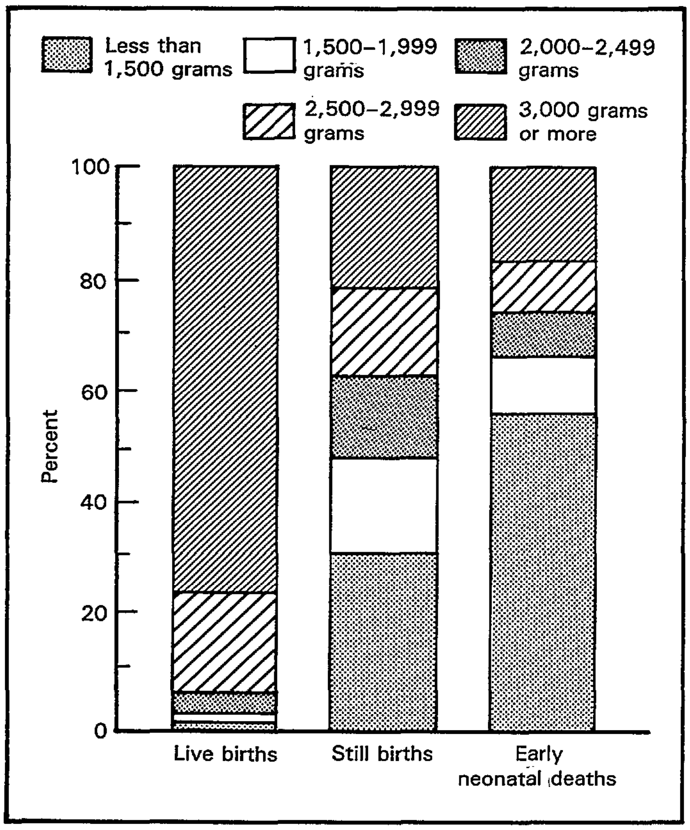

Figure 2. Percent distribution of live births, stillbirths, and early neonatal deaths by birth weight: England and Wales, 1987

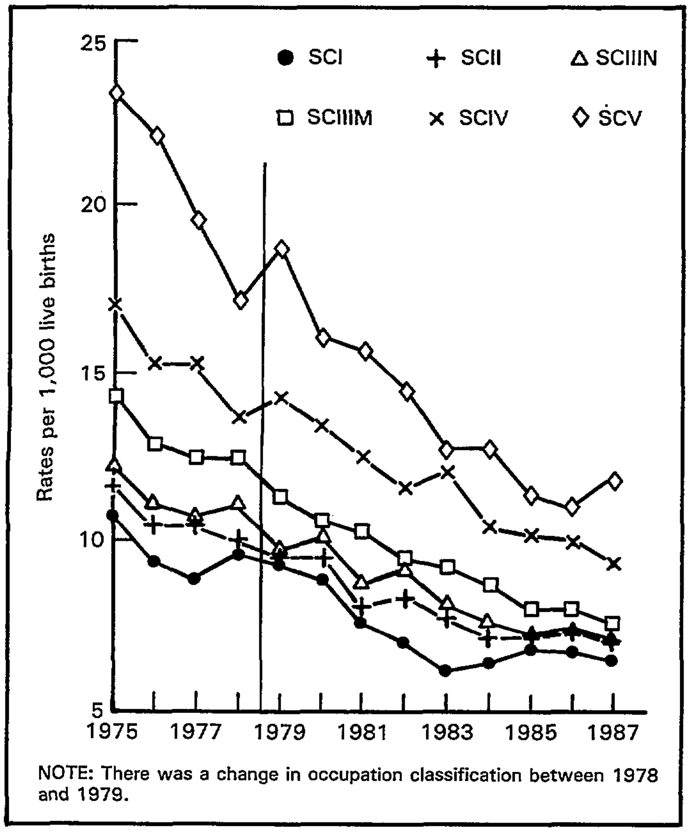

Figure 3. Infant mortality rates by social class, births inside marriage only: England and Wales, 1975–87

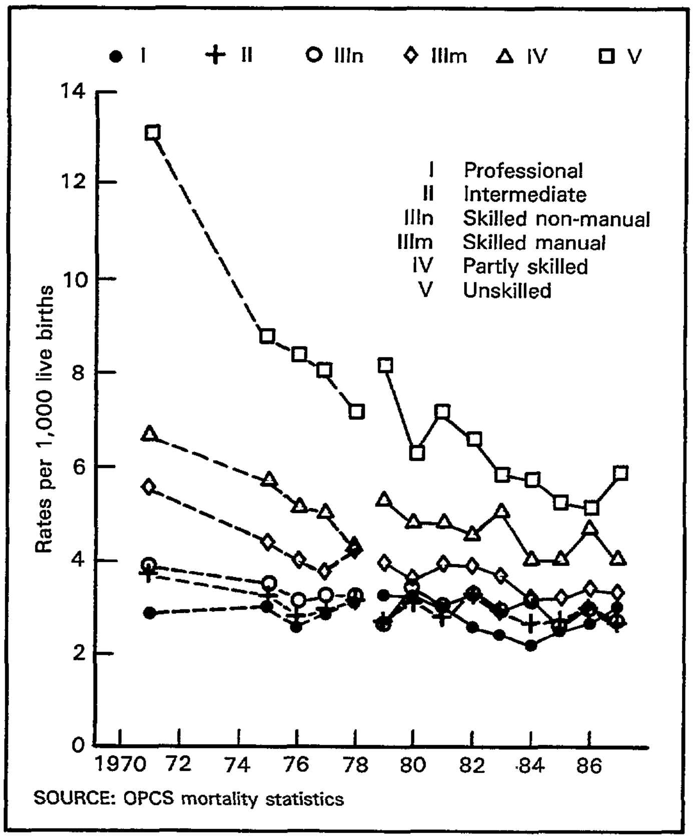

Figure 4. Postneonatal mortality rates by father's social class: England and Wales, 1970–87

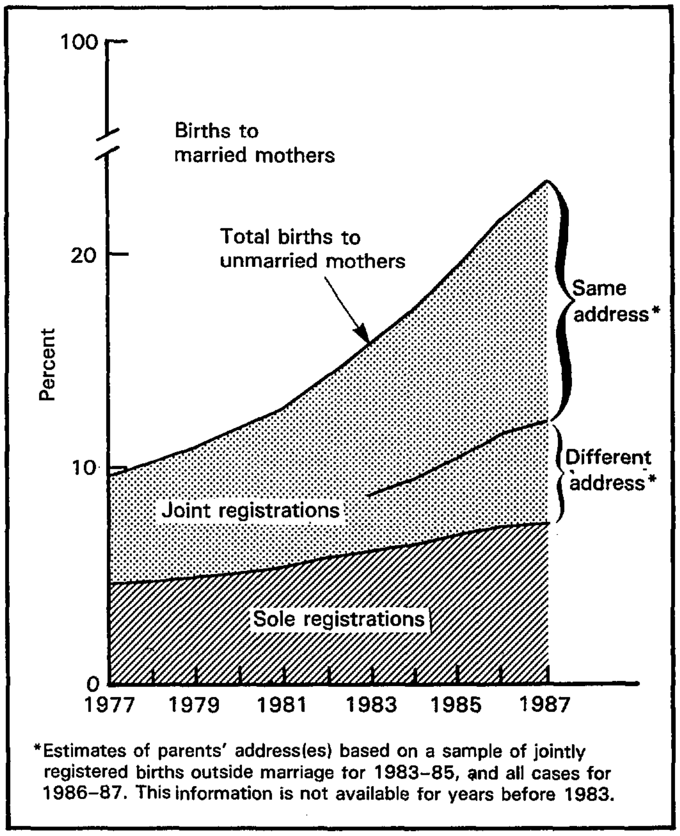

Figure 5. Live births outside marriage as a percentage of all live births, by marital status of mother: England and Wales, 1977-87

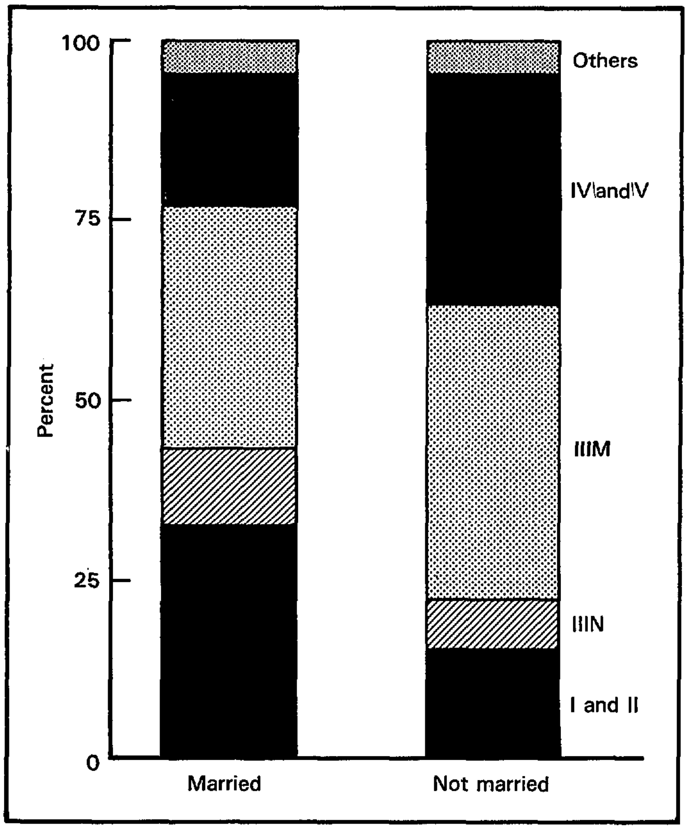

Figure 6. Births by social class, inside and outside (jointly registered) marriage: England and Wales, 1988

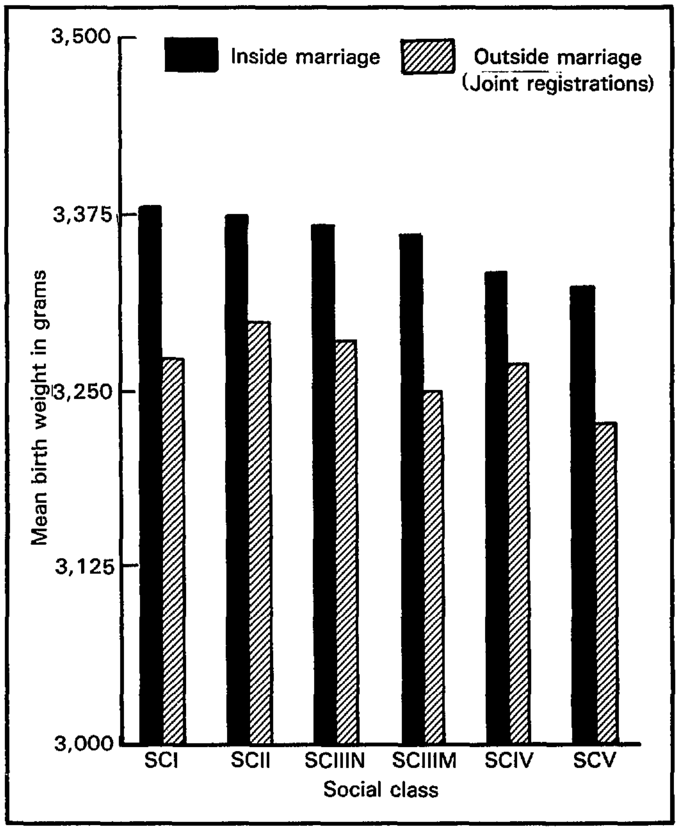

Figure 7. Mean birth weight of infants, by social class and marital status of mothers ages 25-29 years: England and Wales, 1989

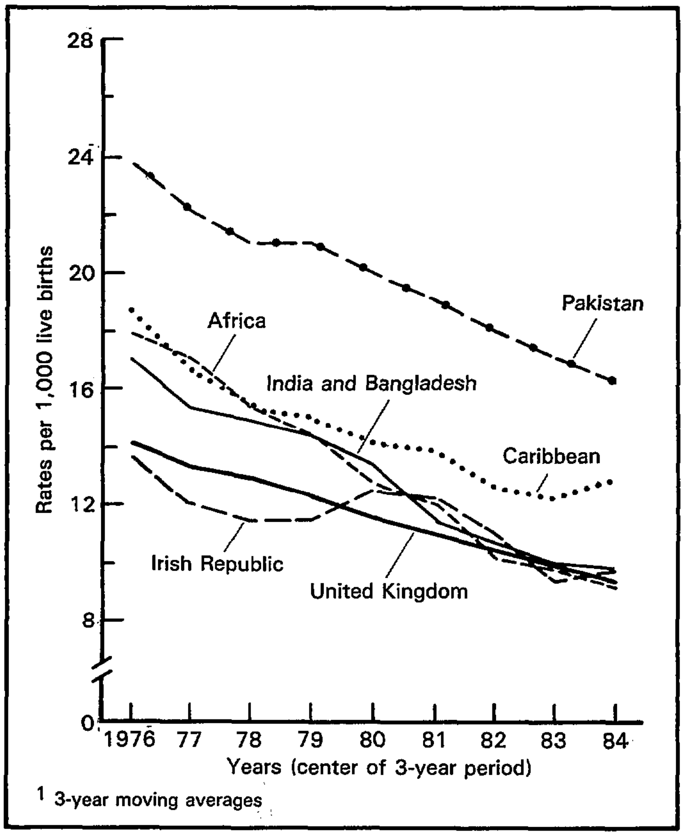

Figure 8. Trends in infant mortality by mother's country of birth: England and Wales[1], 1975-85

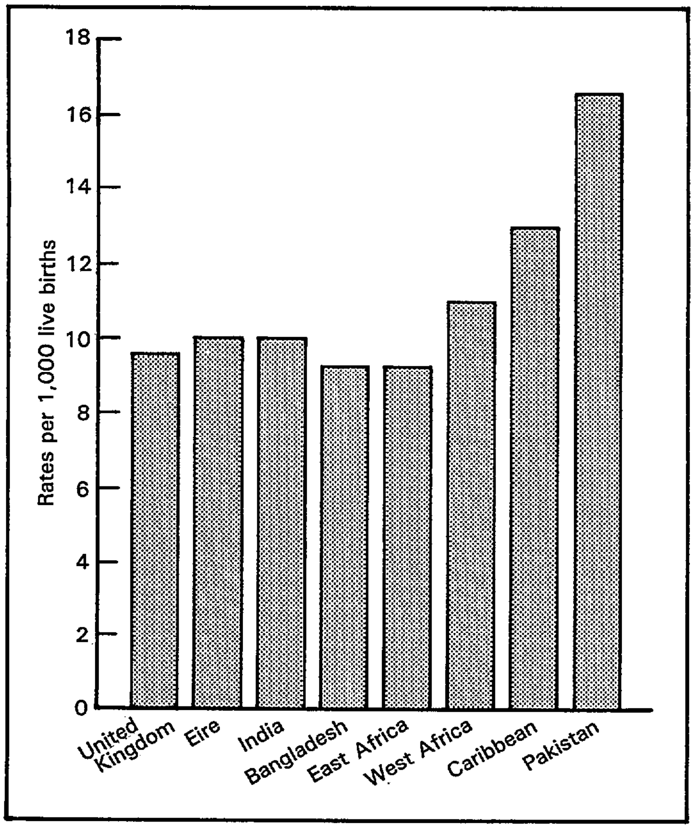

Figure 9. Infant mortality rates by mother's country of birth: England and Wales, 1982–85

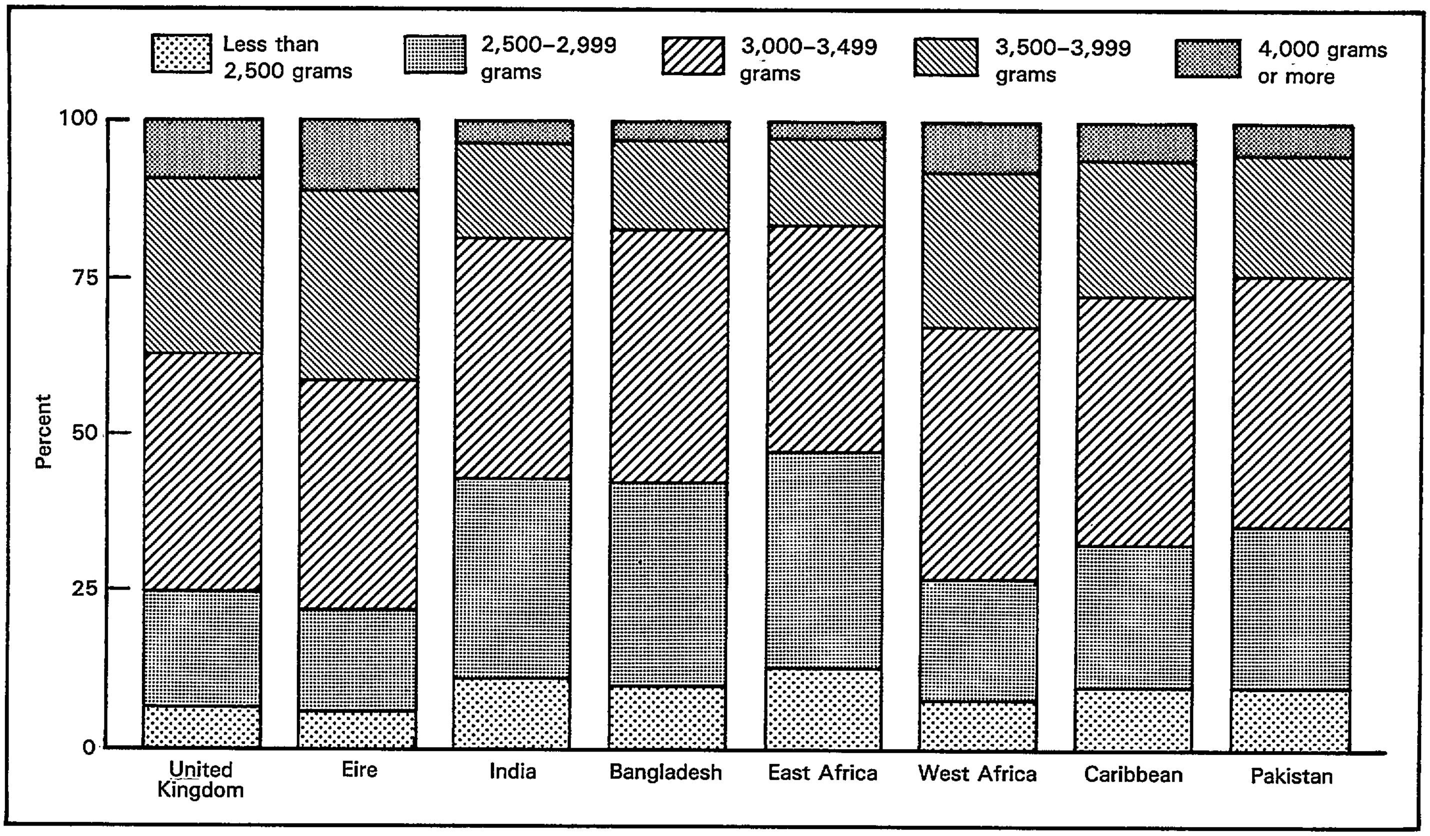

Figure 10. Percent distribution of birthweight, by mother's country of birth: England and Wales, 1982–85

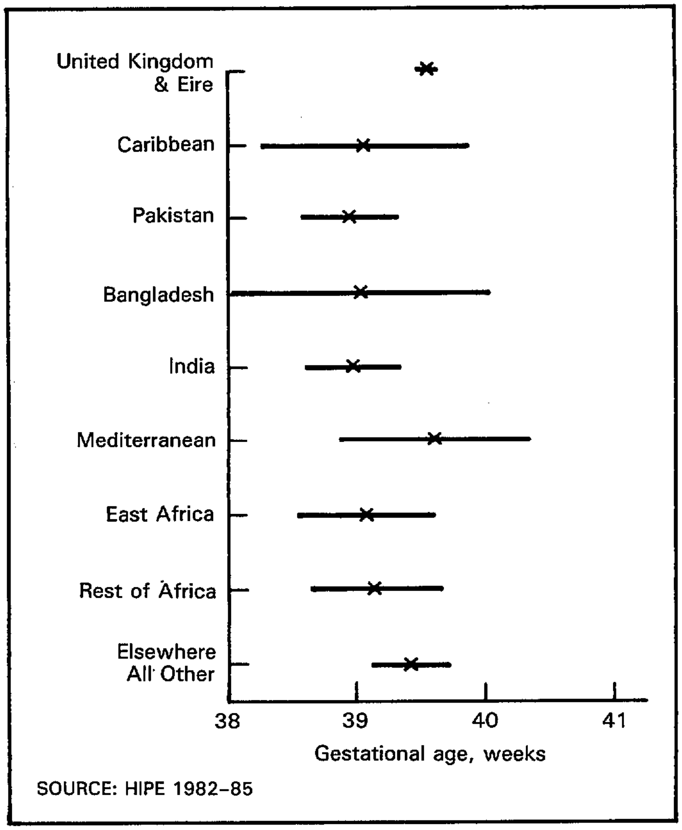

Figure 11. Mean gestational age at spontaneous onset of labor, by mother's country of birth: England and Wales, 1982–85

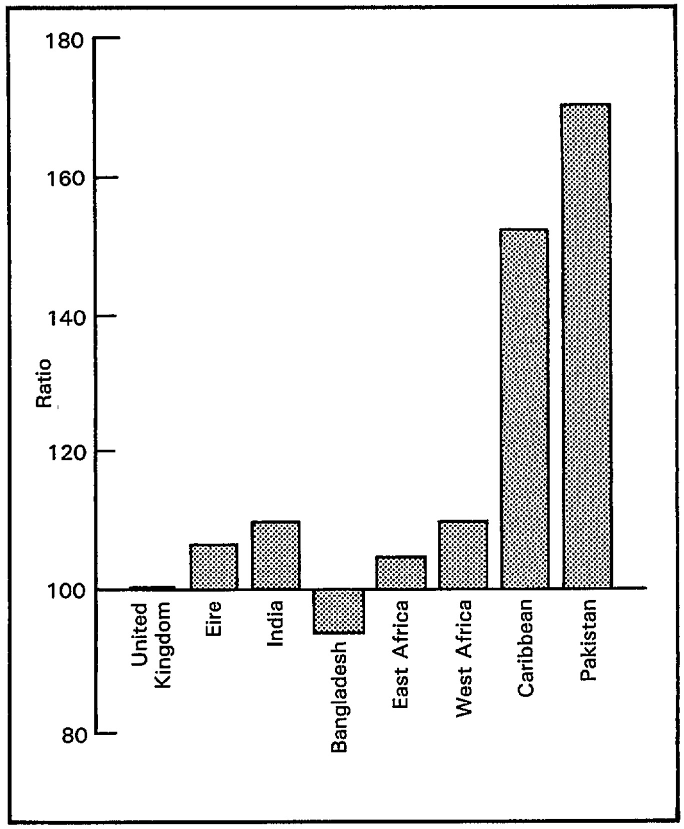

Figure 12. Infant mortality ratios standardized for social class, by mother's country of birth, England and Wales, 1982–85

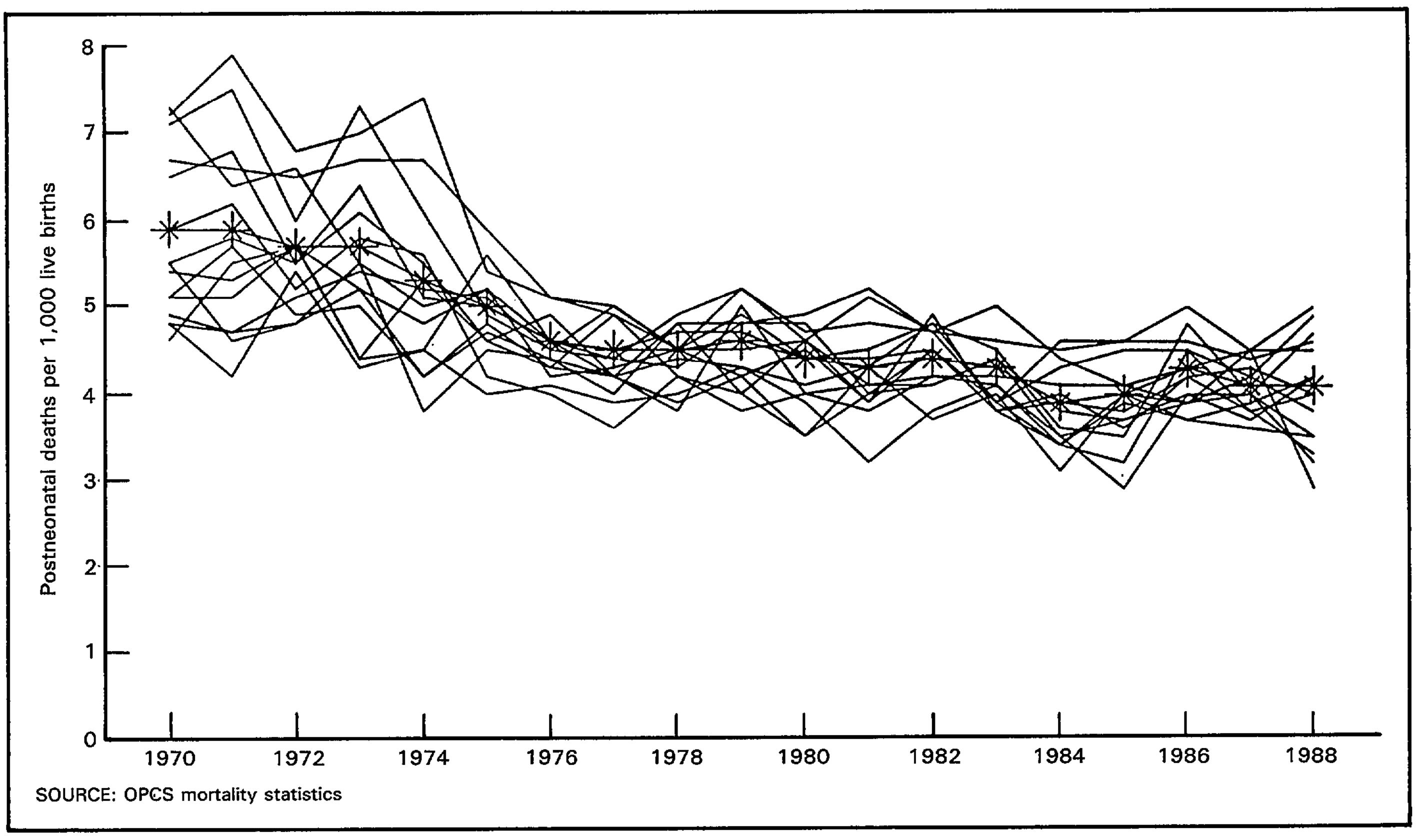

Figure 13. Postneonatal mortality: Fourteen English Regional Health Authorities and Wales, 1970–88

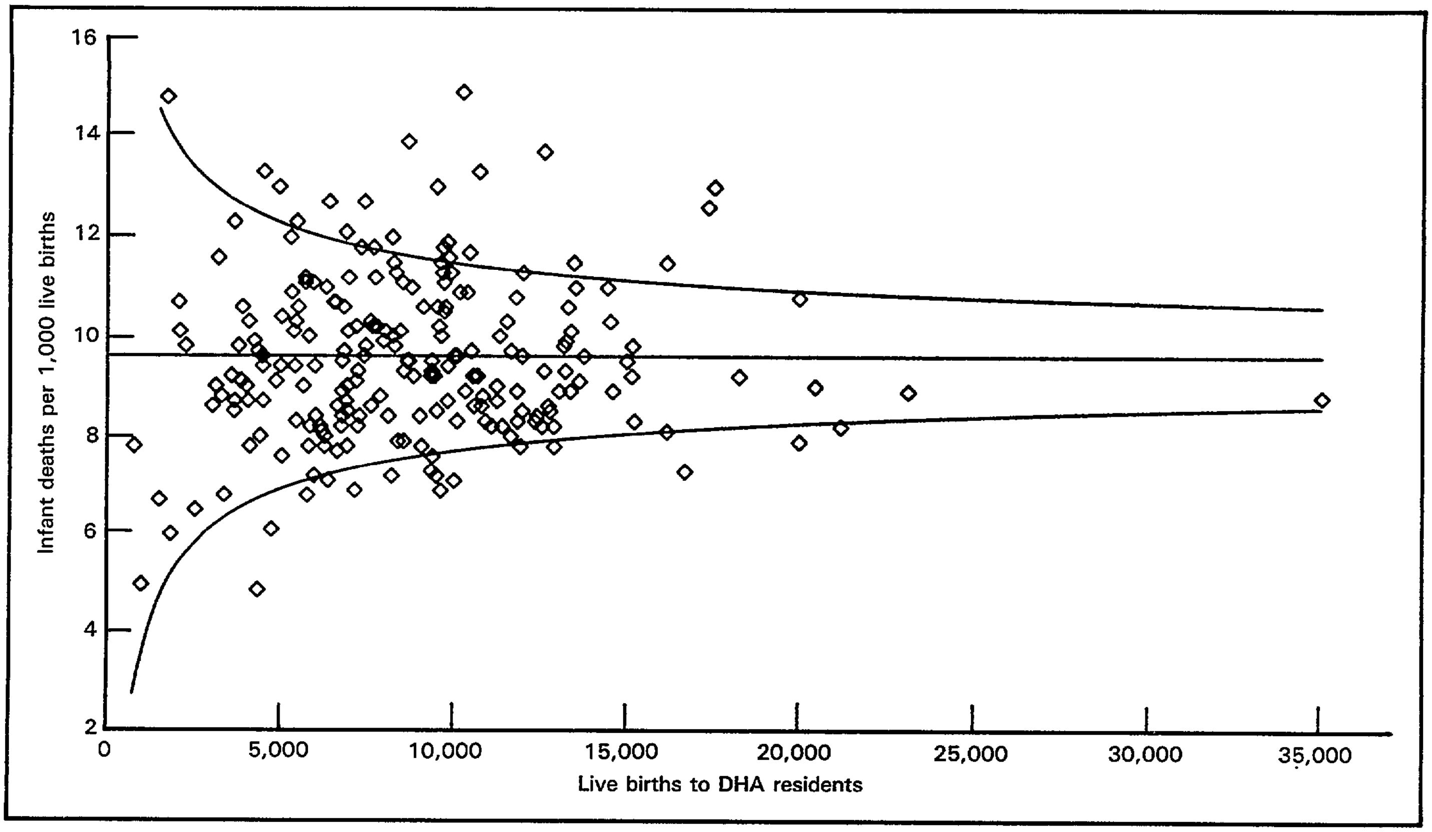

Figure 14. Infant mortality, all live births, grouped by District Health Authority: England and Wales, 1983–85

Social Factors in Scotland

by Susan Cole, M.D.

Introduction

The study described in this paper has been undertaken by Vera Carstairs and Russell Morris, who have allowed me to present some results from it (1,2).

In Scotland it was possible to examine associations between levels of affluence or deprivation in small areas from the 1981 census and mortality and morbidity events, because, in the mid-1970's, the British postcode became mandatory for our 100 percent individual patient-based returns from inpatient episodes in the health service (3). The General Register Office also uses the postcode for usual place of residence in all birth and death certificates.

Postcodes and census deprivation scores

There are 170,000 postcodes in Scotland, a country of 30,390 square miles and 5 million people. Fifty percent of the unit postcodes relate to between 5 and 25 households. There are 18,000 census enumeration districts, and in Scotland (unlike England), the unit postcodes map directly to the enumeration districts which, in the 1991 census, will have digitized boundaries to aid mapping (table 1).

Carstairs and Morris have derived deprivation scores for 1,010 postcode sectors, excluding shipping postcodes and deserted areas, for a total exclusion of 3,000 of the Scottish population. The four census items used to derive a deprivation score for each postcode sector were the proportion of persons in households with no car, with overcrowding (defined as more than 1 person per room), with male unemployment (16-64 years), and with head of households in semiskilled or unskilled occupations (social class IV and V). The scores ranged from -9 being the least deprived to +13 being the most deprived. The scores were grouped into seven deprivation groups (table 2) (3).

Testing the deprivation score against hospital data

The deprivation scores, which were attached to each of the 1,010 postcode sectors, were tested against variables derived from the hospital episode data relating to obstetrics. Records on 181,000 births from the years 1980-82, spanning the 1981 census year, were used. These represented 88 percent of all births, 12 percent being lost because of incomplete hospital data or absent postcodes.

The items selected from the inpatient records were chosen to show either a positive or negative correlation with deprivation, but I was not correct in all the items I chose (table 3). There were high correlations between the deprivation score and low birth weight, height of the mother, maternal age less than 20 years, an admission to hospital during pregnancy, and a husband's social class of IV or V.

The deprivation score in most of these associations is stronger than any of the individual variables, but not by much since they are all highly correlated. The other hospital variables chosen, which did not show as strong an association with deprivation, were length of stay in hospital after delivery, maternal age of 36 years or over, and multiple admissions during pregnancy (table 4).

Deprivation scores and outcome variables

Data were taken from 1980-85 hospital inpatient records and death records. Birth weight and mortality by deprivation score were reviewed. Low birth weight, stillbirths, and postneonatal mortality showed the clearest association with the affluence/deprivation gradient (table 5 and figure 1).

There is some evidence that leads to the inference that medical care may reduce the differences observed in deprived areas. There are not such clear progressive effects to be seen in the association between deprivation and neonatal mortality, nor consequently in perinatal and infant mortality (table 6 and figure 2).

Conclusion

The first target in the WHO campaign, Health for All by the Year 2000, in the European region is that actual differences in health status that exist between countries and between groups within countries should be reduced by at least 25 percent. We regard this work as very important because it may allow us to concentrate on areas of deprivation in specific ways that may help us toward achieving that HFA 2000 target, but there is still much work to be done. Toward the end of the decade we need to check to see if the deprivation measures are still robust enough to show these associations, and we will be looking to the 1991 census to help us clarify how much these small areas may change from one census to another.

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Table 1. Postcodes and the census

Area	Example	Number	Census data	Average no. people
Postcode households	DH11 4LA	170,000	Total pop by sex	5-25
Census enumeration district		18,000	-	350-500
Postcode sector	DH11 4	1,200	Pop by age and sex	6,000

Table 2. Deprivation scores: Scotland, 1981

Deprivation group	Postcode sectors		Population	
	N	(percent)	N	(percent)
1	105	10	306	6
2	180	18	691	14
3	253	25	1096	22
4	219	22	1283	25
5	117	12	744	15
6	91	9	572	11
7	45	4	341	7

Table 3. Associations between maternity data and the deprivation index

Hospital data	Correlations deprivation--elements				
	Deprivation score	No car	Crowding	IV/V	Unemploy-ment
Low birth weight	.59	.59	.57	.47	.60
Maternal height:					
<155 cm	.47	.43	.41	.43	.46
>160 cm	-.68	-.65	-.66	-.58	-.64
Maternal age <20 yrs	.82	.76	.77	.76	.77
1 antenatal admission	.49	.51	.45	.37	.51
Husband social class IV or V	.79	.65	.73	.83	.72
Gravida 3+	.46	.33	.50	.41	.48

Significant at 95 percent r>=/- .26.
Significant at 99 percent r>+/- .34.

Table 4. Associations between maternity data and the deprivation index

Hospital data	Correlations deprivation--elements				
	Deprivation score	No car	Crowding	IV/V	Unemploy-ment
Mean length of stay	.15	.20	.14	.06	.16
Maternal age >36 yrs	-.31	-.30	-.30	-.31	-.25
3+ antenatal admissions	.29	.30	.24	.25	.32

Significant at 95 percent: r>=/- .26.
Significant at 99 percent: r>+/- .34.

Table 5. Deprivation categories and obstetrical outcomes, 1980-85

Deprivation category	Low birth weight (percent)	Stillbirth rate*	Postneonatal mortality rate**
1	4.3	3.9	3.5
2	5.0	5.7	3.7
3	5.2	5.5	3.7
4	6.4	6.0	4.0
5	7.0	6.5	4.0
6	8.1	6.4	4.2
7	9.0	7.1	6.5
All areas	6.4	6.0	4.1

*Per 1,000 total births.
**Per 1,000 live births.

Table 6. Deprivation categories and neonatal mortality, 1980-85

Deprivation category	Neonatal mortality*	Perinatal mortality**	Infant mortality*
1	5.3	8.3	8.8
2	6.0	10.3	9.7
3	6.1	10.3	9.8
4	7.0	11.8	11.0
5	7.4	12.6	11.3
6	6.9	11.8	11.1
7	6.5	12.4	13.0
All areas	6.6	11.3	10.7

*Rates per 1,000 live births.
**Rates per 1,000 total births.

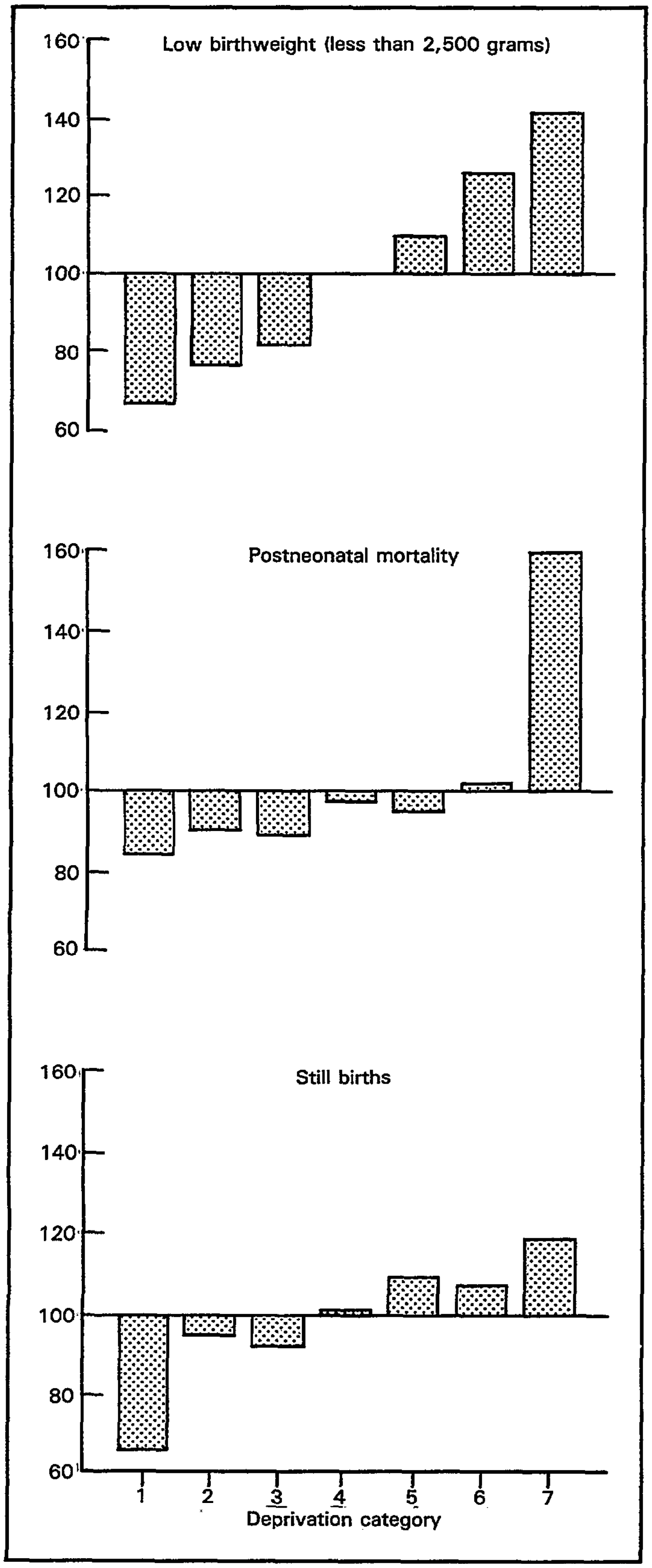


Figure 1. Standardized rates by deprivation category: Scotland, 1980–85

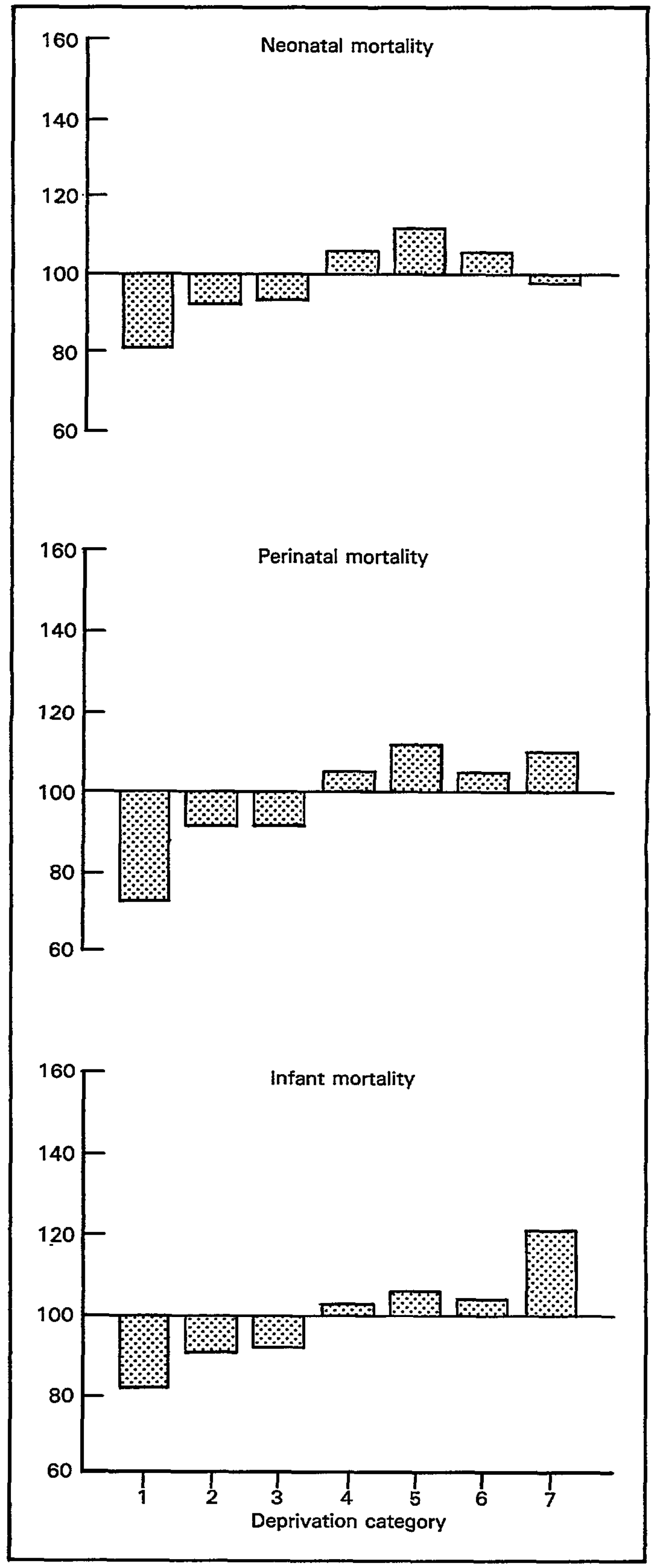


Figure 2. Standardized rates by deprivation category: Scotland, 1980–85

Relationship of Sociodemographic Characteristics to Infant Mortality in the United States

by Joel C. Kleinman, Ph.D., Lois A. Fingerhut, M.A., Kate Prager, Ph.D., and Samuel S. Kessel, M.D.

In this study we will compare infant, neonatal, and postneonatal mortality by maternal characteristics for singleton live births to white and black mothers in the United States. The data source is the 1983 and 1984 national birth cohorts: files of live births that occurred in 1983 and 1984 in the United States, linked with the corresponding death certificates of infants who died before reaching their first birthday. California, Texas, and Washington State were excluded because educational attainment of the mother, one of the key variables, is not available in those states.

The methodological approach was to estimate separate multiple logistic regression models based on singleton live births to white and black mothers using maternal characteristics. Maternal age is divided into four age groups (<18, 18-19, 20-29, and 30+) and crossed with parity (primipara vs. multipara). In other words, the effects of age will be estimated separately for primiparas (mothers experiencing their first pregnancy) and multiparas (mothers of higher parity). In addition we compared two levels of multiparas, those with low parity and those with high parity. High parity is defined as third or higher order births to women less than 25 and fourth or higher order to women 25 and over. The age effects for multiparas refer to the low parity multips. The high parity multips are essentially about 30 percent higher in terms of their infant mortality rates.

Educational attainment is divided into four levels of years of education (<12, 12, 13-15, 16+); residence (whether the mother lived in a metropolitan area, population over 250,000, or outside one of those areas); and nativity (native vs. foreign born), which we have heard about in many of the previous presentations already. In the case of the United States, we will see that it has a somewhat different impact.

We will present the results as directly standardized infant mortality rates that were determined using the fitted results from the multiple logistic models, and were based on the combined distribution of all births as the standard population. There were about 4 million live births among whites and about 35,000 infant deaths. Among blacks we have about 900,000 live births and 15,000 infant deaths.

Table 1 shows the standardized infant mortality rates, adjusted for all the other variables in the model. Among blacks the lowest infant mortality rates were among 18- to 19-year-old primiparas. Among whites the lowest rates were in the 20- to 29-year-old primips. In both cases the highest rates were multiparas under age 18. Going from the lowest to the highest was a relative risk of about 2 for whites and about 1.8 for blacks.

Let us focus a little more on the primips at this point. Note that the patterns for neonatal and postneonatal mortality differ quite a bit. In particular, primips 30 and over have a high neonatal mortality rate but among the lowest postneonatal mortality rates. Among multiparas also, women 30 and over have extremely low postneonatal mortality rates. For the multips, however, there is not as much of an increase going from the 20's to the 30's. It is mainly the teenagers among the multips who have extremely high neonatal and postneonatal mortality rates, especially for whites.

This is a good point to comment on Dr. Feinleib's presentation.[1] He showed some ecological correlations that made it look as if teenage births, especially among blacks in the United States, were a large source of our poor international standing. This is really an excellent example of how you can be misled by ecological analyses, and why it is so important to develop data sets like the ones that we have developed here for ICE

[1] Feinleib, M. The demographic setting: trends in ranking and levels of perinatal and infant mortality, low birth weight, and other outcome measures.

to look at individual variation. Because what happens is if we eliminate teenage births from the white and black population in the United States, we would only lower the infant mortality rate by 4 percent for whites and 7 percent for blacks, thereby slightly increasing the black-white ratio, and having essentially no effect on the United States international standing. Thus, although teenage pregnancy is a very serious social problem in the United States, it is not something that we ought to focus on in this international context.

There is quite a strong educational gradient in infant mortality for whites; from the lowest to the highest level of education is a relative risk of about 1.65. For blacks it is a bit less, about 1.35, and that is due to different trends between neonatal and postneonatal mortality. Neonatal mortality among blacks does not vary much by education. Among whites there is a downward trend. But the big educational difference in mortality is in the postneonatal period.

For marital status the relative risks between neonatal and postneonatal are very similar, and there is a slightly greater relative risk for blacks (1.4) than whites (1.3).

The other thing to keep in mind about the results in table 1 is that these standardized rates ignore interaction effects. Thus, when you look at population subgroups you can see very different relationships between marital status and pregnancy outcome. In particular, among teenagers, the unmarried women actually do better among young teenagers than married women, and that is true for both under-18- and 18- and 19-year-olds. For women 20 and over, married women have lower mortality rates and the discrepancy between married and unmarried women gets larger as the women get older.

Finally, for whites, there is very little difference in neonatal mortality between native born and foreign born, but the foreign born have 20 percent lower postneonatal mortality. For blacks, foreign born mothers have 20 percent lower neonatal as well as postneonatal mortality.

To summarize, it is instructive to divide the mothers into three maternal risk groups. The first is the low maternal risk group, which consists of married primips age 20 to 29 and low parity multips age 20 and over with 13 or more years of education. The second group is high risk mothers, which include unmarried mothers with less than 12 years education who are either teenagers, primiparas 30 and over, or high parity multiparas. And the third is the moderate risk group, which includes all other combinations of maternal characteristics. The data are shown in table 2.

The distribution of the births is very different between whites and blacks. At the low end of the scale, 28 percent of the whites v. only 11 percent of the blacks were low risk; and at the other end, only 4 percent of the whites v. 22 percent of the blacks were high risk.

However, these differences do not account for the black-white difference in infant mortality. At every level of maternal risk, the black rates were considerably higher than the white rates. In fact, the black-white ratio is greatest among the low risk mothers (2.0) and least among the high risk mothers (1.4). This is a consequence of the fact that the gradient for infant mortality is stronger for whites. The infant mortality relative risk of high to low risk is 2.7 for whites v. 1.8 for blacks. This difference occurs primarily in the neonatal period with a much stronger high-to-low relative risk for whites (2.3) than for blacks (1.4). In the postneonatal period, however, the high-to-low relative risks are more similar: 3.6 for whites v. 3.1 for blacks.

One final comparison is of interest. Data are available from the 1964-66 National Natality and Infant Mortality Followback Surveys on infant mortality rates by mother's education for married mothers. Table 3 shows the comparison between the 1964-66 and 1984 differentials by maternal education. Note that the differentials in infant mortality by education (as measured by relative risks) have increased slightly between the two periods. This is perplexing given the fact that 1965 was the year Medicaid and a number of other programs designed to improve health among the poor were introduced in the United States. There are two points that need to be noted in this regard. First, the group with less than 12 years education is much more atypical in the latter period (37 percent of mothers in 1964-66 compared with 21 percent in 1984). Second, although these programs have not had the effect of narrowing the gaps by educational level, the gaps might have increased without them.

We need to better understand how the socioeconomic groups differ in order to intervene most effectively. For example, it has been shown in other studies (based on Missouri data, which has smoking available on the birth certificate), that about one-third of the excess mortality by education and by marital status can be accounted for by differences in smoking prevalence. Thus, reducing smoking in the low socioeconomic groups could decrease the gaps in infant mortality. We need to find other cultural, nutritional, environmental, and behavioral factors that might account for these higher death rates.

Table 1. Standardized infant mortality rates by race and other maternal factors: singleton live births in the United States, 1983-84 birth cohorts

	Black			White		
	Infant	Neonatal	Postneonatal	Infant	Neonatal	Postneonatal
	Rate per 1,000 live births					
Nativity status:						
Foreign born	12.7	8.6	4.1	7.7	5.1	2.6
Native born	16.4	11.0	5.4	8.4	5.1	3.3
Age and Parity:						
Primaparas:						
Under 18	15.9	11.1	4.8	10.4	6.8	3.6
18-19 years	13.6	9.4	4.2	9.3	5.7	3.6
20-29 years	15.6	11.1	4.6	7.5	4.8	2.7
30 yrs & over	23.4	19.1	4.3	9.0	6.3	2.7
Multiparas:						
Under 18 years	24.6	16.0	8.7	15.1	8.7	6.4
18-19 years	19.5	11.8	7.7	12.2	6.5	5.8
20-29 years	15.9	10.2	5.7	8.2	4.8	3.5
30 yrs & over	16.1	11.8	4.3	7.7	5.0	2.7
Parity:						
Low	15.2	10.3	4.9	7.8	4.8	3.0
High	19.6	12.9	6.7	10.5	6.4	4.1
Marital status:						
Married	15.2	10.3	4.9	7.8	4.8	3.0
Unmarried	19.1	12.5	6.5	10.8	6.6	4.2
Educational attainment:						
Less than 12 years	17.4	9.9	7.5	10.9	6.0	4.9
12 years	15.6	10.3	5.3	8.6	5.5	3.0
13-15 years	14.4	10.1	4.3	7.5	4.9	2.6
16 years or more	12.9	9.3	3.7	6.6	4.3	2.2
Metropolitan residence status:						
Metro counties (250,000+ pop.)	16.1	11.0	5.1	8.3	5.1	3.1
All other counties	15.9	10.7	5.2	8.5	5.2	3.3

Rates are directly standardized using the distribution of all live births and the fitted values from multiple logistic regression analyses of neonatal and postneonatal mortality.

Table 2. Distribution of live births and infant mortality rates by maternal race and risk: singleton live births in the United States, 1983-84 birth cohorts

		Maternal risk group		
	All	Low	Moderate	High
		Black		
Distribution of births	100.0%	10.6%	67.1%	22.2%
		Mortality rates per 1,000 live births		
Infant	17.0	11.6	16.3	21.4
Neonatal	10.6	8.4	10.6	11.7
Postneonatal	6.3	3.1	5.7	9.7
		White		
Distribution of births	100.0%	28.3%	67.3%	4.4%
		Mortality rates per 1,000 live births		
Infant	8.2	5.7	8.8	15.4
Neonatal	5.2	3.9	5.5	8.9
Postneonatal	3.0	1.8	3.3	6.5

Table 3. Infant mortality rates by race and educational attainment of mother: United States married mothers, 1964-66 and 1984

Race and years of education	1964-66	1984
White	20.8	8.2
<12	26.9	13.7
12	18.0	7.9
>12	16.7	6.8
Black	39.5	16.0
<12	43.3	19.5
12	34.5	17.2
>12	32.9	13.4

Source: 1964-66 National Natality and Infant Mortality Surveys and 1984 National Birth Cohort (sample).

Sociocultural Factors Associated With Infant Mortality and Birth Weight in Hungary

by Andras Klinger, Ph.D.

Figure 1 presents the general trends in infant and perinatal mortality in Hungary and shows that over the last 30 years, Hungarian infant and perinatal mortality have fallen by two-thirds. Historically, Hungarian mortality has always been much higher than in other European or North American countries. Even now, after a very big decrease, we have relatively high infant and perinatal mortality. In 1989 both rates were about 16 per 1,000.

During the same period from 1960 to 1989, the percentage of low birthweight babies rose and then fell, but remained at a high level. Indeed, the main cause of high infant mortality in Hungary is that we have always had a very high incidence of babies born with a weight below 2500 grams. You can see that there was a peak in the mid-1970's, when the rate reached 11 percent. A very slow decrease started at that time, and now the proportion is around 9 percent, which I think is also one of the highest in the industrialized countries.

There has always been a question whether the general level of mortality varied by social and cultural group in Hungary. We heard that in England, investigations of differential infant mortality started in the 1920's. We even have some publications from the late 19th century in which statisticians discussed the very significant differences in infant mortality by the parents' socioeconomic level. There were also very interesting studies in the 1920's and 1930's and even later.

We have matched data from birth and death certificates from 1970 on, and have data on both parents' occupation and education. But simplifying things, what I will show you is the so-called social or occupational group of the main supporter which is, in most cases, the father; in unmarried cases it is the mother or the mother's parents. It is mainly the father because we have relatively few illegitimate births, about 8 or 9 percent. We also have data on the education of both parents, but I would like to focus on the mother's education. As we heard from other studies, particularly from Norway, there are correlations between the two parents' educational levels.

Besides these general items, we performed several studies, the last one in 1985. We tried to measure the effects of these two basic items as well as others, such as the housing situation, work during pregnancy, alcohol consumption, coffee consumption, smoking, and nutritional standards. We also tried to correlate them with other socioeconomic phenomena, but I will not go into detail.

Table 1 shows the three basic social strata that we can use for the period from 1950 on. They are basically manual occupations in agriculture, manual occupations outside agriculture, and nonmanual occupations. From 1970 on, for more detailed analyses, we can use seven social groups very similar to the British social classification. But if we want to embrace a longer period, we should look at the three basic social strata.

The upper part of table 1 shows the infant mortality rates in the three groups, and the lower part measures the ratio of infant mortality in each social strata to the level in the nonmanual occupations, the most favorable group. It shows that there has always been a very big difference, but especially in the earlier years: in 1950, the difference between the lowest stratum and the highest was about 2:1. Then the differential decreased somewhat and now the agricultural population's infant mortality is again about 60 percent higher than that of nonmanual workers. If we could develop a more detailed classification and also include those who have occupations requiring higher education, the difference would again be about 2:1.

Perhaps more detailed analyses can be done on the basis of table 2, where we consider maternal education. The categories in the table run from 0 to 13+ years of education, and obligatory education in Hungary is 8 years. In the years since 1960, the infant mortality rates in each educational group have declined, but the rank order of infant mortality for each group has changed very little. As the lower part of table 2 shows however, the relative differences in infant mortality have grown over time. In 1960 the ratio of infant mortality rates between the lowest and highest education groups was 3:1 but now it is nearly 4:1.

The real question is, What could account for these differences? Is it really social difference that accounts for the infant mortality differentials? Is it educational difference? Or something else? Therefore, we tried to look at the birthweight differences between these educational groups (table 3). You can see that in the lowest education group, the proportion of live births under 2500 grams is much greater than in the higher education groups. In the case of those who had the lowest education, this proportion was about the same in 1988 as in earlier years, 23 percent, but in the case of those with the highest educational level, it was only 5 percent in 1988. The relative differences in the very low birthweight group, below 1500 grams, are about the same. That is, 3 percent in the case of the lowest educational group and less than 1 percent in the case of those with the highest education.

At first glance it seems that birthweight distributions are an easy explanation for the differences in infant mortality. But if you consider the bottom section of table 3, which shows infant mortality ratios for these groups, the answer is much more complicated. Very interestingly, for the lowest education levels, infant mortality in the very low birthweight groups is lower than for those with higher education.

Important differences in infant mortality in the expected direction appear only within the so-called normal group, for example, over 2500 grams. It means that there is somehow a difference in the impact of low birth weight across these different education groups. What does low birth weight mean for those who have higher education?

We tried to use a combination of birth weight, length of gestation, and education and we came to the conclusion that the real difference is that in the case of the very low education group there are many more low birthweight term births (table 4). In the low education group, the proportion of births in this high-risk category is more than two times higher than in the high education group. Thus the difference in the proportion of low birthweight term births appears to be the principal contributor to the difference in infant mortality rates by level of maternal education. This is a question that we have to explore a little further in analyzing the kinds of data I mentioned earlier, such as the data on smoking habits, working, and alcohol consumption. Possibly, some kind of correlation with the sociocultural groups could be established.

I would like to mention that the question which, I think, exists not only in Hungary but also in other countries, is not only the level of infant mortality, but also what will happen to those children who survive infancy? Will the quality of those babies be the same or worse than the others. Specifically, the proportion of low weight births has not changed much over time in Hungary, but infant mortality in each weight group has declined sharply over the past 30 years. This means that now a much larger percentage of the surviving population is composed of those born weighing less than 2500 grams.

Therefore, we carried out, on a sample basis, a longitudinal study in which we included all babies born with a weight below 1500 grams, 20 percent of those born with weights between 1500 and 2500 grams, and about one-half a percent of those born with weights over 2500 grams (table 5). The first step was to look at the proportion entering primary school, obligatory from 6 years of age. For this study, we considered children born in 1980-81 who should have entered school in 1987. It is very interesting to see that among those born with a weight below 1500 grams and living at the age of 6, only about one-half could enter school at the age of 6 while the rest had to wait until the following year or even then were not able to go to a normal school. Seventy percent of those who were born with weights between 1500 and 2500 grams, and 86 percent of those who were born with a normal weight entered school on schedule.

Here again we can find some social differences. If you consider the level of education of the mother, the differences are very high. Let us mention only those born with a weight below 1500 grams. Of those whose mothers had less than 8 years of education, only one-fourth were able to enter school and the others had to wait. On the other hand, for those with mothers in the highest education group, 65 percent entered school on schedule despite their very low birth weight.

From all these data on the whole phenomenon of social or cultural differences and birthweight combinations, it follows that birth weight is significant not only at the moment of birth, but over a very long period, over the entire lifetime of these children.

We hope to visit the same population again during this year--when they are around 10 years old--and it is expected that real physiological differences between these children will be identified so that we can give real answers as to the future situation of these very low birthweight children.

Table 1. Infant mortality by the social strata of supporters in Hungary

Social strata of supporter	1950	1960	1970	1980	1988
	Infant mortality rates (per 1,000 liveborn)				
Manual occupations					
- in agriculture	97	49	35	32	19
- outside agriculture	83	49	39	24	17
Nonmanual occupations	49	36	28	18	12
Total	86	48	36	23	16
	Infant mortality rate ratio to nonmanual occupations				
Manual occupations					
- in agriculture	1.98	1.36	1.25	1.78	1.58
- outside agriculture	1.69	1.36	1.39	1.33	1.42
Nonmanual occupations	1.00	1.00	1.00	1.00	1.00

Table 2. Infant mortality by educational level of mother in Hungary

Educational level (completed years)	1960	1971	1980	1988
	Infant mortality rates (per 1,000 liveborn)			
0	95	56	50	39
1-5	52	52	42	35
6-7	57	47	38	26
8	47	35	25	18
9-12	38	27	18	12
13+	31	22	16	10
Total	48	35	23	16
	Infant mortality rate ratio to 13+ years of education			
0	3.06	2.55	3.13	3.90
1-5	1.68	2.36	2.63	3.50
6-7	1.84	2.14	2.38	2.60
8	1.52	1.59	1.56	1.80
9-12	1.23	1.23	1.13	1.20
13+	1.00	1.00	1.00	1.00

Table 3. Infant mortality by educational level of mother and birth weight in Hungary, 1988

Educational level (completed years)	Birth weight (grams) ≤1499	1500-1999	2000-2499	≤2499	2500+	Total	Standardized[1]
	Percentage distribution of livebirths						
0-7	3.0	4.9	15.4	23.3	76.7	100.0	
8	1.5	2.3	7.0	10.8	89.2	100.0	
9-12	1.0	1.3	4.1	6.4	93.6	100.0	
13+	0.7	1.1	3.5	5.3	94.7	100.0	
Total	1.4	1.9	6.1	9.4	90.6	100.0	
	Infant mortality rates (per 1,000 liveborn)						
0-7	451	74	23	89	13	31	21
8	544	99	25	115	7	18	17
9-12	526	119	28	121	4	12	15
13+	540	112	15	101	5	10	15
Total	529	101	25	112	6	16	16
	Infant mortality rate ratio to 13+ years of education						
0-7	0.84	0.66	1.53	0.88	2.60	3.10	1.40
8	1.01	0.88	1.67	1.14	1.40	1.80	1.13
9-12	0.97	1.06	1.87	1.20	0.80	1.20	1.00
13+	1.00	1.00	1.00	1.00	1.00	1.00	1.00

[1]Based on the average birthweight distribution.

Table 4. Distribution of liveborn children by maturity, birth weight, and maternal education (5 percent sample of 1985 birth cohort)

Maturity-birth weight	Mother's education					Total
	0 years	<8 years	8 years	Secondary	University	
				Percent		
Normal weight - preterm	39	30	24	20	20	27
Low weight - preterm	9	8	6	8	4	6
Low weight - full term	33	26	20	12	14	22
Total high risk	81	64	50	40	38	55
Normal weight - full term	19	36	50	60	62	45
Total	100	100	100	100	100	100
- low weight	42	34	26	20	18	28
- normal weight	58	66	70	80	82	72
- premature	48	38	30	28	24	33
- full term	52	62	70	72	76	67
Number of cases	650	2,300	3,100	100	530	6,680

Table 5. Seven-year-old children in September 1987, by birth weight, schooling, and maternal education (Sample study)

Birth weight	Mother's education <8 years	8 years	Secondary	University	Total
			Percent		
Less than 1500 gm					
Can be admitted to school	24	47	60	60	48
Withheld	46	41	36	30	40
Special education	14	10	3	7	9
Total	84	98	99	97	97
Incapable of learning	16	2	1	3	3
All	100	100	100	100	100
1500-2500 gm					
Can be admitted to school	50	69	82	81	70
Withheld	41	27	15	15	25
Special education	6	3	2	2	4
Total	97	99	99	98	99
Incapable of learning	3	1	1	2	1
All	100	100	100	100	100
2500 and more gm					
Can be admitted to school	70	85	91	82	86
Withheld	25	12	9	16	12
Special education	5	3	-	2	2
All	100	100	100	100	100

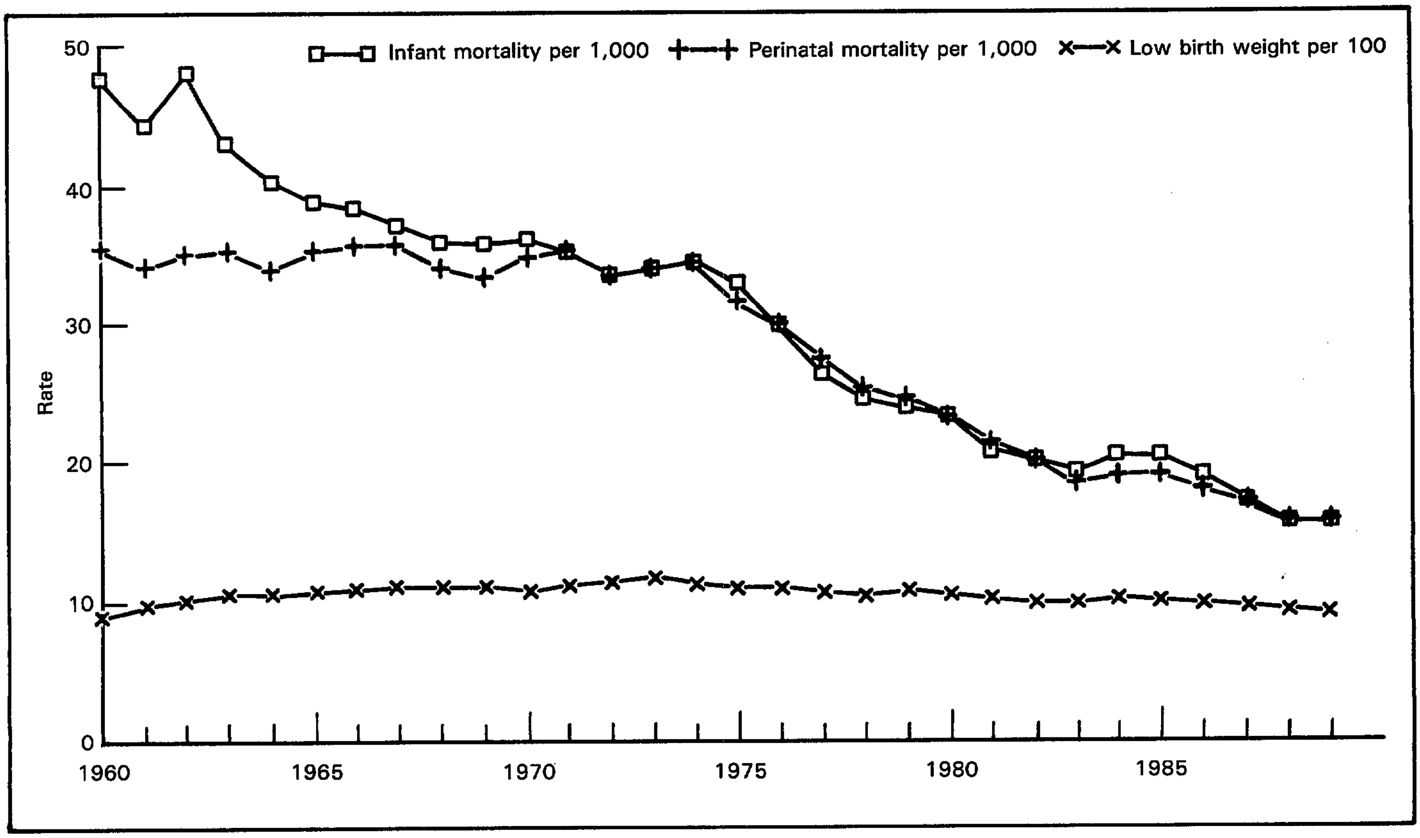


Figure 1. Infant and perinatal mortality and low birth weight rate: Hungary 1960–89

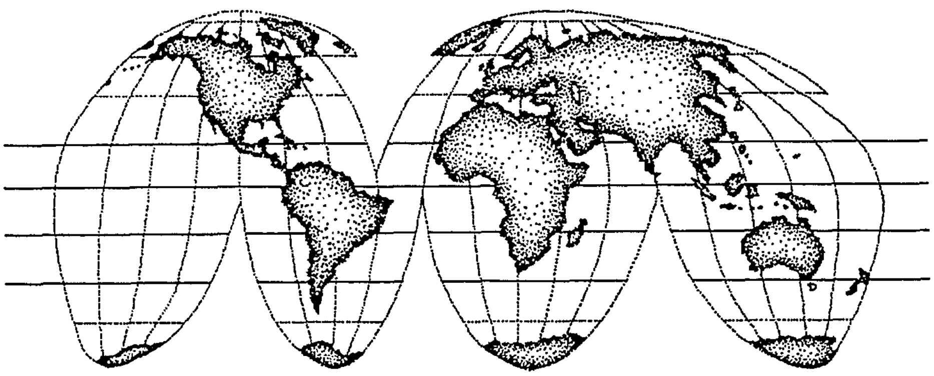
Discussion

DR. BAKKETEIG: Listening to the presentations this afternoon brings out some very interesting points. I think it is amazing how constant the presented relative risks are. If you move from country to country and look at different adverse outcomes associated with different socioeconomic groups, the relative risks seem to be between 1.5 and 2.

The association between socioeconomic conditions and postneonatal mortality is rather strong, except for Sweden. I think it is very interesting to look at the Swedish setting. What is it with Sweden that makes the social differences disappear?

Furthermore, the results shown from Hungary bring out a very interesting point. Differences in birthweight distributions among different social groups and the bearing this might have on the chances of survival were demonstrated. Some of the social groups where small babies were common did better in terms of survival. We see the same phenomenon in other population comparisons. I think we should be aware that even in our other populations, we might have subgroups where the same phenomenon operates.

So, I think it all brings out that we need a lot more research in this area, we need to get behind the figures. We really have to delve into some of these relationships and try to understand what is actually happening behind the results presented here.



Birth Weight, Gestational Age, and Age at Death

Differences and Trends in Birthweight Distributions Among the ICE Countries

by Francis Notzon, Ph.D. and Stephen Evans, M.Sc.

That birth weight is an important variable to consider in any study of perinatal and infant mortality is perhaps a truism. The strong association between birth weight and the risk of early infant death has been demonstrated repeatedly, across many populations and subpopulations, and over time within these groups (1-3). Birth weight has the added advantage, for the researcher, of being simply measured, unambiguous, and present in every individual. Finally, it is a variable that is routinely recorded by the vital registration systems of almost every industrialized country, and hence is available for virtually all births occurring in these populations. A variety of biological and social factors have been found to be associated with birth weight, including genetic characteristics, sex of the child, parity, plurality, parental height and weight, particularly of the mother, nutrition during pregnancy, exposure to toxins, altitude, and social and economic status (4). These factors are known in turn to vary within a given population, as well as across populations and over time.

We will present results of a comparison of various birthweight measures for the ICE countries. This research is an extension of earlier work (5). Our current analysis will show measurable differences in birthweight parameters across these countries, as well as definite trends in these measures for certain countries. We will also show some evidence of differences in the definition of viability across countries.

Materials and methods

As discussed in an earlier presentation,[1] the data used here are from the ICE data base, that is, a standard data set composed of information on annual birth cohorts from the approximate interval 1980-85 for each of the ICE countries. This data base provides information on live births, fetal deaths, and infant deaths, and is grouped into 100-gram intervals, with an initial interval of 0-500 grams and a final interval of 4500+ grams. In the section on birthweight trends, we have combined information from this data base with information from an earlier ICE data set to permit a longer term assessment of trends.

The birthweight distribution curves we will present are based on 200-gram birthweight intervals smoothed through spline interpolation. The percentiles are based on 100-gram groupings and are estimated by means of linear interpolation from the cumulative percentages plotted on a logistic scale. This procedure provides more consistent results than interpolation using a linear scale, which tends to underestimate the percentiles at low weights and overestimate them at high weights.

The birthweight curves and percentiles were computed from live births and late fetal deaths for each country. This combination of live births and fetal deaths of 28 weeks or more gestation, hereafter referred to as total births, was used to reduce variation in the definition of viability both across countries and over time within countries. In addition, because the proportion of multiple births also varies across countries, this analysis was limited to singletons only.

The validity of the results to be presented was enhanced by the quality of the information contained in the ICE data base. In particular, the proportion of events with unknown birth weight was very low in almost all of the ICE countries (table 1). Unknown birth weights were of concern because these births include a disproportionate number of neonatal deaths, and these are often of low birth weight. We found that, for singleton total births, the proportion with unknown birth weight was at or below two-tenths of 1 percent in

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[1]Hartford, R.B. Definitions, standards, data quality, and comparability.

almost all of the countries, and ranged from a low of .03 percent in Osaka to a high of 5 percent among Israeli non-Jews, the only group in which the proportion unknown exceeded 1 percent. Because of problems with the reporting of birth weights in England and Wales in the early 1980's, all statistics reported for England and Wales are based on data years 1983-85.

Results

Figure 1a presents the birthweight distribution curve for a single population, U.S. whites. This curve is based on total births for the years 1980-85 and represents over 5 million events. As is true for all populations, the curve resembles a normal distribution with an extended left-hand tail. The distribution is truncated on the right because the ICE data base combines all births of 4500 grams or more into a final birthweight category. Figure 1b illustrates the difference in birth weights between singletons and multiples, with separate curves for each group. Although the curve for multiple births is shifted to the left, it continues to resemble a normal distribution with a prolonged lower tail.

An illustration of how these distributions can vary across countries is shown in figure 2. The Norwegian distribution is the heaviest of the ICE countries, with a median far to the right of the other two distributions depicted here, Osaka and U.S. blacks--the two populations with the lowest median birth weights. The Osaka distribution is also much tighter than the other two; the difference is especially noticeable when comparing it to the U.S. black curve. The left-hand tail of the black distribution is considerably larger than the other two, a difference that is particularly striking when comparing it to the Osaka births.

We can also depict these differences using the logistic transformation of the cumulative distribution (figure 3). The zero line defines the 50th percentile, or median birth weight for each population, and shows clearly how different these distributions are. The focus can also be limited to births under 2500 grams (figure 4) to emphasize the point that despite large differences in the Osaka and Norwegian median birth weights, the Osaka distribution below 2000 grams is quite similar to, and somewhat lower than, the Norwegian curve, and far lower than the U.S. black curve.

Table 2 provides additional information on the prevalence of low birth weight in the ICE countries, as well as on the distribution of these births. The highest level of low birth weight (percent under 2500 grams) is found in U.S. blacks (11.5 percent), more than three times the level in Norway (3.5 percent). The percent low birth weight in Osaka is midway between the two extremes, at 5.6 percent. The ranking of ICE countries is quite similar for very low birth weight (percent under 1500 grams), with two exceptions: U.S. whites have a relatively large proportion of very low birth weight while Osaka now ranks near the bottom of the scale. The country rankings for births under 500 grams are quite different and appear to indicate important differences in registration procedures across the ICE countries. At the low end of the scale the proportions are so small, such as .005 percent in Denmark, that it would appear that infants dying shortly after birth--the overwhelming proportion of births in this weight category--are not registered as live births. The highest proportion in this weight group is reported by U.S. whites and blacks, with the U.S. black figure far in excess of that reported by any other country.

In addition to the use of arbitrary cutoff points, it is also possible to compare birth weights below which a set percent of all births lie. Thus we can compare median birth weights, weights at the 10th and 90th percentiles, and so on. Table 3 provides percentile birth weights for all of the ICE countries for the 1980-85 interval. As might be expected from the low birthweight rates provided above, U.S. blacks reported the lowest birth weights for the percentiles below the median. For the median and higher percentiles, the lowest weights were for Osaka births. Norwegian births were the largest for all of the percentiles. For some of the percentiles, intercountry differences were extremely large: almost 750 grams for the 3rd percentile (U.S. blacks, 1675 grams and Norway, 2421 grams); about 600 grams for the 5th percentile and almost 450 grams for the 10th percentile (same two countries); and more than 350 grams for the median (Osaka and Norway). For each case except the median, eliminating the U.S. black figure would reduce the differential substantially. Birthweight differences in the order of 500 grams also existed for the higher percentiles.

Birthweight trends

An important characteristic of the distributions in all of the countries is how stable they are over time. Figure 5 shows six annual birthweight curves for Scotland for the years 1980-85. From this figure it is clear that no major changes in birth weight have occurred during this period, and the same could be said for each of the ICE countries.

Despite the relative stability of these birthweight distributions, it is also true that some changes have occurred in several of the countries. Because these changes are gradual and small in the absolute sense, they are easier to see if a longer time interval is used. Combining the current ICE data base with information from earlier ICE studies, we can consider trends over the 1972-85 interval for several of the countries. The trends presented here are based on 500-gram groups, the grouping used in the earlier ICE data. In addition, data from Osaka are not available before 1980, but information is available from the earlier data set for all Japanese births.

An earlier presentation described long-term changes in low birth weight in several countries.[2] We can also describe birthweight trends for the various percentiles. In general, U.S. blacks and whites recorded the largest increases in birth weight at all percentiles. Sweden and Norway had moderate gains in birth weight while in Japan birth weights declined slightly at each of the percentiles. Table 4 presents information on trends in birth weight for the 10th, 50th, and 90th percentiles for Japan, Norway, Sweden, and U.S. blacks and whites.

Presumably, these trends are due to changes in the prevalence of factors known to be associated with birth weight, such as changes in smoking patterns, prenatal care, maternal nutrition, and weight gain during pregnancy. In the United States, a factor that may account for some part of the relatively large rise in birth weights is the change in physician advice concerning desirable weight gain during pregnancy. The previous U.S. standard of 20 pounds' weight gain was revised sharply upward during this time interval.

In Japan, the downward trend in birth weight for each percentile--the opposite of the trend in the other countries--may be due to a gradual change over time in the definition of viability. That is, over time a growing proportion of infants dying shortly after birth may have been correctly registered as live births followed by infant deaths, rather than as fetal deaths. Included in this category are many infants of extremely low birth weight. This change would affect birth weights for the various percentiles, despite the fact that these measures are based on total births (live births plus late fetal deaths), for the following reason: since many of the extremely small infants have gestational ages of less than 28 weeks, then failing to count them as live births would mean they would not be counted as late fetal deaths either, due to the defined gestational age of 28+ weeks for late fetal deaths.

It is also possible that some of the decline in birth weights in Japan may be due to a change in weight gain advice offered by Japanese physicians. Because of the relatively high mortality rates in Japan for very heavy births (4500+ grams), over the past 10-15 years Japanese physicians have begun advising women to limit their weight gain during pregnancy to 9 kilos (about 20 pounds) (6).

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[2]Feinleib, M. The demographic setting: trends in rankings and levels of perinatal and infant mortality, low birth weight, and other outcome measures.

It should be emphasized however, that while these trends do show measurable, consistent change in birth weights in these countries, the amount of change is quite small. A change of only 20 to 30 grams, or even 80 grams, in median birth weights over a 14-year period is testimony to the remarkable stability of these distributions.

Summary and conclusion

Strong differences exist in birthweight distributions across the ICE countries, in terms of both the shape and location of the distributions. Notable differences include an extremely high proportion of births in the lower tail of the distribution for U.S. blacks, while for Osaka births the proportion in the lower tail is very low, despite the generally small size of all Osaka births. In other words, a low median birth weight does not necessarily equal an unfavorable birthweight distribution. These and other differences exist despite efforts to make these populations more comparable, by excluding multiple births and by including late fetal deaths in the study populations.

Second, while these birthweight distributions are quite stable over time, some definite trends in birth weight can be detected. While some of this change may be artifactual--due to changes in the definition of viability over time--it is unlikely that this can account for all of the change observed in birth weights.

Finally, there are considerable differences across countries in the proportion of births falling below the low birthweight or very low birthweight cutoff, and as we have seen, birth weights for a specific percentile also vary strongly by country. Fixed cutoffs for low birth weight are an international standard, and the proportion under 2500 grams is a closely watched figure, especially here in the United States. While mortality rates are traditionally measured for specific birthweight groups, comparing mortality at birth weights representing specific percentiles is a simple way to standardize for differences in the parameters of birthweight distributions. Comparing mortality risks across countries at the birth weights representing specific percentiles of births may provide a very different picture than traditional comparisons of mortality.

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6. Personal communication from Hakuyo Ebara, M.D., Osaka Medical Center and Research Institute for Maternal and Child Health, Osaka, Japan.

Table 1. Proportion of singleton total births with unknown birth weight and data years, ICE countries

Country	Percent with unknown birth weight	Data years
Osaka	.02	1980-84
North Rhine-Westphalia	.07	1980-85
Denmark	.10	1982-87
England and Wales	.13	1983-85
Scotland	.15	1980-85
U.S. whites	.18	1980-85
U.S. blacks	.20	1980-85
Norway	.22	1979-84
Israel Jews	.50	1980-85
Sweden	.80	1980-85
Israel non-Jews	5.00	1980-85

Table 2. Percentage of total births in low birthweight categories, ICE countries, 1980-85*

	Percentage of total births		
Country	<500 gm	<1500 gm	<2500 gm
Denmark	.005	.777	4.861
England and Wales	.024	.869	6.092
Israel Jews	.013	1.022	6.667
Israel non-Jews	.005	.909	6.455
North Rhine-Westphalia	.024	.728	5.003
Norway	.024	.656	3.541
Osaka	.029	.759	5.575
Scotland	.010	.820	5.850
Sweden	.009	.575	3.688
U.S. blacks	.328	2.442	11.528
U.S. whites	.090	.838	4.711

*See table 1 for data years for each country.

Table 3. Birthweight percentiles for total births, ICE countries, 1980-85*

Country	Percentile						
	3rd	5th	10th	50th	90th	95th	97th
Denmark	2277	2511	2771	3455	4103	4302	4433
England and Wales	2207	2423	2677	3338	3965	4154	4280
Israel Jews	2153	2384	2643	3278	3898	4068	4182
Israel non-Jews	2177	2399	2642	3282	3902	4092	4228
North Rhine-Westphalia	2282	2500	2745	3395	4020	4206	4333
Norway	2421	2638	2887	3549	4195	4388	NA**
Osaka	2289	2465	2659	3184	3712	3877	3991
Scotland	2219	2438	2691	3359	3893	4169	4294
Sweden	2413	2618	2863	3525	4172	4371	NA**
U.S. blacks	1675	2054	2440	3192	3828	4030	4169
U.S. whites	2307	2526	2788	3450	4093	4294	4423

*See table 1 for data years for each country.
**Birth weight for 97th percentile cannot be calculated, as it falls in final birthweight group of 4500+ grams.

Table 4. Trends in birth weights for various percentiles, ICE countries, 1972-85

Country	10th percentile			50th percentile			90th percentile		
	1972	1985	Change	1972	1985	Change	1972	1985	Change
Japan	2666	2662	-4	3208	3177	-31	3733	3728	-46
Norway	2834	2860	26	3525	3546	21	4166	4186	20
Sweden	2836	2842	6	3504	3516	12	4145	4162	17
U.S. blacks	2356	2429	73	3136	3196	60	3760	3834	74
U.S. whites	2700	2777	77	3379	3456	77	4013	4090	77

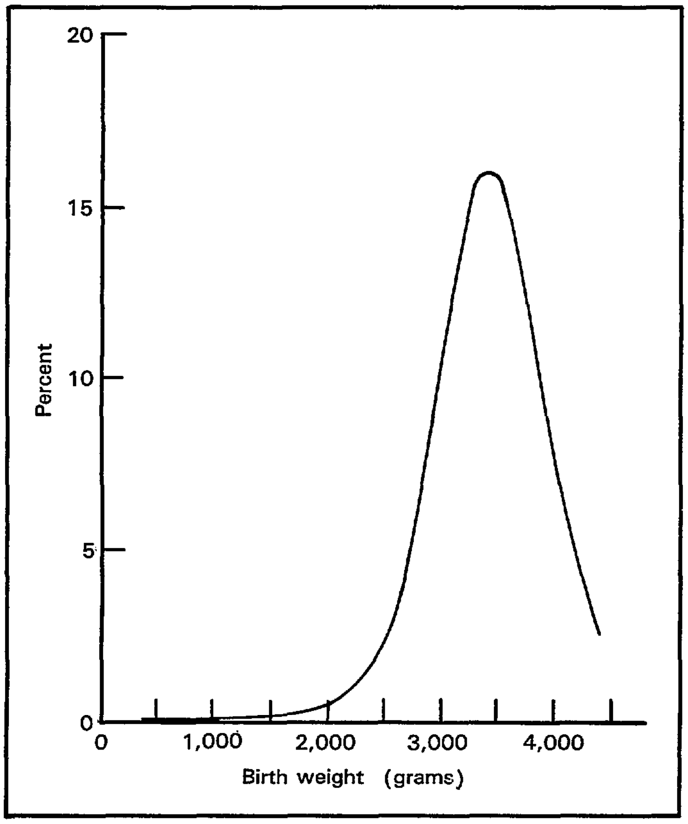

Figure 1a. Birth weight distribution, singleton total births: United States whites

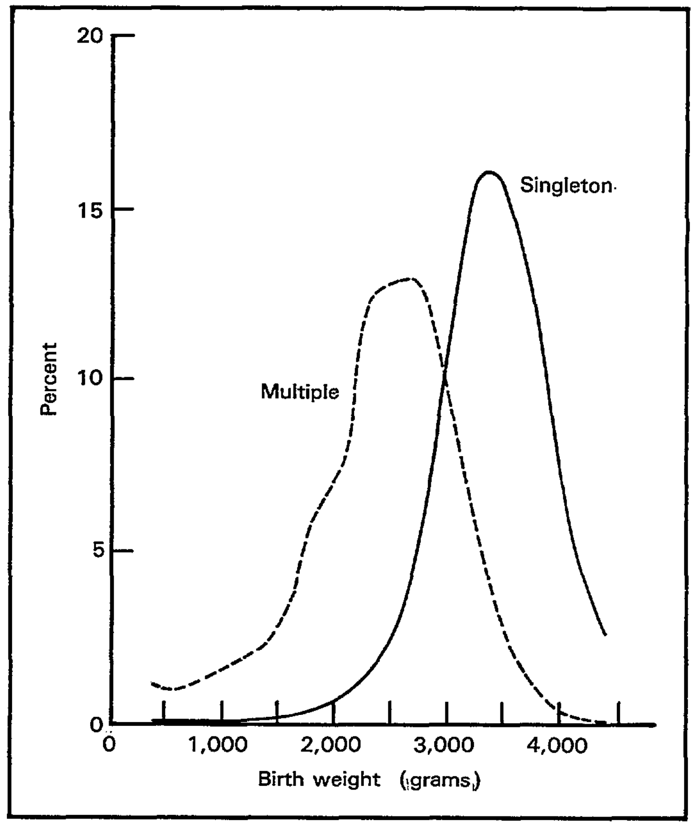

Figure 1b. Birth weight distributions, total births: United States whites

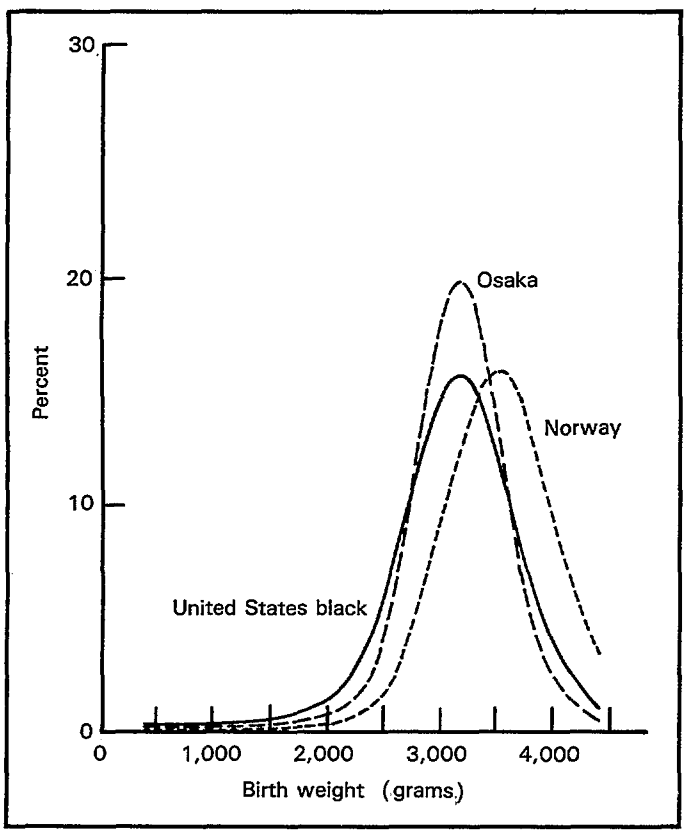

Figure 2. Birth weight distributions, singleton total births: ICE countries

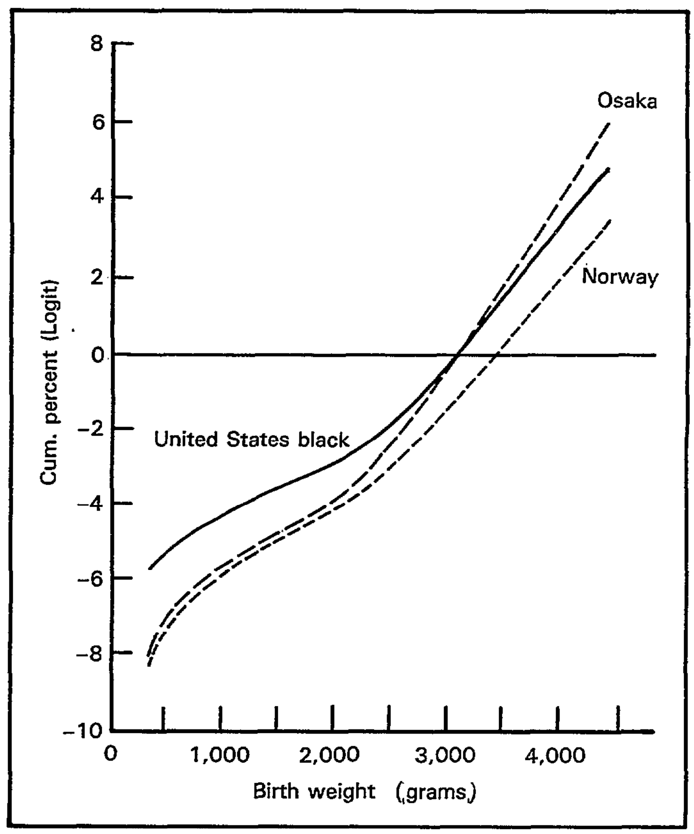

Figure 3. Birth weight distributions, singleton total births: ICE countries

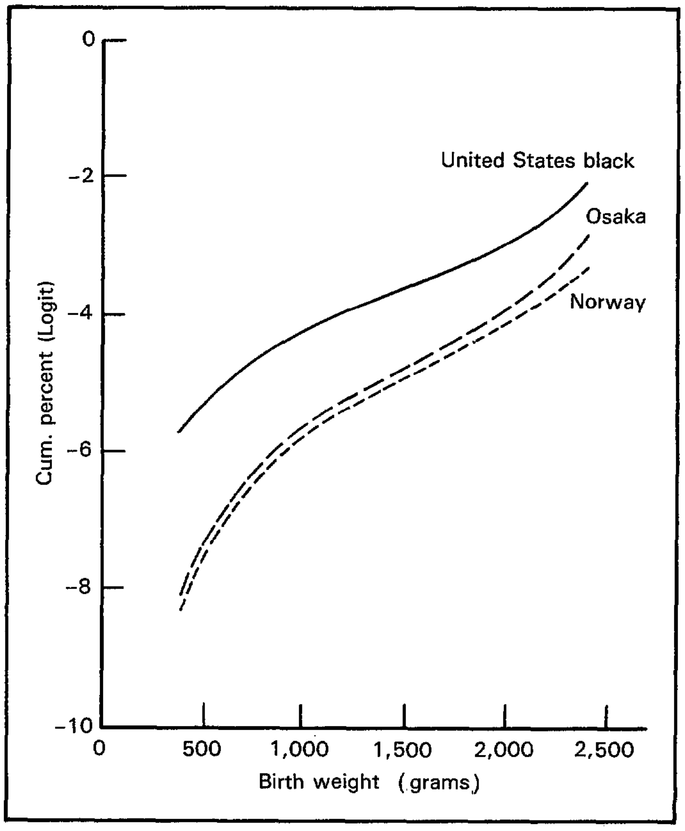

Figure 4. Birth weight distributions, singleton total births under 2,500 grams: ICE countries

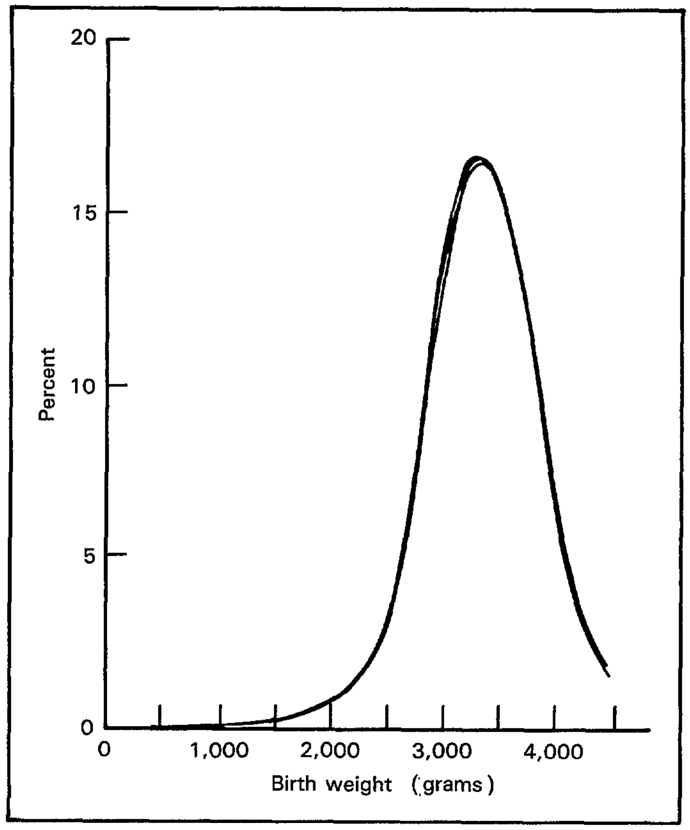

Figure 5. Birth weight distributions, singleton total births: Scotland, 1980–85

Discussion

DR. PINNELLI: I would like to ask the authors if they have checked the quality of the data for birth weight and length of gestation. The reason I ask is that I have had occasion to note that there are problems of geographical and temporal comparability for this kind of data as far as the Italian experience is concerned. In figure 1, frequent heapings may be observed in the 50-gram birthweight distributions. Marked irregularities can be seen in the distribution, because its value undergoes a notable change depending on whether or not the cumulative frequency includes the round number (for example, <2500 or ≤ 2500). Therefore, there is a strong concentration of frequencies at the round numbers. Differences of this kind may also be observed at the national level, but they occur above all at the regional level, where they can prove an obstacle to a correct geographical analysis. The indices of irregularity are visible in table 1, as the values vary considerably from region to region. A more reasonable measure of the frequency of low weight might be obtained by calculating the average frequency for data including and excluding the exact figure of 2500 grams. The disturbance of geographical comparability provoked by the different level of irregularity in the regional data is thus attenuated. I would say that this kind of problem can also exist at an international level, and that it can disturb geographical comparisons.

As far as the length of gestation is concerned, in Italy we have observed a very rapid change in the frequency of births with short gestation periods (table 2). Observing the frequency of births with gestation periods of less than 37 weeks at a regional level in the Italian regions, we realized that certain regions presented very strange data, the values of which were certainly too high (table 3). These excessively high frequencies diminish greatly over time, leading to a sharp drop in the frequency of births with short gestation periods at a national level. What happened in these regions? What happened was that we changed from defining length of gestation in months to doing so in weeks, and not all the regions followed the same classification criteria. These criteria were, however, homogenized over time. The diversity caused by definitions and classification criteria is therefore another problem that should be borne in mind when making international comparisons.

DR. KARLBERG: Thank you so much. You have just brought up two very important issues, as we know that some errors may exist in these variables. I wonder if Sam Notzon could comment on birth weights?

DR. NOTZON: Clearly, some heaping does occur in the birthweight data. One thing we found most interesting was that in the United States the birth weights in all of the participating States continue to be reported in pounds and ounces and are then converted into grams. This is one of the reasons why you did not see birthweight distributions using 100-gram intervals in my slides, because distributions based on 100-gram groups show some very noticeable heaping in the United States, and for each one of the U.S. States.

MR. EVANS: I thought that everybody was quite aware that birth weights are measured in nearly every country within 50 grams or 2 ounces. This is an exercise that I, personally, set for first-year medical students to say that they should look at the data when they see a birth weight of 3, 4, 5, or 6 grams, that is, actually measured to 1 gram. I think we should resist any attempt to try to be more precise because we will only be fooling ourselves.

I have had medical students who have suggested sedating babies in order to stop them from wriggling on the scales so that weight could be measured more precisely. I am, personally, against that.
(Laughter.)

DR. KARLBERG: I will ask Howard Hoffman to make some comments on similar problems with gestational age.

MR. HOFFMAN: I will say something and maybe engender some other people to comment as well. Obviously, one reason we did not take single weeks gestation was not the sheer magnitude of the task but because we were troubled by the quality of the data and the comparisons between countries. Also, the time period of these data, from 1980 through 1986, was a time of conversion among many obstetricians from using LMP dates to relying more and more on ultrasound dates. There are certainly experts in the audience here who know more about that than I do, and maybe Bob Goldenberg would say a word or two. This is going to remain a troubling consideration. It is not something that we are going to be able to get rid of. So, I think there are problems even beyond those discussed by Dr. Pinnelli that we will have to face up to in the future on gestational age.

DR. GOLDING: If I can take up something that you mentioned, Howard, there is a lot of discussion as to obstetric estimations of gestational age based on ultrasound and its comparability with the LMP dates, and it is very difficult to combine the two and get something meaningful. I think if we are going to discuss how to get accurate or meaningful gestational age data, one needs to collect the LMP dates. One also needs to collect the ultrasound estimation as a separate piece of information, and then one can start manipulating the data, but this sort of "if this is not here, then we will have that" is very misleading and confusing.

DR. GOLDENBERG: Just a comment on a study that we recently published looking at ultrasound data and LMP data. What was very clear in our population over the last 6 or 8 years is that the physicians were using ultrasound data much more than they were using LMP data to define the gestational ages, and that at least in our population using ultrasound as we did shifted the entire distribution of the gestational ages to the left, making the mean gestational age almost an entire week earlier over time.

I think that in a couple of other places that we have looked at a similar phenomenon is going on, so that at least in the last 10 years it looks like gestational age data are not particularly stable.

DR. KARLBERG: We have had the same experience in Sweden, where we have analyzed gestational ages based on ultrasound and those based on LMP data. We have also found slightly higher gestational ages for LMP-based data. Of course, there is some error in measurement of gestational age even when based on ultrasound data.

MS. BARELL: I would just like to make a comment to Dr. Goldenberg. I hope what he is talking about has happened since 1985, because in the data that we are dealing with in the United States, the gestational age distribution shows 14 to 16 percent of births are postterm. This is way out of line in relation to most of the other countries. So, I am assuming that the shift to the left has taken place after that point because if it was before that point, then I do not know where it was.

DR. GOLDENBERG: I am not talking about vital statistics data because most of the vital statistics data are calculated from last menstrual period. I think the post-dates rate, if you look at vital statistics data, stays the same, but if you look at hospital-based data or data that is controlled by ultrasound measurements, then the post-dates rate would fall from 10, 12, or 14 percent down to 3 or 4 percent when ultrasound is used to determine the gestational age. So it just depends on whether you are using LMP or ultrasound-based data.

MR. HOFFMAN: Just one thing, hopefully to clarify the situation. Going back to Jean Golding's comment, since 1989 most U.S. vital statistics record LMP, and they also record a clinical estimate of gestational age. That clinical estimate is an obstetrically based clinical estimate in most instances, not a pediatric or a newborn evaluation, and it often is something that may be sent to the hospital of delivery, I presume, a month before the woman delivers. It is based probably on clinical judgment, often on ultrasound. So we do have the possibility, even with vital statistics data, of examining that.

I, personally, have been looking at some data from Missouri for LMP-based gestations recorded as 30 weeks, and we have seen that birth weights are incompatible with about one-third of those. The infants are heavier than their gestational age would indicate. Using U.S. vital statistics data, about two-thirds of the births that by LMP look like 30 weeks (and I am not saying that this is true in other places) probably are not 30 weeks.

So we have this problem, and fortunately, we do have two sources of data. However, it is not nearly as good as what Sweden has with their ultrasound data.

Table 1. Irregularity index and percentage of low birthweight newborns (average of <2,500 gm and ≤2,500 gm)

Regions	Ir	$\frac{\% < + \leq 2500}{2}$
Piemonte	3.5	6.5
Valle d'Aosta	5.9	6.8
Liguria	2.6	6.4
Lombardia	3.5	6.3
Trentino A.A.	3.0	6.3
Veneto	2.9	5.5
Friuli	3.8	6.3
Emilia Romagna	4.8	5.4
Marche	4.9	4.7
Toscana	6.0	6.1
Umbria	4.8	5.0
Lazio	5.4	5.7
Campania	12.5	6.7
Abruzzo	5.9	5.5
Molise	4.2	6.3
Puglia	6.3	5.3
Basilicata	5.5	6.1
Calabria	7.7	6.3
Sicilia	8.7	5.5
Sardegna	3.7	6.7
Italia		6.0

$$Ir\ (2500) = \frac{F\ (2500)}{\frac{1}{19}\ F\ (2410 + \ldots + 2590)}$$

Table 2. Newborns according to the length of gestation (percentage)

Weeks of Gestation	1980	1981	1982	1983	1984	1985	1986	1987	1973*
<31	1.1	1.0	0.9	0.9	0.9	0.9	0.9	0.9	
32-46	12.4	9.3	6.0	5.3	5.1	4.6	4.7	4.7	7.1
37-41	83.4	86.6	89.9	90.2	90.0	89.5	90.0	91.0	92.8
>42	3.2	3.1	3.1	3.6	4.0	5.0	4.5	3.4	
Total births	645,854	627,831	623,854	606,324	592,046	581,216	559,029	555,022	886,214

*<9 months
.9 months

Table 3. Percentage of singleton births with less than 37 weeks of gestation

Regions	1980-81	1982-83	1984-85	1973*
Piemonte	8.7	5.1	4.8	10.1
Valle d'Aosta	6.3	6.3	5.6	21.1
Liguria	5.9	5.7	4.7	7.8
Lombardia	6.5	5.3	5.1	10.3
Trentino A.A.	3.9	3.4	3.6	8.3
Veneto	5.5	4.8	4.3	10.2
Friuli	6.5	5.4	5.5	14.6
Emilia Romagna	7.6	4.3	4.0	11.1
Marche	9.2	5.3	4.2	8.0
Toscana	7.3	4.8	4.2	7.0
Umbria	6.4	5.0	4.2	7.3
Lazio	7.5	5.1	4.4	6.9
Campania	14.3	6.3	5.8	3.4
Abruzzo	13.4	14.5	9.5	5.1
Molise	10.2	7.1	6.3	4.8
Puglia	9.9	5.9	5.4	4.3
Basilicata	7.8	5.3	4.2	4.1
Calabria	25.8	9.4	8.4	3.2
Sicilia	25.2	6.8	4.9	4.2
Sardegna	6.9	8.0	5.2	3.2
Italy	11.4	6.0	5.2	7.1

*<9 months

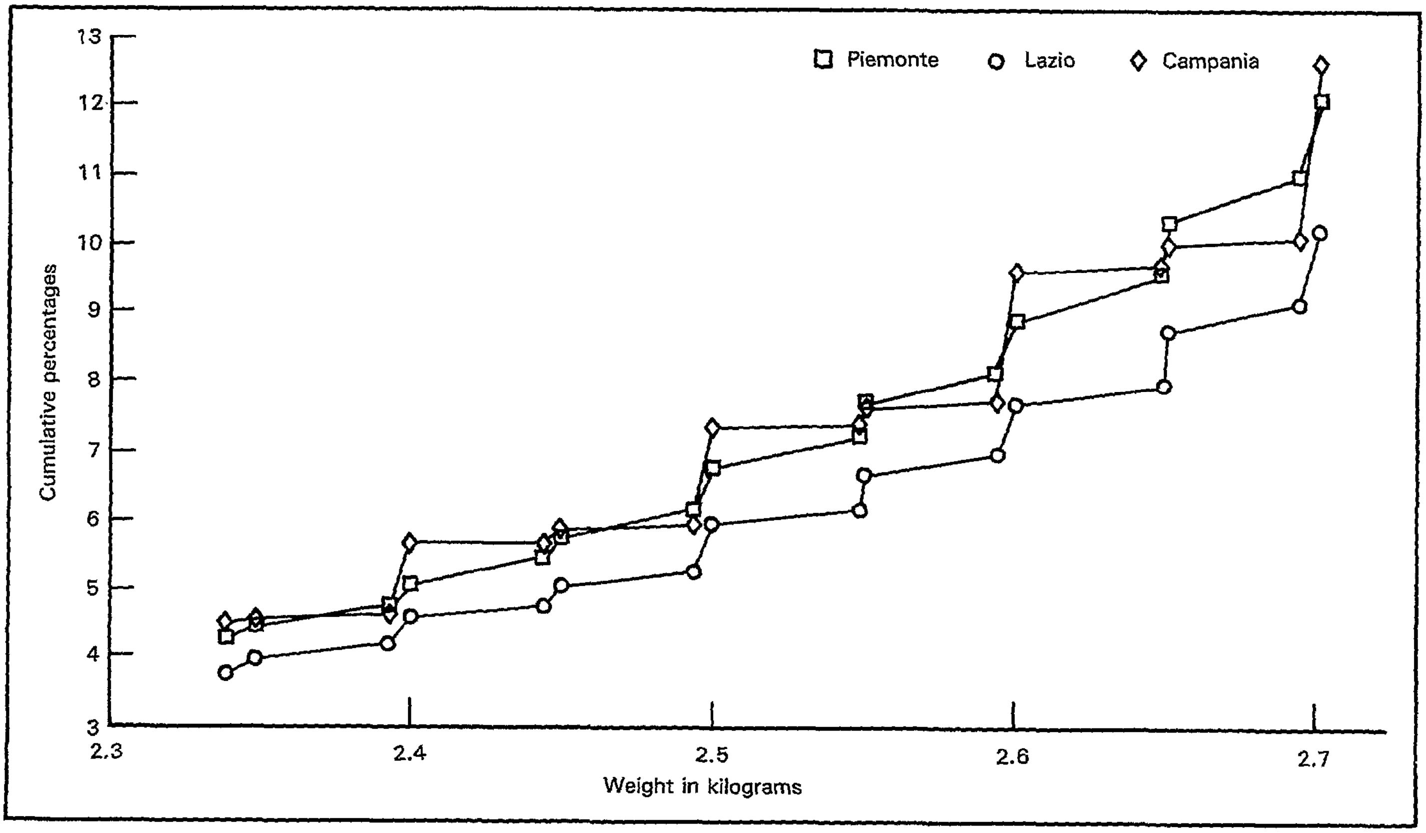

Figure 1. Live births according to birth weight: Piemonte, Lazio, Campania, (Italy), 1985

Comparison of Postearly Neonatal Mortality by Birth Weight

by Rudiger von Kries, M.D., Roger Newson, Eva Alberman, M.D., and Eberhard Schmidt, M.D.

The comparison of infant mortality data between different countries is important for the definition of international standards and for detecting and understanding national problems.

Postearly neonatal mortality deserves particular attention. Improvements in neonatal care not only resulted in a decrease of total mortality but also in a postponement of deaths resulting from sequelae of perinatal illness and prematurity. Differences in postearly neonatal mortality may truly exist, for example, as a consequence of differences in health care systems, constitutional or socioeconomic differences, or be an artifact due to confounding because of higher proportions of high risk children in some countries than in others, or differences in the data collection systems.

The ICE data set provides an opportunity to analyze these questions. This data set includes contributions from nine countries. For Denmark, England and Wales, Israel, Norway, Scotland, Sweden, and the United States these are national data; for Japan these are data from the Osaka region only; and for West Germany these are data for one state, North Rhine-Westphalia, with almost one-third of the West German population. Since the differences in infant mortality rates between different populations within the United States are well known, the U.S. data are presented separately for U.S. whites, blacks, and others.

The time periods of data available in the ICE data set vary by country. Data from all countries are available for the years 1982, 1983, and 1984. Therefore, the comparison of the postearly neonatal mortality rates will be confined to this 3-year period.

The weight classes for births and infant deaths range from less than 500 grams to more than 3500 grams. The calculation of infant mortality data for the 500 gram class, however, resulted in very unrealistic figures as demonstrated in the paper by Dr. Alberman.[1] Although this mistake is less relevant for the postearly neonatal mortality rates, data for birth weight less than 500 grams have been excluded from the analysis.

Methodology questions

Prior to the analysis, several questions concerning the validity and comparability of the national data sets had to be considered:

1. The comparability to official national or local data sets;
2. The definition of postearly neonatal mortality rates;
3. The differences in the assessment of birth weight for postearly neonatal deaths in contributing countries.

The comparability of infant mortality to the official statistics was checked for North Rhine-Westphalia and England and Wales. The figures were almost identical, suggesting that at least for these two countries there was no bias due to transformation of the official national data sets to the ICE data set.

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[1] Alberman, E. Survival in very low birthweight infants.

Postearly neonatal mortality is not a commonly used parameter. It is a common practice to express infant mortality data in relation to the number of births. For postearly mortality, however, the number of births as the denominator underestimates the true death rates because the precise denominator would be the number of surviving babies after the first week of life. The differences between these two estimates of postearly neonatal mortality were analyzed for each country (figure 1). The difference was small (ranging from 0.01 to 0.03 deaths per 1,000) for the majority of the countries and populations. Higher values were only observed for Israel (0.05 per 1,000) and U.S. blacks (0.06 per 1,000). Therefore, the more precise estimates have to be used for statistical hypothesis testing, particularly for stratified analyses in the low and very low birthweight groups. Since the patterns of mortality rates in the different countries were similar, irrespective of the denominator used, the more common estimate of mortality rates (deaths/births) will be used in this paper.

The North Rhine-Westphalia data are death cohort data, not birth cohort data. Thus birth weight is not automatically available for infant deaths. Although birthweight data are requested for deaths occurring during the first year of life, reporting is not compulsory. The number of missing values increased with increasing age at death to more than 50 percent after the first 2 months of life (figure 2).

We subsequently analyzed the proportion of missing values on birth weight in infant deaths for the other countries (figure 3). A substantial proportion of birthweight values were also missing for postearly neonatal deaths in the Scotland and Sweden data sets. At present we cannot explain this observation, as the data from Scotland and Sweden are supposed to be birth cohort data.

Results

Total death rates (for all birth weights) after the first week of life in the contributing countries are shown in figure 4. High rates of 6 per 1,000 or above were reported for Israel, North Rhine-Westphalia, and U.S. blacks. For the Scandinavian countries (Norway, Denmark, and Sweden) and U.S. whites the mortality rates were close to 4 per 1,000. In England and Wales, Scotland, and for U.S. others (non-white, non-black population) the rates were in the 5 per 1,000 range. The Osaka data showed the lowest death rate of 3.1 per 1,000.

The birthweight-specific death rates are shown in figures 5a-e. As to be expected, the highest postearly neonatal death rates were found in the less than 1500 gram groups (60 to 110 per 1,000) decreasing to 2 to 5 per 1,000 in the 2500-3499 gram groups. For babies with a birth weight of less than 1500 grams, the patterns of total and birthweight-specific death rates were similar for most countries with three exceptions:

1. High death rates as compared to total death rates were reported for Osaka.
2. Death rates for Scotland and U.S. blacks were substantially lower than to be expected from the total death rates.
3. There was almost no difference between U.S. blacks and U.S. whites for postearly neonatal mortality in the very low birthweight babies.

In the 1500 to 1999 gram babies, death rate patterns were very similar to those in the <1500 gram group. In the 2000 to 2499 gram babies the death rates were very similar to the total death rates, except for U.S. blacks and Scotland, which were still lower than to be expected from the total death rates, and those for North Rhine-Westphalia, which were much lower. In the 2500 to 3499 gram and the 3500+ gram strata, death rates for most countries were similar to the total death rates, again with the exception of North Rhine-Westphalia (very low) and U.S. blacks (slightly lower).

Discussion

The high postearly neonatal mortality rates in Israel, North Rhine-Westphalia, and U.S. blacks, and the very low rates in Osaka deserve particular attention.

The high rates from North Rhine-Westphalia, a highly industrialized state of the German Federal Republic, need to be explained. These rates slightly overestimate the true rates since death cohort data have been used during a time period with decreasing natality. During the years 1982-84 natality in North Rhine-Westphalia decreased by about 0.5 to 4.5 per 1,000 per year, thus understating the denominator used in calculating death rates.

Confounding due to a particularly high proportion of very low birthweight babies could be excluded since the proportion of very low birthweight babies in North Rhine-Westphalia (0.85 percent) was very similar to the figures in Denmark (0.78 percent), Scotland (0.85 percent), England and Wales (0.81 percent), or U.S. whites (0.8 percent).

For the low and very low birthweight groups, the death rates in North Rhine-Westphalia were almost the highest in the whole data set. Awareness of this problem has prompted political action. Very decentralized care of premature labor resulting in late and long distance transport of the babies was found to be one of the reasons for the high death rates in these weight groups. The foundation of centers for perinatal care where high risk pregnancies are referred has been promoted.

In contrast to the high mortality rates in North Rhine-Westphalia for very low and low birthweight infants, the rates for babies with a birth weight of 2500 grams and above were almost as low as in the Scandinavian countries and for U.S. whites. This, however, might be a consequence of misclassification than of low mortality. For a substantial proportion of infant deaths the birth weight was unknown, although they certainly had a birth weight. Assuming that the infant deaths with missing birth weight were equally distributed over all birth weight groups, the true mortality rates in all birthweight groups, including the low and very low birthweight infants, should have been higher. Considering the birthweight registration practice for infant deaths--where doctors are requested to add the birth weight to the death certificate--it appears more likely that normal rather than low birth weights have escaped reporting. The consequence of nonrandom misclassification following this pattern would be spuriously low death rates in the normal birthweight groups.

In Israel the high total mortality rate was consistent with the birthweight-specific rates, with a peak in the 2000 to 2499 gram range. The high postearly neonatal mortality in Israel therefore is a true phenomenon. Confounding due to a higher proportion of at risk infants might be an additional contributing factor of small magnitude however, as the proportion of very low birthweight infants in Israel (1.02 percent) is only slightly higher than in Denmark (0.78 percent), Scotland (0.85 percent), England and Wales (0.81 percent), and U.S. whites (0.8 percent).

The excessively high total postearly neonatal mortality rate in U.S. blacks contrasts with slightly above average mortality rates for the different birthweight group strata. The high total postearly neonatal mortality rate is mainly a consequence of a much higher proportion of high risk very low birthweight infants in U.S. blacks (2.27 percent), which is more than twice the rate in the British Isles and North Rhine-Westphalia, and more than three times as high as for the Scandinavian countries.

In Osaka the very low total postearly neonatal mortality rate is a consequence of the low proportion of very low birthweight infants (0.45 percent), whereas the birthweight-specific mortality rates in the low and very low birthweight groups are almost as high as in Israel and North Rhine-Westphalia. As demonstrated in other contributions to this symposium, the extremely low proportion of very low birthweight infants is due to a registration practice where deaths in very premature and thus very low birthweight infants are considered as fetal deaths and not as infant deaths.

Summary

The international comparison of infant mortality data can improve understanding of national problems. It is essential, however, to understand how the data are collected in the countries to be compared. The North Rhine-Westphalia data show that death cohort data can only be compared to birth cohort data from the other countries if fluctuations in natality over time are taken into consideration. Birthweight-specific mortality rates may be distorted if birthweight data are not available for all infant deaths and if the failure to report birth weights in all infant deaths is nonrandom.

Surprisingly, missing data for birth weight were also a considerable problem for the birth cohort data contributed from Scotland and Sweden.

Analysis of the birthweight-specific death rates has shown that the high total postearly neonatal mortality rate for U.S. blacks is mainly due to the high proportion of high risk very low birthweight babies in this population; the very low total postearly neonatal death rates in Osaka resulted from a registration practice considering deaths in many very low birthweight infants as fetal deaths, resulting in a spuriously low proportion of high risk very low birthweight babies.

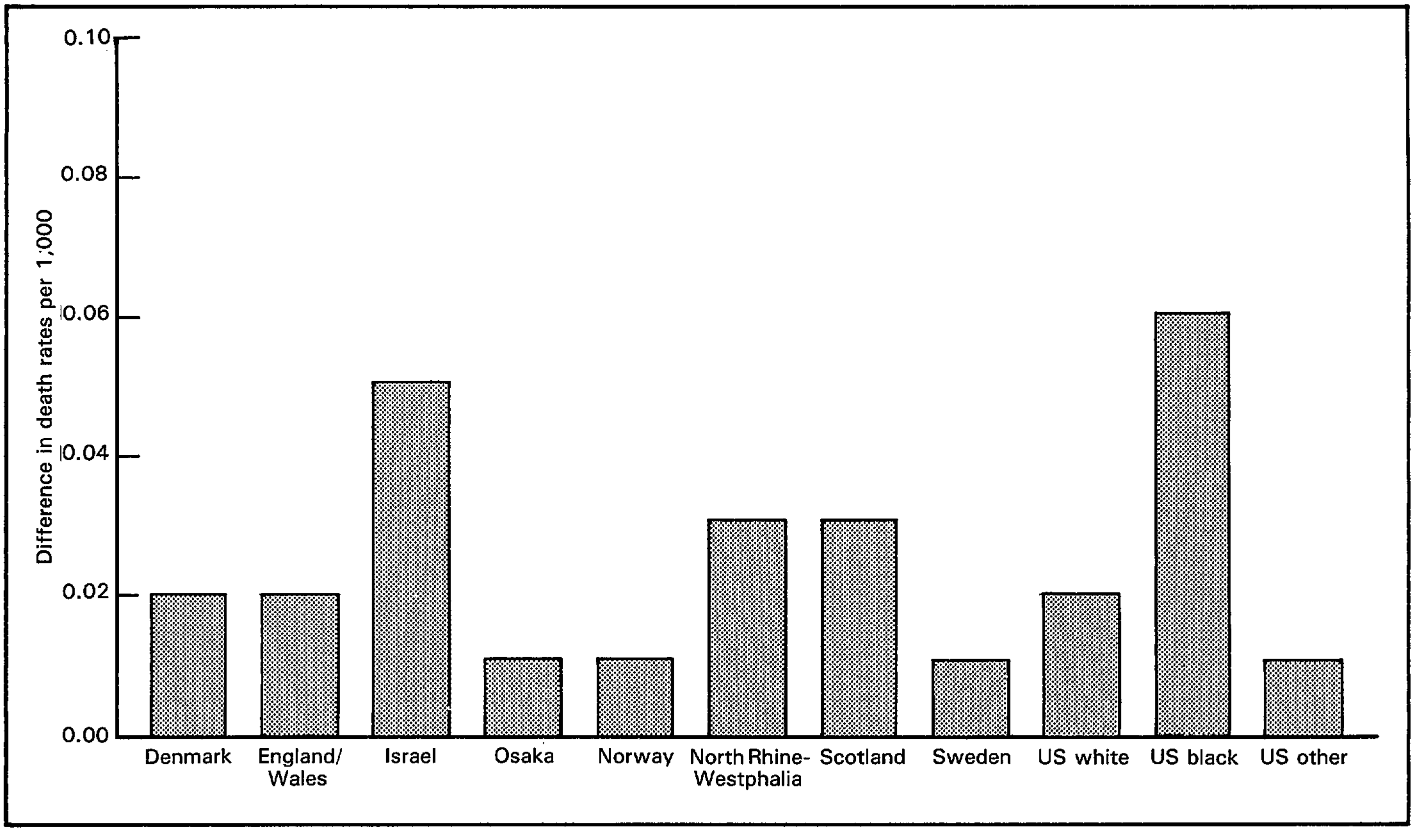

Figure 1. Post-early neonatal mortality: Differences between rates produced by two different methods of calculation, i.e. deaths/one week survivors minus deaths/live births: selected countries

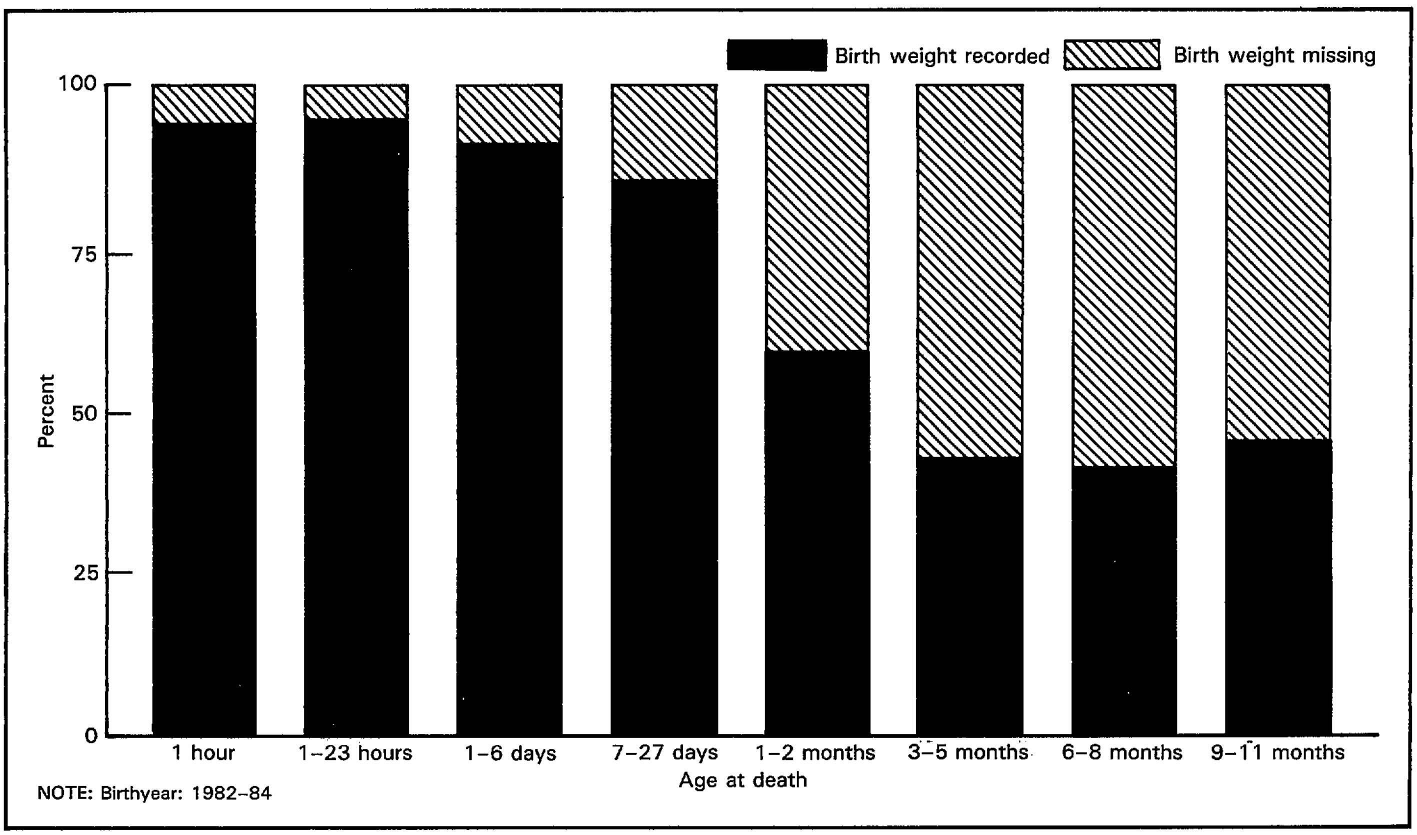

Figure 2. Completeness of birth weight recording on death certificates, by age at death: North Rhine-Westphalia, 1982–84

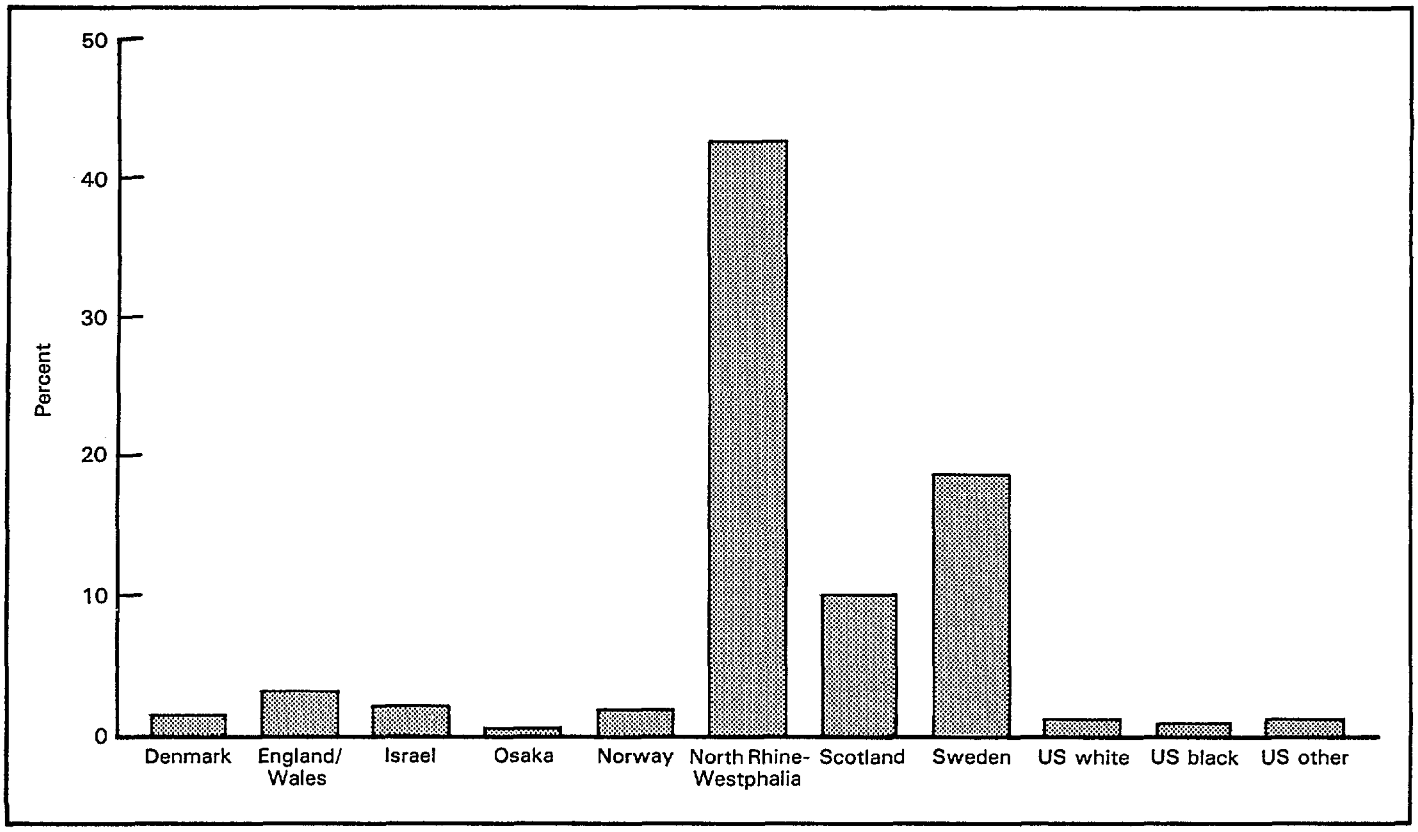

Figure 3. Percent of post-early neonatal deaths with missing birth weight: selected countries, 1982–84

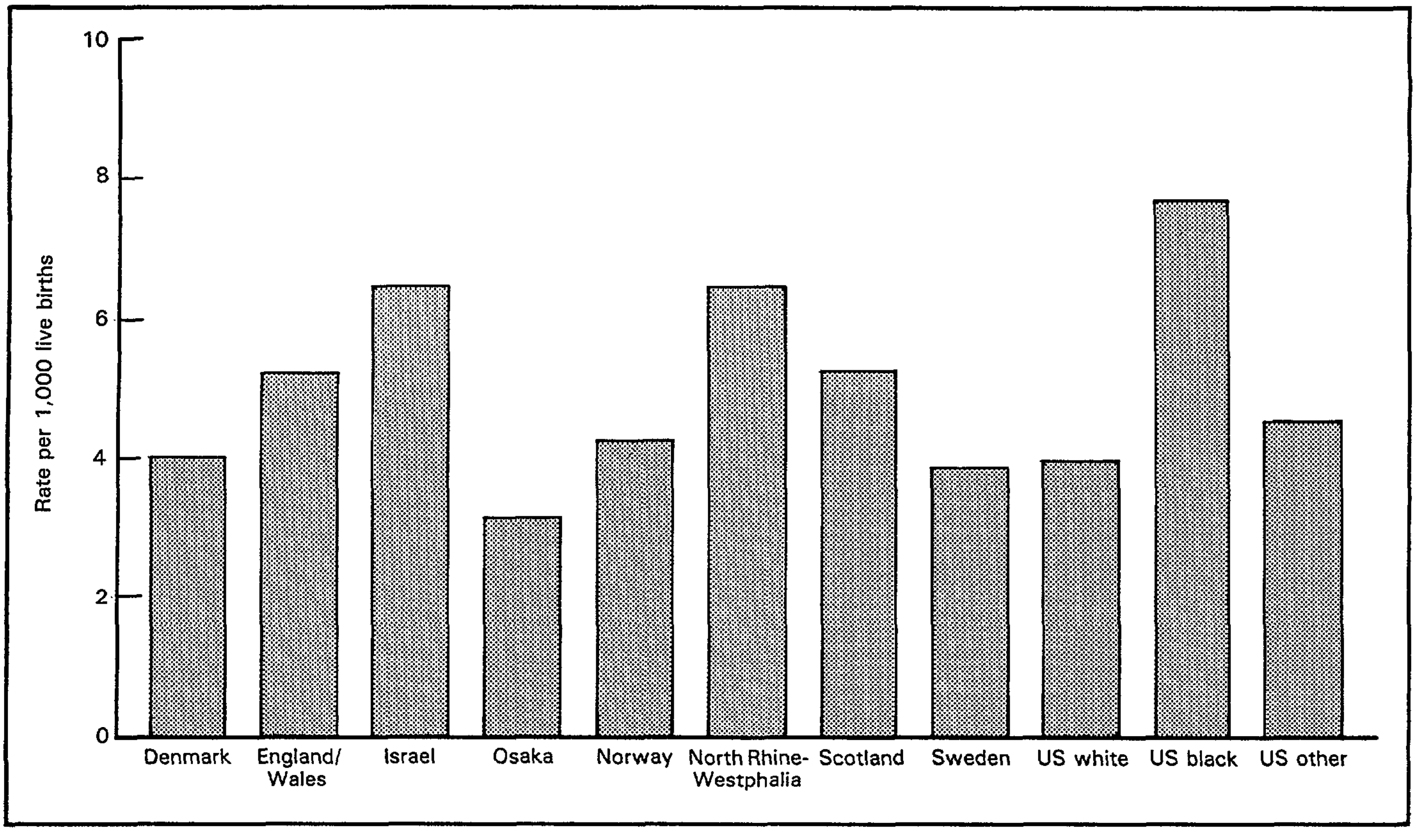

Figure 4. Rate of post-early neonatal mortality: selected countries, 1982–84

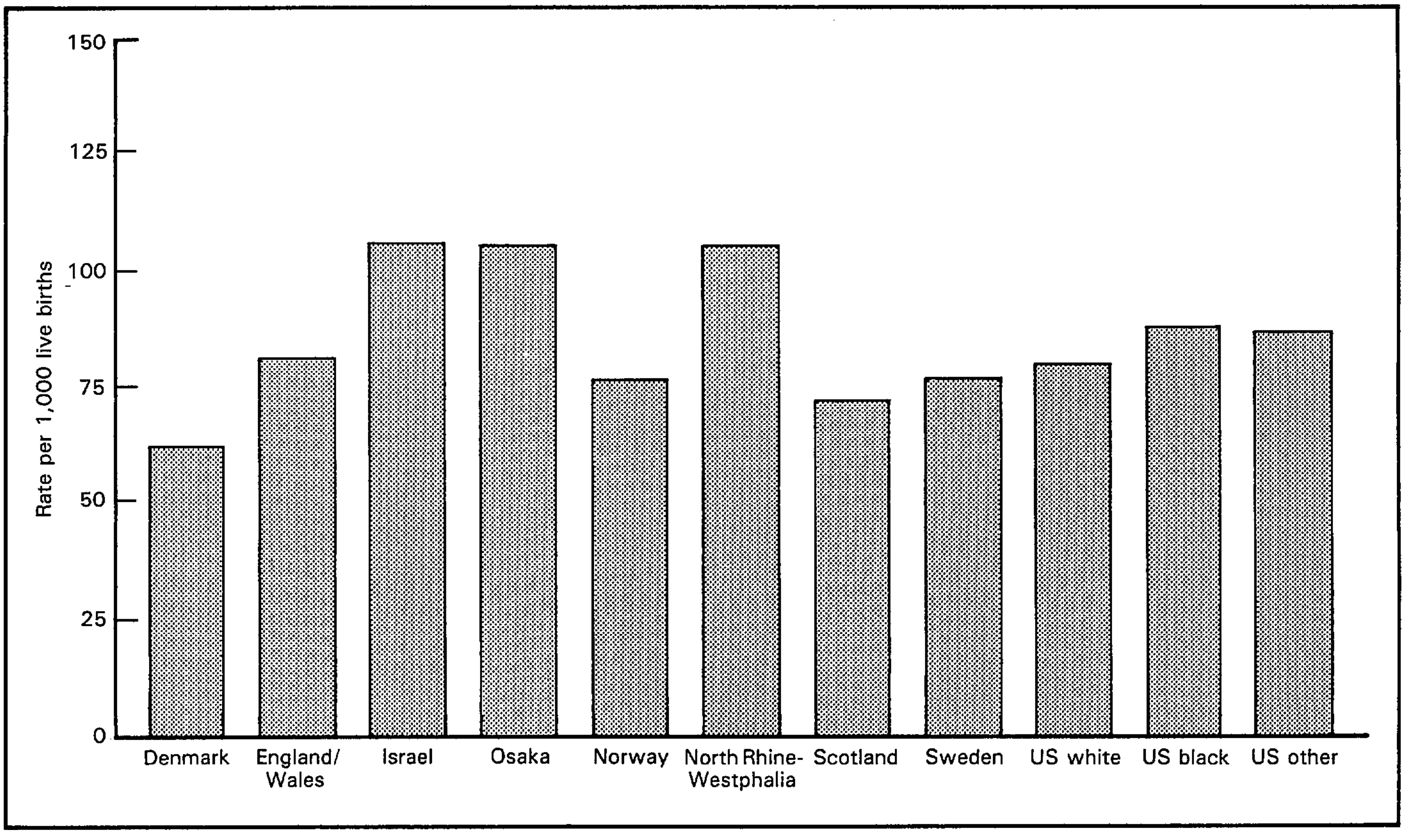

Figure 5a. Rate of post-early neonatal mortality for birth weight less than 1,500 grams: selected countries, 1982–84

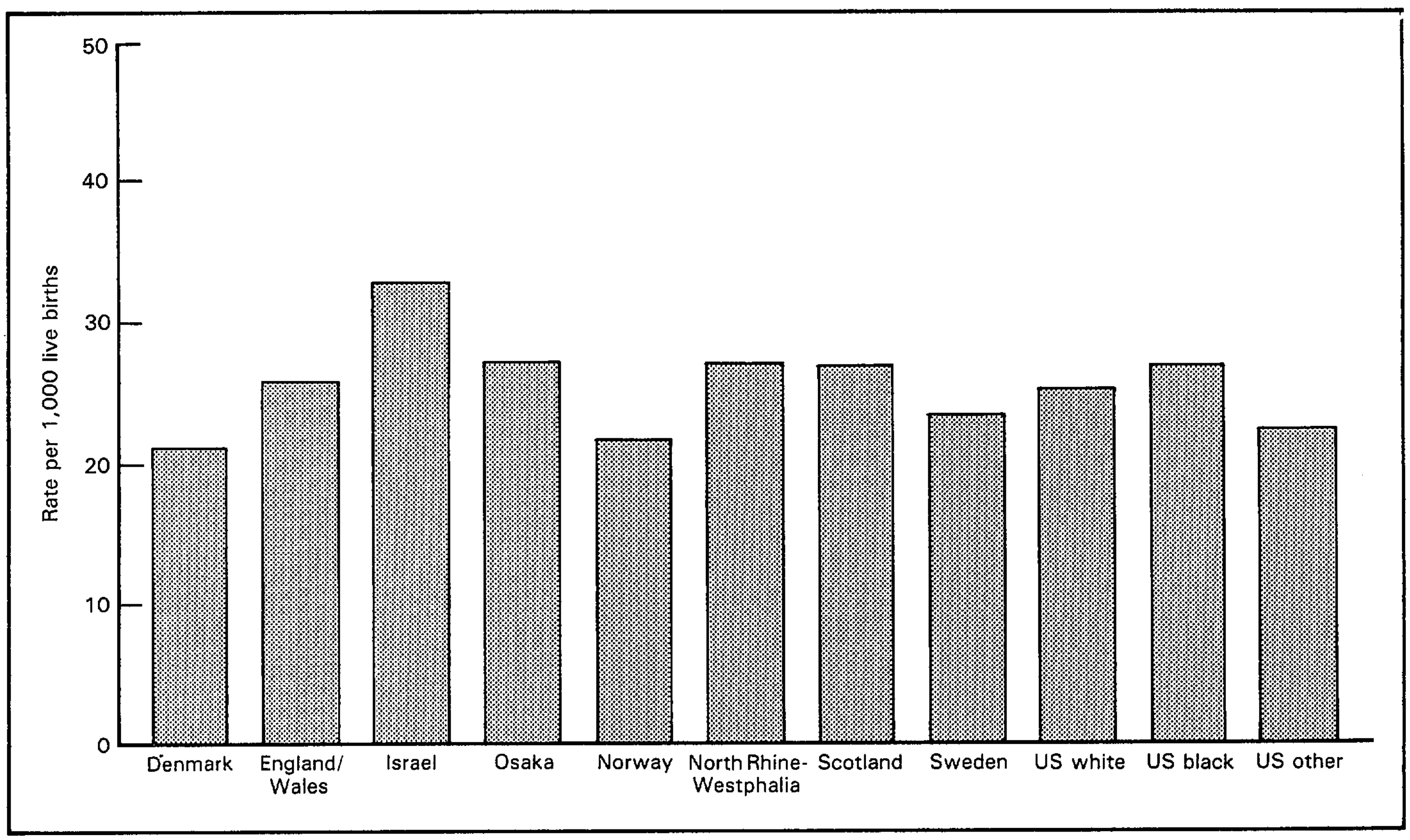

Figure 5b. Rate of post-early neonatal mortality for birth weight 1,500–1,999 grams: selected countries, 1982–84

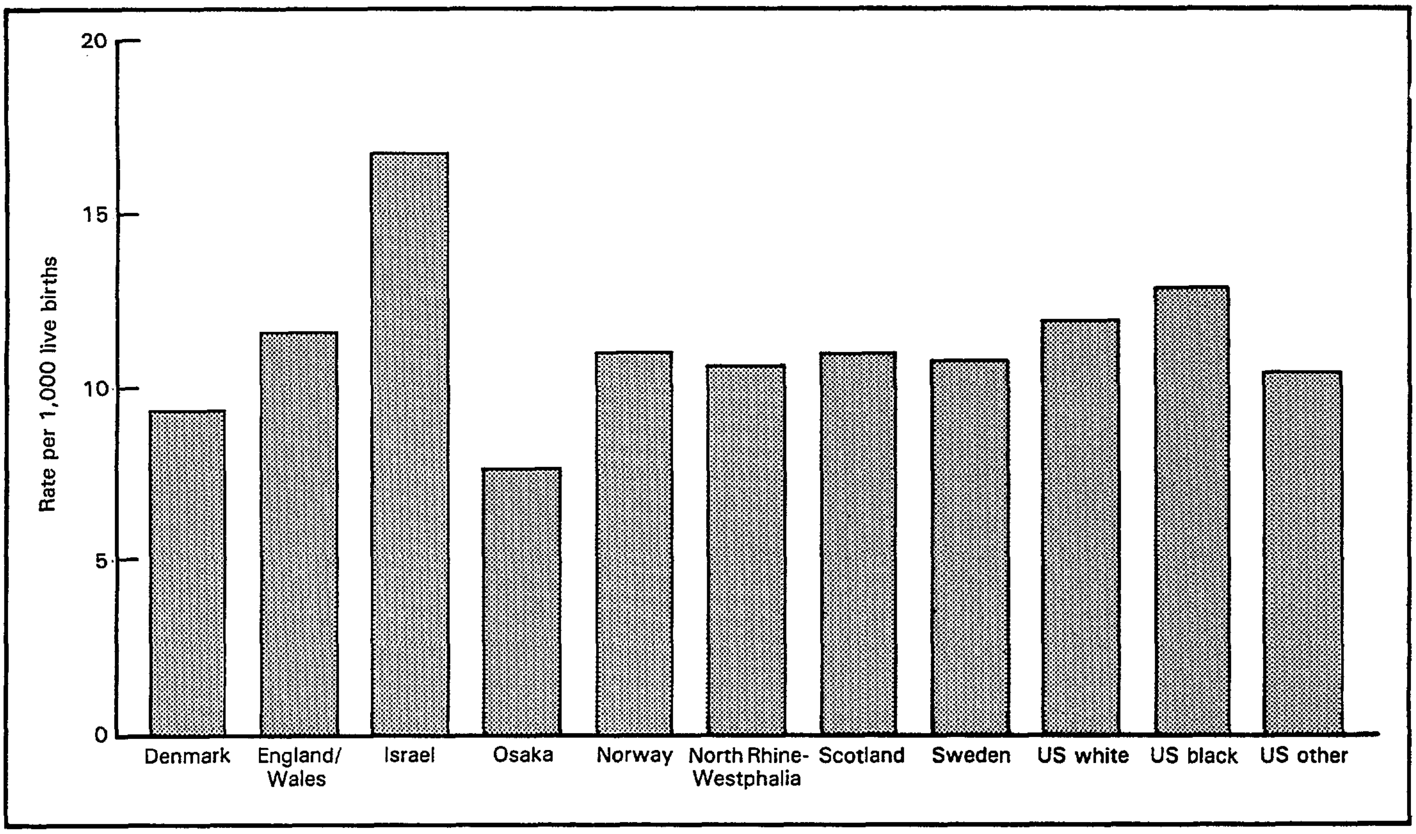

Figure 5c. Rate of post-early neonatal mortality for birth weight 2,000–2,499 grams: selected countries, 1982–84

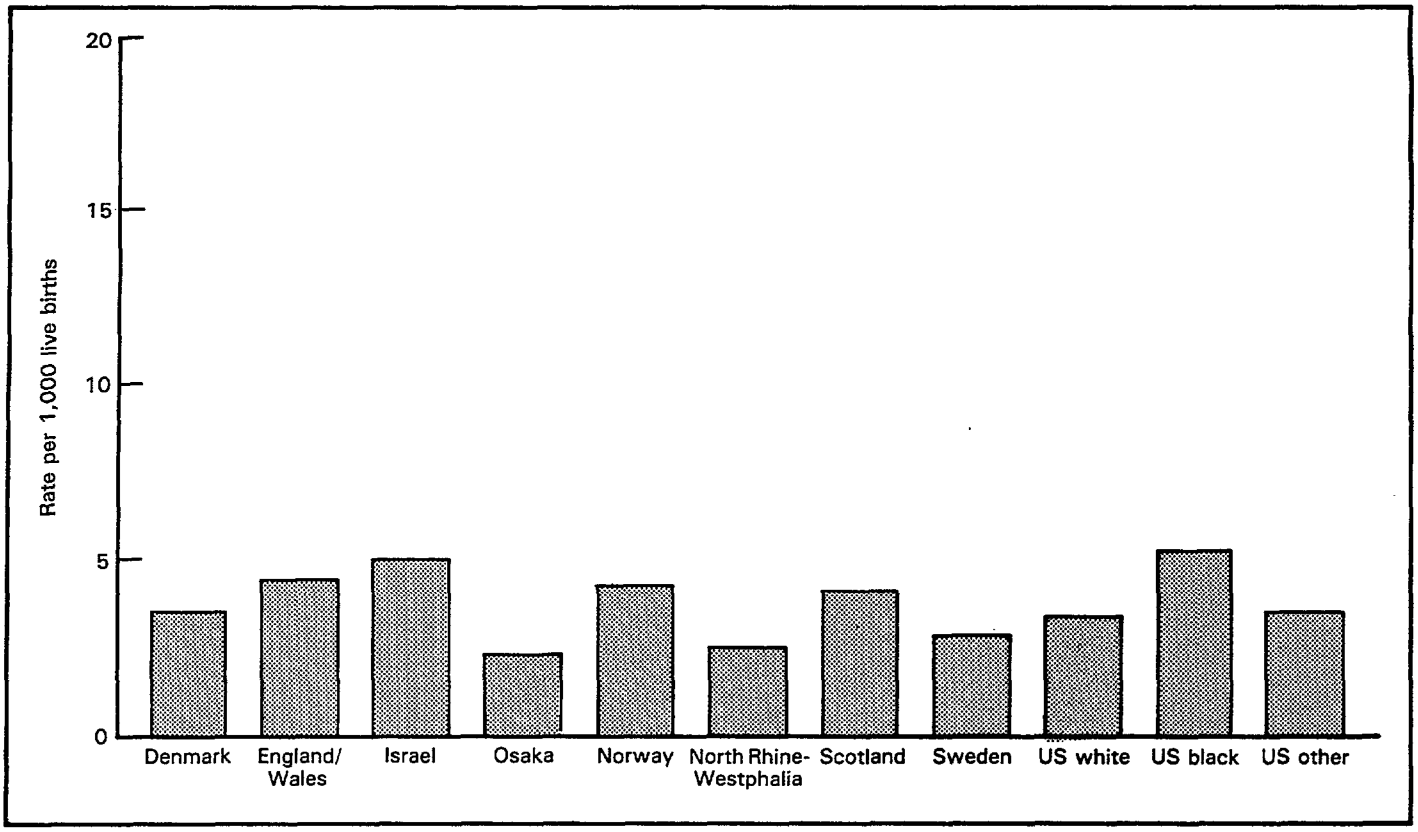

Figure 5d. Rate of post-early neonatal mortality for birth weight 2,500–3,499 grams: selected countries, 1982–84

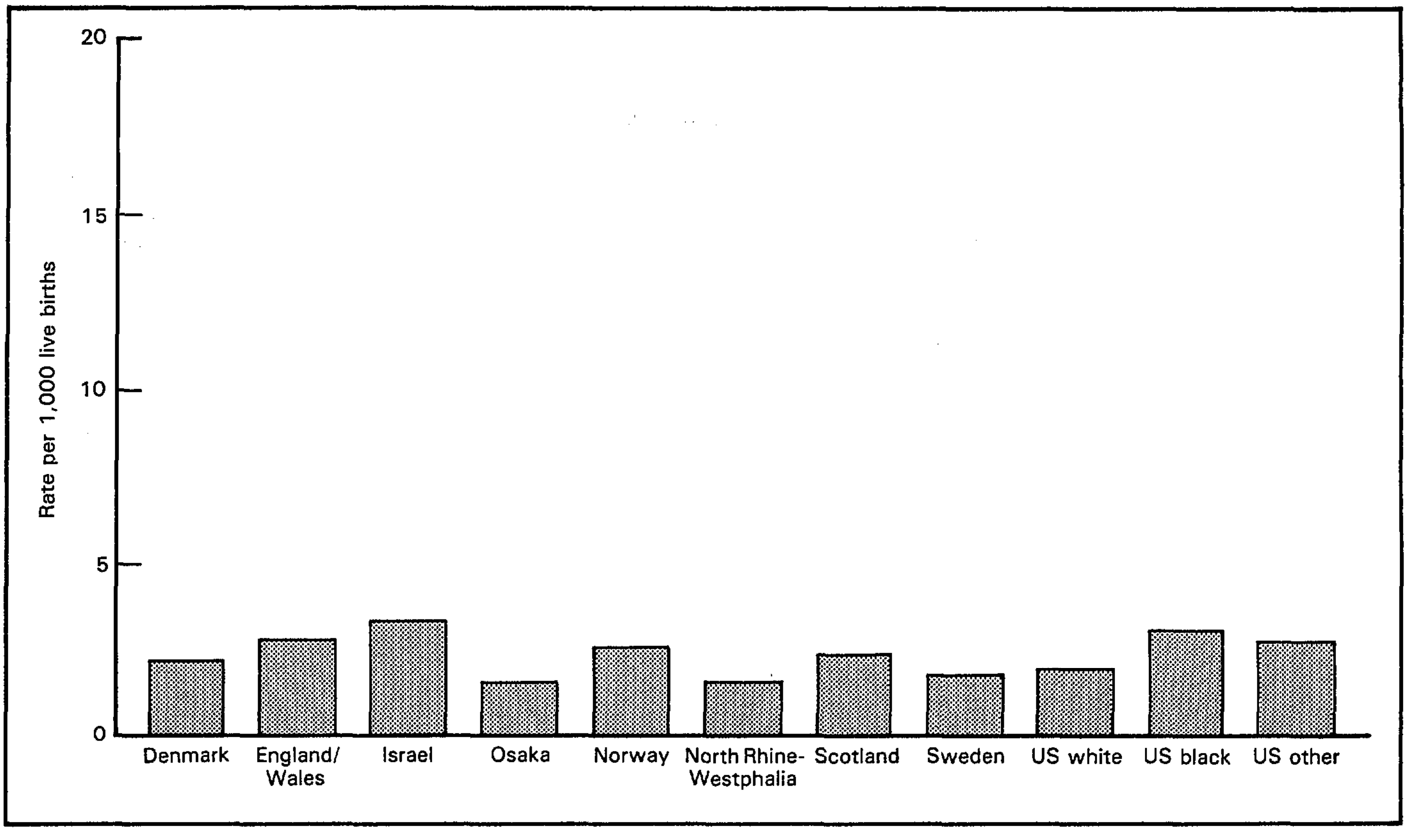

Figure 5e. Rate of post-early neonatal mortality for birth weight 3,500 grams or more: selected countries, 1982–84

Discussion

DR. KIELY: You showed that overall it did not make much difference whether you use births or survivors as a denominator. Would you consider the possibility that, in birthweight-specific mortality and very low birthweight babies, it would make a lot of difference whether you use survivors or births, given that there are so many deaths in the first week in very low birthweight babies?

DR. VON KRIES: I think you are completely correct in what you pointed out. I think that for all statistical variations of the data, you have to use the survivors at 1 week as the denominator. I believe there is evidence from the data that this is the correct approach. The populations with the highest proportion of very low birthweight infants--Israel and U.S. blacks--were the populations where the difference was greatest. I think you are completely correct.

Implications of Differences in Birthweight Distribution for Comparisons of Birthweight-Specific Mortality

by Joel C. Kleinman, Ph.D.

In this presentation, I will use data from the International Collaborative Effort (ICE) on Perinatal and Infant Mortality for a selected group of countries to illustrate how differences in birthweight distributions can affect comparisons of birthweight-specific mortality. The basic approach has been discussed extensively in recent years by Wilcox and Russell (1-4) but the method is not new. Suggestions to modify the 2500-gram cutpoint for low birth weight when comparing different populations have been made for the past 50 years (5-7).

Birthweight distributions and birthweight-specific mortality rates were based on births grouped into 200-gram intervals from 500-699 grams through 4500 grams or more. All births were assumed to occur at the midpoint of the interval (600, 800,...4400) with the last interval at 4750 grams. Let us begin by examining the birthweight distributions using a probit scale (figure 1). There are two reasons for preferring a probit scale. First, it shows the important tails of the distribution much more clearly than other scales. Second, if the births follow a Gaussian or normal distribution, then the probit scale would show a straight line. In fact, figure 1 shows a straight line down to about the 2500-gram point but a marked departure below that. Thus, the birthweight distribution is essentially a mixture of two distributions, a predominant Gaussian distribution containing most of the births and a residual distribution at the lower birth weights. The birthweight distributions have large differences in the medians, which correspond to the zero point on the probit scale. Note especially that Osaka and U.S. blacks had the two lowest medians (about 3200 grams); yet Osaka had the second lowest and U.S. blacks the second highest mortality rates. The important difference between these two birthweight distributions is the births in the residual distribution. U.S. blacks had by far the greatest proportion of births in the lower (non-Gaussian) tails of the distribution while Osaka had among the smallest.

The essence of the Wilcox-Russell approach is that differences in the predominant distributions have essentially no impact on mortality. When comparing populations this approach can lead to substantially different results than traditional methods. These different results in turn have different implications for prevention.

There are three parameters that characterize the birthweight distribution: the mean and standard deviation of the predominant distribution and the proportion of births in the residual distribution. Estimating these three parameters requires specialized computer programs that are not available in standard packages. I have found, however, that the mean and standard deviation of all births above 2000 grams provides a very close approximation to the mean and standard deviation using the more complex methods.

In addition a simple approximation to the proportion of births in the residual distribution can be obtained by first assuming all births above 2500 grams are in the predominant distribution. Thus, the births below 2500 grams consist of births in both the predominant and residual distributions. Assuming the predominant distribution is Gaussian, the proportion (p) of births one would expect above 2500 grams can be calculated by referring Z=(2500-mean)/sd to a standard normal table where the mean and standard deviation are the estimates for the predominant distribution. The estimated total number of births (above and below 2500 grams) in the predominant distribution (b) is then the observed number of births above 2500 grams divided by p. Finally, the proportion in the residual distribution is just 1 minus the proportion in the predominant distribution, 1-b/B. These are relatively simple methods for approximating the three characteristics of the birthweight distribution. The results that follow, however, are based on more complex iterative estimates using the EM algorithm (8).

In order to focus on the residual distribution, we can plot the birthweight distribution not in terms of the actual birth weight in grams but in terms of the Z-score where Z=(bw-mean)/sd (figure 2). Since the Z-score essentially normalizes the birthweight distribution to give a mean of zero and standard deviation of one, the predominant distributions just fall out one right on top of the other, but you can see the excess a lot more clearly at about Z<-1. U.S. blacks have the highest proportion in the residual at every point on the Z-scale. Osaka has the best birthweight distribution until about Z<-4 when it merges with the others and actually starts to look as bad as the U.S. distributions. (Part of the reason for this may be that reporting is better in the United States and Japan, with many more births under 500 grams and fetal death reporting required well below 28 weeks.)

Table 1 shows quantitative summaries of the birthweight distributions for each of the countries. The means of the predominant distributions vary from 3,192 for Osaka and 3,217 for U.S. blacks to 3,537 for Sweden. U.S. whites and Denmark have about the same means (nearly 3,500), followed by England and Wales at 3,354 and Israel (both Jews and non-Jews) at 3,300. The standard deviations are much less variable, but Osaka stands out as having by far the lowest. Although Osaka and U.S. blacks have similar means, they are at opposite extremes in terms of the proportion of births in the residual distribution (1.3 vs. 4.3 percent). Sweden and U.S. whites have the next lowest proportions of residual births (1.8 and 2.0 percent) while the other countries have similar proportions (2.2 to 2.7 percent).

Now, let us move to mortality. Table 2 shows the different mortality characteristics by age at death. Because of differences in reporting, births under 500 grams are excluded. The highest rates by far for all the categories are the Israeli non-Jews. U.S. blacks are second, again by a large amount. Osaka had the lowest infant mortality rate, followed by Denmark and Sweden. However, Sweden had a considerably lower fetal death rate than any of the other countries (raising the possibility of under-reporting due to their requirement for fetal death registration at 28 weeks or more gestation). Osaka, on the other hand, had the third highest fetal death rate (perhaps due to their reporting fetal deaths beginning at 12 weeks gestation, as well as a possible tendency to report live births who die just after birth as fetal deaths). The net impact of these differences is summarized in the feto-infant mortality rate, which measures all fetal deaths of 28 weeks or more gestation plus infant deaths divided by live births plus fetal deaths. Sweden has the lowest rate of all the countries, with Denmark 5 percent higher, Osaka 9 percent higher, and U.S. whites 16 percent higher. England and Wales and Israeli Jews were about 40 percent higher, U.S. blacks twice as high, and Israeli non-Jews nearly triple. The basic purpose of the analysis that follows is to determine how much of the excess mortality in the other countries is due to birthweight distribution and how much is due to birthweight-specific mortality.

Let us turn now to the birthweight-specific mortality curves. The first thing to note when comparing birthweight-specific mortality rates is that a logit scale should generally be used. The logit scale measures birthweight-specific mortality rates in terms of the logarithm of the odds of death. Because birthweight-specific mortality rates range from over 900 per 1000 around 800 grams to only about 2 or 3 per 1000 around 4000 grams, it is mathematically impossible to see comparable differentials across the entire range of birth weights in either the arithmetic or logarithmic scales. For example, in terms of relative risk there is about a threefold differential between the Swedes and the Israeli non-Jews at 4000 grams, but only about a 1.8 relative risk at 1000 grams. In terms of arithmetic difference in mortality rate, the Israeli non-Jews are about 8 deaths per 1,000 higher at 4000 grams compared to 311 deaths per 1,000 higher at 1000 grams. In terms of relative odds, however, the differentials are fairly similar: 3.1 at 4000 and 3.7 at 1000 grams. Thus, comparisons of birthweight-specific mortality become clearer visually when the rates are plotted in a logit scale.

Figure 3 compares the birthweight-specific mortality curves for the eight populations. Israeli non-Jews have the highest rates over the entire range of birth weights. Between 800 and 2000 grams, U.S. blacks have much lower rates than any of the other population groups and maintain relatively low rates until about 2500 grams. Osaka, on the other hand, has a relatively high rate between 1000 and 2500 grams but the lowest rate between 2500 and 3500 grams. The Swedes, who have the lowest overall feto-infant mortality rate, have higher rates than 3 or 4 other countries between 1000 and 3000 grams but have among the lowest rates over 3000 grams.

Note that these curves have different points at which the minimum mortality is achieved. Intuitively, it seems desirable to compare birthweight-specific mortality among the populations by starting at the birth weights where each achieves its minimum value and then examine how the differences in birthweight-specific mortality spread out from that point. Empirically, it appears that the minimum mortality occurs at a birth weight about one standard deviation above the mean. Thus, plotting the birthweight-specific mortality rates using a Z-score, rather than the actual birth weight, on the x-axis allows for comparison of the populations relative to their optimal mortality.

Figure 4 compares the eight populations using the Z-scores on the x-axis. Note that the minimum values all seem reasonably close to Z=1. (Remember that some of these birthweight-specific mortality rates are based on rather small numbers with consequently large standard errors.) Israeli non-Jews maintain their position with the highest mortality at all values of Z. However, for Z-values between -5 and -3 there are few differences among the other populations except, surprisingly, Osaka has a noticeably high rate. U.S. blacks, which in the original scale had much lower rates at the lower birth weights, now converge with the other populations at Z<-2 and are clearly high for larger values of Z.

Now there are 21 birthweight-specific mortality rates for each population, so how do we use all those comparisons to get a reasonable summary of how these populations compare in terms of birthweight-specific mortality? It is clear from figures 3 and 4 that there are substantial differences in the way the populations compare at lower vs. higher birth weights. Thus, it makes sense to compare birthweight-specific mortality rates below and above critical birth weights measured either in the gram scale or the Z-scale. In order to do this, I fit separate quadratic models to weight-specific mortality for births below and above 2500 grams and separate quadratic models for births with Z below and above -2. Since Sweden had the lowest overall mortality rate, I used dummy variables to represent each population's odds ratio relative to Sweden. Table 3 shows the results.

There were substantial differences for Osaka and U.S. blacks in their odds ratios below and above 2500 grams. Below 2500 grams, U.S. blacks had by far the lowest odds ratio (.69) but above 2500 grams they had one of the highest (1.28). Osaka showed almost exactly the reverse effect: high odds ratio below 2500 grams (1.32) but the lowest above 2500 grams (.72).

When birthweight-specific mortality was modeled using the Z-score, every population showed increases in their odds ratios, primarily because Sweden had the highest mean birth weight (and consequently the highest birth weight at which the minimum mortality was achieved). In particular, the odds ratios for U.S. blacks were similar below and above -2 (1.5 and 1.8, respectively) and, although there were still differences for Osaka (1.43 and 0.97, respectively), the differences were reduced. There are other major shifts for the populations that had mean birth weights very different from Sweden's. England and Wales had odds ratios around 1.5 in the Z-scale compared with 1.2 in the gram scale. The odds ratios for Israeli Jews increased from around 1 in the gram scale to 1.3 in the Z-scale. Israeli non-Jews went up even more to around 3.5 in the Z-scale.

Now, let us go a step further and look at the contribution of birthweight distribution vs. birthweight-specific mortality to feto-infant mortality. The first step is to figure out what the expected mortality would be if all populations had Sweden's birthweight-specific mortality rates. Note that this is essentially the denominator of a Standardized Mortality Ratio used in an indirect adjustment for birth weight. The logistic models without the dummy variables can be used to calculate Sweden's birthweight-specific mortality. When these rates are applied to each population's birthweight distribution, the expected feto-infant mortality rate is obtained (table 4).

The observed value is 9.9 for Sweden and the expected value for Sweden is always going to be 9.9 because what I am doing is applying the birthweight-specific mortality in Sweden under either the gram model or the Z-model to that country's birthweight distribution. For the other countries, however, comparison of the observed with the expected values allows for calculation of the portion of excess mortality attributable to birthweight distribution and the portion attributable to birthweight-specific mortality. For example, U.S. whites had a 16 percent higher feto-infant mortality rate than Sweden; based on the expected value using the gram model one would expect a 13 percent higher mortality, but the expected value under the Z-model is only 5 percent higher. This means that if the gram model is correct, 81 percent of the excess mortality among United States whites is due to birth weight, and only 19 percent is due to birthweight-specific mortality. If the Z-model is correct, however, the expected feto-infant mortality rate among U.S. whites is only about 5 percent higher than Sweden's rate. Thus only 31 percent of the excess, 5 out of 16, is due to birthweight distribution, and 69 percent is due to birthweight-specific mortality.

For U.S. blacks the difference between the two models is even larger. Based on Sweden's birthweight-specific mortality using the kilogram scale, blacks would do even worse than they were observed to do, i.e., their feto-infant mortality would be 21.9 instead of the observed 20.3. This is primarily due to the extremely low mortality of U.S. blacks in the low birth weight range. However, applying Sweden's birthweight-specific mortality to the birthweight distribution of U.S. blacks in the Z-scale, their mortality would be only 13.5. Thus, in the gram scale, all of the excess mortality among U.S. blacks relative to Sweden is attributed to birthweight distribution, while in the Z-scale only 30 percent of the excess is due to their birthweight distribution; the remaining 70 percent is due to higher birthweight-specific mortality.

Denmark, Israeli Jews, and Osaka also show all of their excess mortality attributed to birthweight distribution when using the gram scale but a much lower proportion when using the Z-scale.

The implications of using the Z-model are important. Basically the Z-model implies that population differences in mean birth weights are of little importance. What this implies for intervention is that if you change the birthweight distribution by only "fattening up" the babies, you are not going to have any effect on mortality. The entire birthweight-specific mortality curve (and the optimal birth weight) is merely going to shift to the right.

The relevant part of the birthweight distribution is the residual. Interventions need to focus on reducing the incidence of births in the residual distribution, which in a sense translates into reducing preterm delivery. The contrast between Osaka, with one of the lowest mortality rates and U.S. blacks, with one of the highest rates, reinforces this point. Both these populations had similar mean birth weights (which were much lower than the mean for any of the other countries) but very different proportions in the residual distribution.

A corollary of this point is that the low birthweight rate, because it is so heavily influenced by the mean, is an inappropriate indicator of risk. Very low birth weight (<1500 grams) is preferable because a much higher proportion of those very low birthweight babies are in the residual distributions. So, if a quick summary of the birthweight distribution is required, it is better to use the incidence of very low birth weight than low birth weight.

Finally, the Z-model suggests that there are much greater differences in birthweight-specific mortality than appears from comparisons in the gram scale. Thus, reducing feto-infant mortality requires a decrease in weight-specific mortality at all birth weights as well as a reduction in the incidence of births in the residual distribution. In fact, the Z-model suggests that in many countries the latter, not the former, is considerably more important.

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Table 1. Characteristics of the birth weight distributions: selected countries 1983-86

	Predominant distribution Mean	SD	Percent in residual distribution	Percent <1500 gm	Percent <2500 gm
Denmark	3478	509	2.2	0.81	4.9
England and Wales	3354	491	2.2	0.89	6.1
Israeli Jews	3294	472	2.7	1.13	7.0
Israeli non-Jews	3301	486	2.3	1.02	6.8
Osaka	3192	410	1.3	0.59	5.3
U.S. whites	3469	504	2.0	0.86	4.7
U.S. blacks	3217	508	4.3	2.56	11.6
Sweden	3537	508	1.8	0.65	3.8

Table 2. Mortality rates by age at death: selected countries 1983-86

	Mortality rates per 1,000						Ratio to Sweden		
	Total births	Neonatal	Post-neonatal	Infant	Fetal	Feto-infant	Infant	Fetal	Feto-infant
Denmark	321,599	3.6	2.5	6.1	4.4	10.4	0.98	1.17	1.05
England and Wales	1,893,301	4.9	3.9	8.8	5.3	14.1	1.42	1.42	1.42
Israeli Jews	220,268	6.6	2.9	9.6	4.4	13.9	1.54	1.18	1.40
Israeli non-Jews	69,701	10.7	8.6	19.2	10.3	29.3	3.10	2.77	2.96
Osaka	213,735	3.3	2.0	5.3	5.5	10.8	0.85	1.48	1.09
U.S. whites	2,759,803	4.4	2.9	7.3	4.3	11.5	1.17	1.16	1.17
U.S. Blacks	455,218	8.0	5.9	13.8	6.5	20.3	2.23	1.75	2.05
Sweden	376,160	3.8	2.4	6.2	3.7	9.9	1.00	1.00	1.00

NOTE: Excludes births and deaths below 500 grams.

Table 3. Odds ratios for birthweight-specific feto-infant mortality based on quadratic models in two intervals: selected countries 1983-86

	Gram model		Z-model	
	GM<2500	GM>2500	Z<-2	Z>-2
Denmark	0.84	0.99	0.97	1.05
England and Wales	1.11	1.20	1.54	1.42
Israeli Jews	0.98	0.94	1.32	1.18
Israeli non-Jews	2.51	2.61	3.86	3.28
Osaka	1.32	0.72	1.43	0.97
U.S. whites	1.03	1.05	1.16	1.12
U.S. blacks	0.69	1.28	1.53	1.80
Sweden	1.00	1.00	1.00	1.00

Table 4. Observed and expected feto-infant mortality rates: selected countries 1983-86*

	Rates			Ratio to Sweden			% of excess attributable to birthweight distribution	
	Observed	Expected		Observed	Expected			
		GM Model	Z-model		GM Model	Z-model	GM Model	Z-model
Denmark	10.4	11.1	10.3	1.05	1.12	1.04	240	80
England and Wales	14.1	12.4	10.2	1.42	1.25	1.03	60	7
Israeli Jews	13.9	14.4	11.8	1.40	1.45	1.19	113	48
Israeli non-Jews	29.3	13.7	10.6	2.96	1.38	1.07	20	4
Osaka	10.8	11.5	10.0	1.09	1.16	1.01	178	11
U.S. Whites	11.5	11.2	10.4	1.16	1.13	1.05	81	31
U.S. Blacks	20.3	21.9	13.5	2.05	2.21	1.36	115	35
Sweden	9.9	9.9	9.9	1.00	1.00	1.00	--	--

*Expected rates based on separate quadratic models for GM<2500 v. GM>2500 and Z<-2 v. Z>-2.

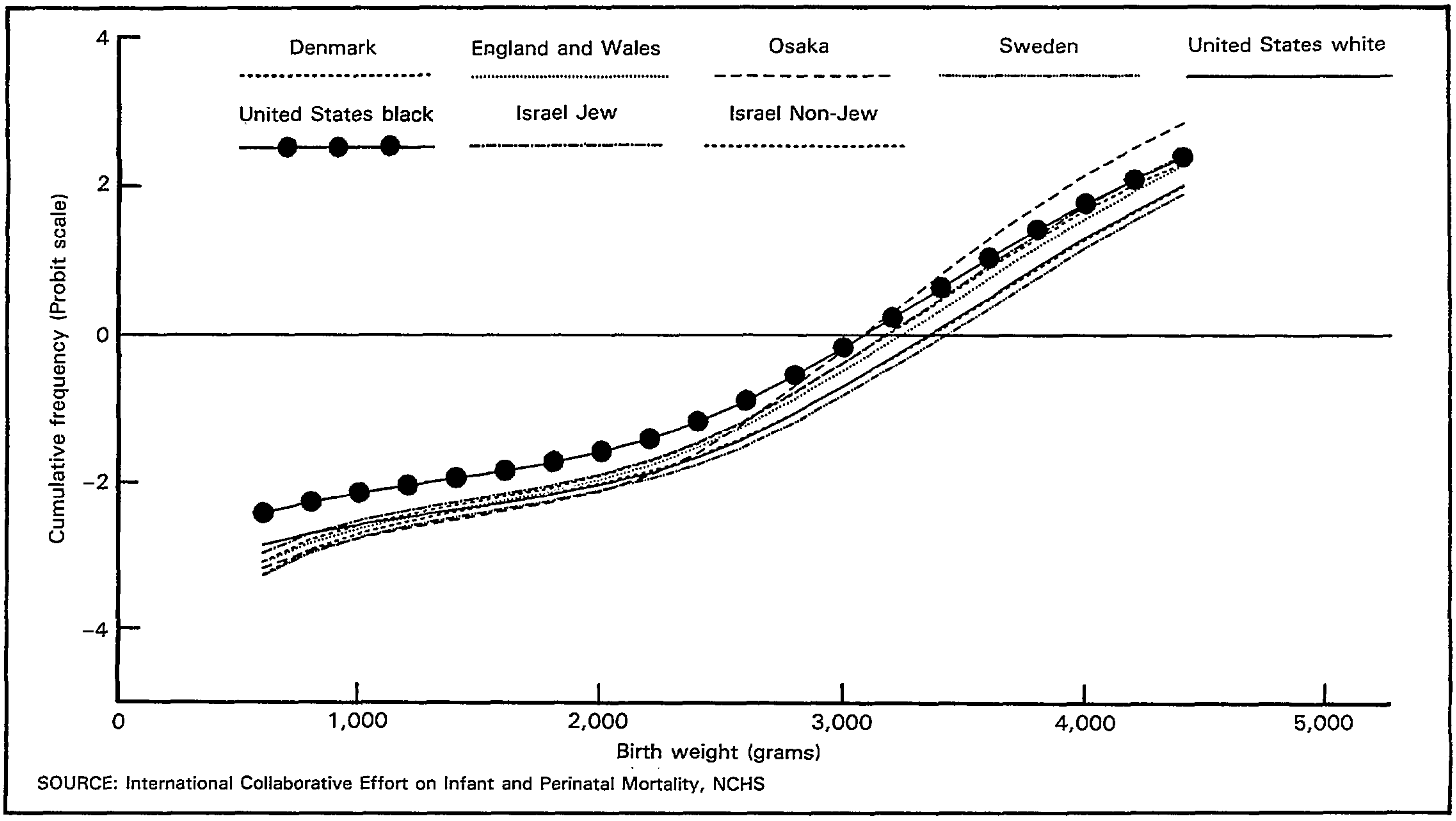


Figure 1. Birthweight distributions, singleton live births plus late fetal deaths: selected countries, 1983–86

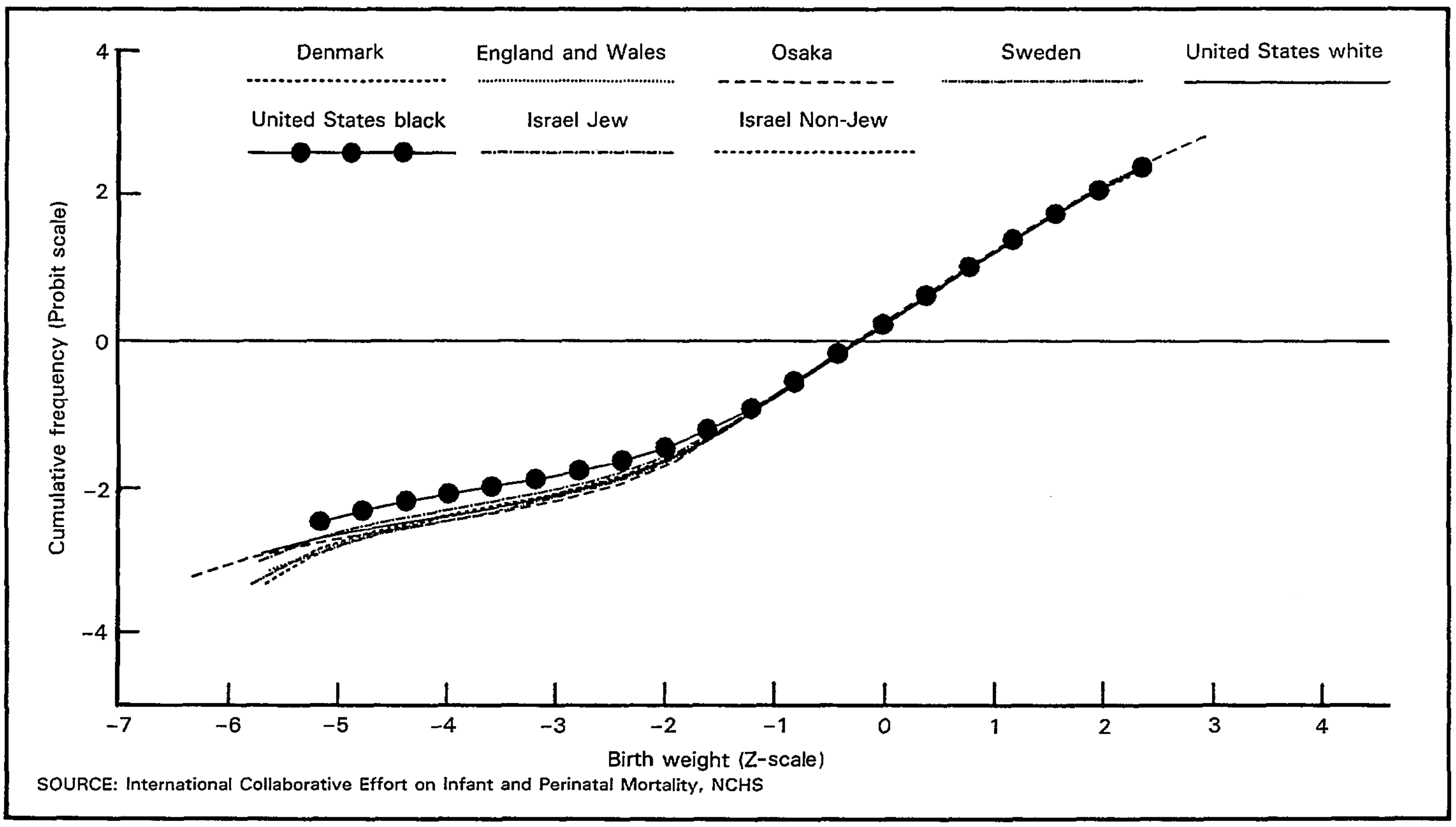


Figure 2. Birthweight distributions, singleton live births plus late fetal deaths: selected countries, 1983–86

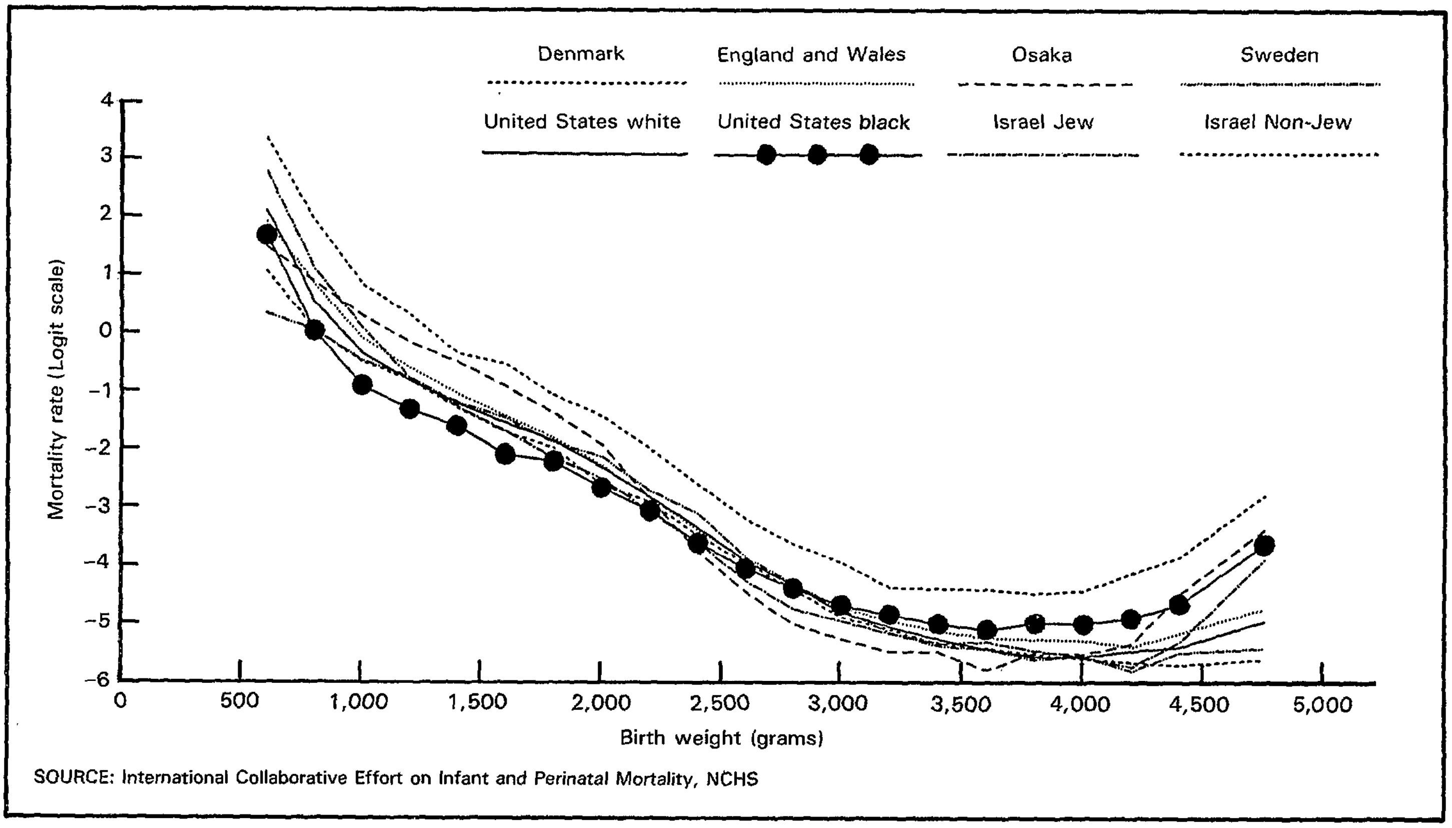


Figure 3. Birthweight-specific feto-infant mortality, singleton live births plus late fetal deaths: selected countries, 1983–86

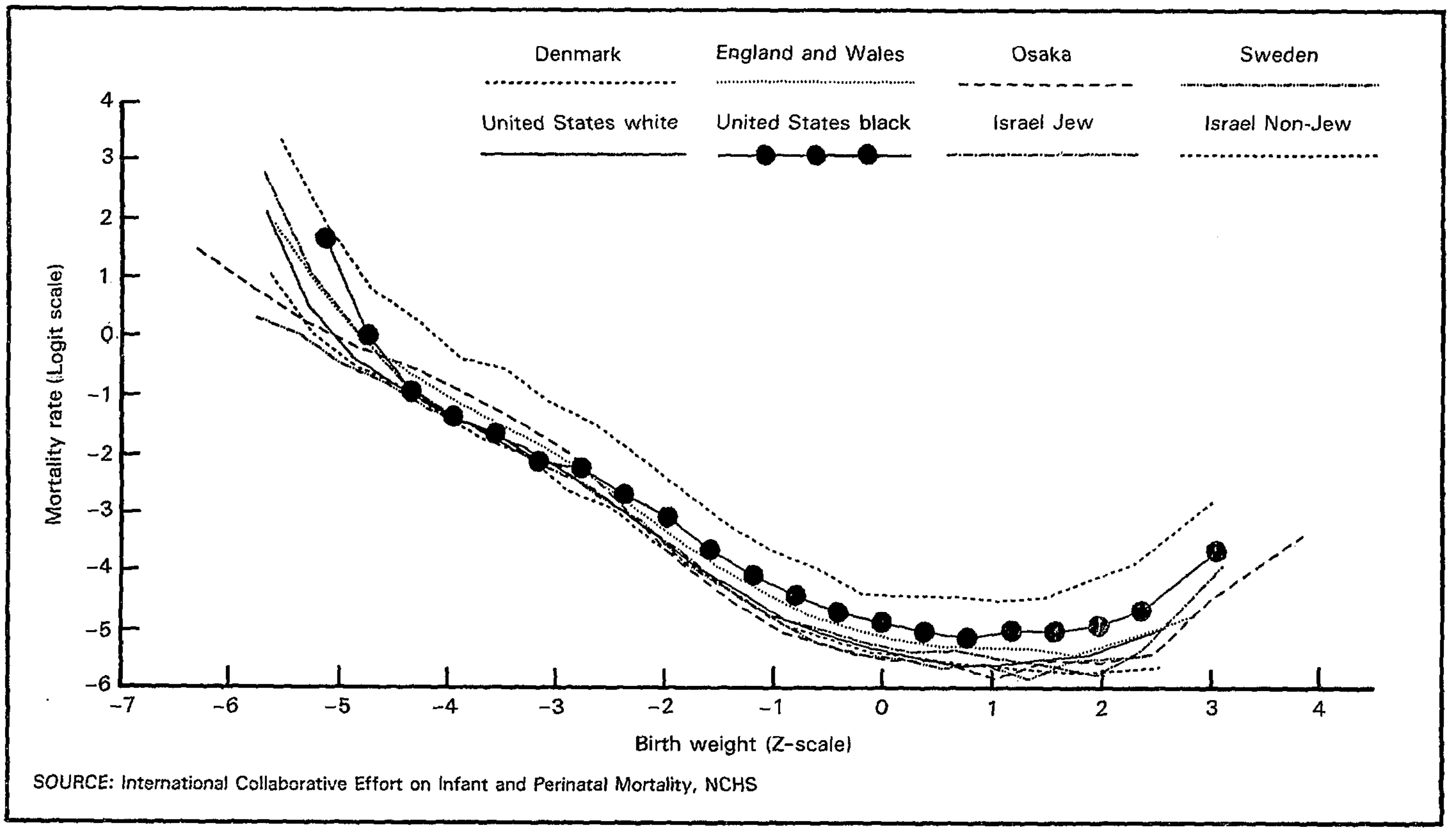


Figure 4. Birthweight-specific feto-infant mortality, singleton live births plus late fetal deaths: selected countries, 1983–86

Discussion

DR. KARLBERG: Thank you for a very interesting presentation. I think it is more and more clear that the birthweight distribution has a great impact when we analyze perinatal data.

May I start the discussion and give a short report on our experience from analyses of birthweight distributions with a subpopulation model using techniques for decomposing mixtures of normal distributions, obtaining a dominating primary "healthy" subpopulation and a remainder or secondary smaller but broader subpopulation. The method has been applied on data from the 1973 International Comparative Study sponsored by WHO. Hungary, Japan, and Sweden showed birthweight distributions of quite different levels and shapes. After standardization from their own primary subpopulation mean and standard deviation, Japan and Sweden showed virtually coincident distributions. This indicated that the difference was of biological character, although Hungary still showed a heavier lower tail. Birthweight-specific early neonatal mortality rates were standardized the same way for the three countries. The parallel courses of the standardized birthweight mortalities indicate an improved description of the biological events. (A more detailed report with graphical presentations is given in the Symposium Workshop.)

DR. ALBERMAN: I wonder whether I may be devil's advocate. First of all, I should say, Joel, I thought that was a beautiful presentation and made a lot clearer what I had not understood before, but is it possible that artifactual differences due to registration practices are creating a situation that is not actually biologically there, and I am being the devil's advocate here.

We know that the U.S. registration practices are certainly increasing the proportion of fetal deaths at the very low end of the birthweight distribution, and I have a suspicion they are also increasing the proportion of live births at the lower end. We also know that the Swedes have a relatively high proportion of unknown birth weights and quite an extraordinarily low mortality at the low birth weights. So, would it make a difference if you allowed for those?

MR. LEON: I am also impressed by the presentation, but I wonder if in some way one has got to balance that statistical sophistication, particularly when you get into modeling the Z-scores. Perhaps the technique starts to detract from the importance of the Wilcox-Russell approach, which is perhaps heuristic in terms of pointing out that we have got to bear in mind that there are two components--the residual distribution plus the differences in birthweight-specific mortality--and those are things that seem to me are important to be reminded about constantly.

So, just because you remove interactions on the Z-score, that may not be a mathematical convenience but perhaps it gets away from the issue that it is important to be aware of those interactions. My other point was in relationship to your last point--that increasing the birth weight of babies is not necessarily going to rectify the situation. I wonder if you can in practice increase mean birth weight without doing something to the birthweight-specific mortality rates?

DR. VERLOOVE-VANHORICK: I have just a short question. Where does gestational age come in? We have heard that it is difficult to measure, and I quite acknowledge that, but nevertheless I think that most of the problems that have been stated here in the last part of the morning could be well, perhaps not solved, but be clarified if we include gestational age in the discussion.

DR. EBARA: May I ask the difference in kilograms in American blacks versus whites? I thought there was a big difference between these two scores. So, that should also mean a big difference in birthweight-specific mortality. Is that correct? Do U.S. blacks have a higher birthweight-specific mortality rate than whites, despite receiving the same therapy, or do they receive a different therapy in the different hospitals?

MS. BARELL: I would like to answer Eva Alberman because we have used the Wilcox-Russell technique on Israeli Jewish populations, where there is very little chance of there being a difference of registration areas between those coming from Russia or those coming from Morocco, and we found that the Wilcox-Russell technique or a modification of it is very helpful in getting to the basic normal distribution of each ethnic group in Israel.

My question to Joel Kleinman is why did you use indirect standardization when the problem is basically a problem of the birthweight-specific mortality of each country? Why not use direct standardization? It seems to make much more sense to me.

DR. KLEINMAN: I am not good at taking notes. So, I hope I got these questions right and in the right order. First, Eva, in terms of the artifacts of registration, I think, indeed, that the comparison of the overall mortality rates is certainly affected by artifacts of registration. I think Sweden is not doing quite as well as they appear because they use, I believe, a 28-week cutoff for registration of fetal deaths.

The United States, for example, uses 20 weeks, and it varies from State to State, but by and large we use 20 weeks. We find, for example, in the six States that have no registration cutoff-- in other words, they are supposed to register all products of conception, regardless of gestation--that the fetal death rate in those States starting at 20 weeks is about 30 percent higher than in the States that have a 20-week cutoff. So, registration practices have a great effect on the overall differences.

However, I do not think that is a problem specific to looking at these two approaches to comparing birthweight-specific mortality. They certainly, though, need to be taken into account when looking at either one of the approaches for birthweight-specific mortality, because I think there are a lot of births that just do not get registered in the Swedish system, and there are differences in classification of live births and fetal deaths.

The next questioner asked something about why stress the heuristic versus the quantitative benefit of using the Wilcox-Russell method, and what I tried to do for the most part today was present the heuristic argument. I do, indeed, think that they are the really important contributions, but if we can, why not go a step further and try to use the implications of that quantitatively to get a better handle on how to go in terms of looking at which is the most important consideration.

Wilcox and Russell's first article concentrated on black and white differences in the United States. I think it was a really terrific contribution because of the fact that everyone at that time believed that the mortality difference was entirely due to birth weight, and this article raised some questions about whether the entire difference or only half the difference was due to birth weight. In fact, when you compare U.S. blacks and whites using this model, you find that only one-half the difference is due to birth weight, and the other half is due to birthweight-specific mortality. This result leads us to the next question--the effects of treatment on birthweight-specific mortality. Birthweight-specific mortality has often been used as an indicator of the quality of care, and the thing that makes the kilogram model suspect to me is that although there are black populations in the United States that get superb intrapartum care--in other words, they live in the inner cities where there happens to be a large university teaching hospital that has the latest in technology--I think by and large the black population does not get the same quality of care as the white population. Therefore, it seems to me that to have them show up much lower in terms of birthweight-specific mortality is an anomaly that needs to be explained.

Gestational age comes into that as well because some of these differences, I think, are due to gestational age. There may be something to the possibility that populations differ according to their gestational distribution, as well as their birthweight distribution, but that is a little more iffy.

Finally, concerning indirect versus direct standardization, I like indirect. You could have done basically the same thing I did with direct standardization, but I thought it was much more visual to present what the expected infant mortality rate would be had we applied Sweden's rate to all the other countries, rather than to summarize the birthweight-specific mortality as a weighted average of the other.

I prefer indirect standardization in general because the only way standardization is really applicable is when relative risks are constant, and I think we saw in the birthweight-specific mortality that it is impossible to get relative risks constant because you are dealing with rates up close to one in one case and rates close to zero in the other case. So, any method of standardization is an approximation to what you want to get, and I think indirect standardization does it in a more heuristic way.

DR. HOGUE: Joel Kleinman's point that it is the residual distribution that is important, and that therefore one should look at the under 1500-gram group, is very well put. I wanted to ask Joel if, in looking at the proportion of mortality explained by the birthweight distribution, you have looked at the proportion explained by births that are preterm? An approximation of the proportion that are preterm would be births under 1500 grams. You might move your analysis one step further by splitting up the proportion that is related to the birth weight distribution into the portion that is related to preterm as opposed to full term delivery.

MS. ZADKA: I would like to answer some of the questions that have been raised about Israel. First was Howard Hoffman's question about late fetal death. There are three main reasons why this flattening occurs in the Israeli fetal death rates. One, of course, is the very small number that we are dealing with. There are about 350 cases per year, and if we split them between Jews and non-Jews the numbers are even smaller.

The second reason is the high proportion of the cases with unknown gestational age. I do not know how the allocations were done for the ICE data set, but all the unknown gestational ages and birth weights are included as fetal deaths. So, it depends on how you dealt with them, but it could also have flattened the numbers.

The third point is that we have started using ultrasound as the gestational age indicator. I think that gestational ages are changing as a result, and some of the cases that are now registered as late fetal death are really late induced abortions because of the early detection of congenital malformations. Some of the congenital malformations are being aborted at 28 and 29 weeks, and they are not included in fetal deaths. Fetal loss after 28 weeks is reported as fetal death.

Now, about the birthweight distribution among the Israelis, Joel pointed out that there were about 5 percent of unknown birth weights among the non-Jews, and he asked whether it could be due to incomplete registration and could they be of low birth weight. They are not. The cases of unknown weight among the non-Jews are due to a curious reason. Some of the death notifications are recorded in Arabic, and so they have different numbering. Some of those who are punching the information do not know the Arab numbering, so they record birth weight as "unknown." So, I guess these births are equally distributed among all the weight groups because there is really no reason why only births under 2500 grams would be recorded in Arabic.

DR. MCCARTHY: One short comment and a question. The comment is that in unreported data, when we are able to categorize the residual portion of the graph using Georgia data into low-, medium-, and high-risk women, with a combination of both socioeconomic and medical complications, we in fact can cut down on the residual portion. This suggests to me that the residual portion may be very much related to pathology during pregnancy and that it would be very interesting to look at this. The comment is meant to generate interest among our international colleagues in trying to come up with data sets that have the necessary information, so that we can see if the residual is also associated with pathology in their populations. So that is my comment.

My first question is to Joel Kleinman. I agree with you about using the logit transformation, in particular when you are trying to describe the full range of birth weight. For simplicity's sake, however, and in particular if we want to try to increase the capacity of everyone to make these international comparisons, when you are dealing with births greater than 2500 grams it may be simpler just to use birthweight-specific rates. Would you agree with that?

DR. KLEINMAN: It does not make a difference.

DR. MCCARTHY: Right, okay. I said that so that we do not get into the complexity associated with using logit scales and things like that. The second question would be why do you think that your best birthweight-specific mortality rates occur at one standard deviation past the mean? Teleologically speaking, I would have thought that would occur at the median.

DR. KLEINMAN: First, to get to Carol Hogue's comment, I think the important thing to remember in this is that the proportion attributable to events under 1500 grams is not something that comes directly out of the model. Basically, the model is saying that the differences that are due to the birthweight distribution are due only to the residual distribution. You are assuming by the nature of the model that it has no effect on mortality, other than to mark the point where mortality falls and so that the numbers of births at each birthweight interval are relevant there.

Now, you could figure out what proportion is attributable to events under 1500 grams. I would think that most of the 40 percent excess infant mortality for U.S. whites relative to Sweden was attributable to the birthweight distribution. I would think a fairly substantial proportion of that 40 percent is due to births under 1500 grams because that is where most of the residual distribution is.

I agree with Brian that the residual distribution is essentially a marker of pathology, but it is not a marker only of pathology during pregnancy. It is a marker of pathology prior to pregnancy. It is probably smoking differences and a whole lot of other things, but pathology is certainly one of them. Finally, with respect to the over 2500-gram mortality rates, there is no difference. I mean you could not tell the difference if you plotted it on a log scale or a logit scale because the rates are so low. It is only when you want to look at the graph extending to birth weights below 2500 grams that you really have to start using the logit scale.

DR. KARLBERG: Thank you so much. May I just give one comment on whether we should expect that there should be no risk at all for certain births? As I see it as a clinician, there are different types of risks. The one for the low birth weights is highly related to low maturity, but there is a risk associated with birth even if you are normal. There are various factors that contribute to this risk, but perhaps this approach may enable us to separate the different components of risk. Would you like to comment on that?

DR. KLEINMAN: I am sorry. I told you I take lousy notes. Petter Karlberg's comments reminded me of Brian McCarthy's last question, and I would like to hear Brian's response, so that is why I got up again. Why the minimum mortality occurs at a birth weight that is one standard deviation above the mean rather than at the mean, I think is a difficult question.

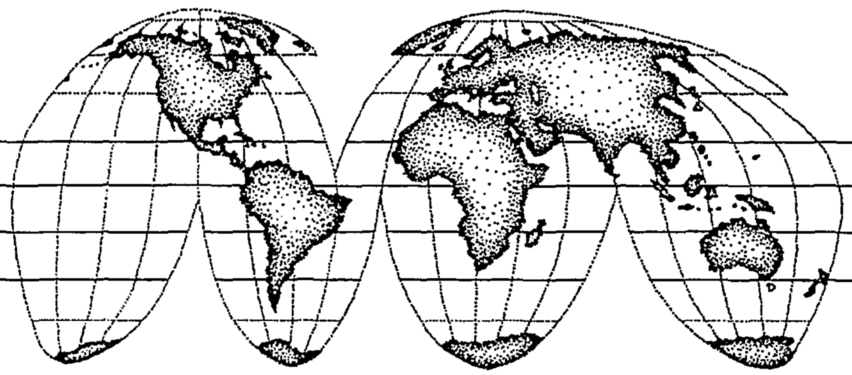
I think that you were saying that there is a teleological argument--that perhaps by natural selection or something the best outcomes would happen at the mean--but that does not happen with other biological variables. The best outcome in terms of blood pressure seems to be at quite low blood pressures, considerably below the means in many populations.

Now, part of that may be that there are things that influence the birthweight distribution that are not good. For example, one possibility is that people, at least in the developed countries that we have been looking at, are eating too much. So they are gaining more weight than they really should, and that has an effect on the baby's birth weight, but it has no real effect on mortality. So, you are sort of shifting the distribution. I just thought of that.

(Laughter.)

DR. MCCARTHY: Just a short comment on Joel's response. The same reasoning that I would have applied for the tail applies to the main distribution. That is, there is pathology within that distribution and that gestational age, as someone else has also commented on--and which I think I will show as well tomorrow--and this pathology has an effect, so that as we were able to subtract pathology from what seems to be a normal distribution, in fact there is a slight movement of the optimal birthweight-specific mortality rate toward the mean. If that is true, then the disparity between the mean and the optimal birth weight may suggest the amount of pathology in the population--again, another means.

DR. KARLBERG: Let me say, "thank you," and may I say as a final comment that mathematical models are very useful to try to find out what is going on, but we have to remember that the model is an approximation of reality. It stimulates us to think what these factors are, and I think we will continue to do so during the rest of the symposium.



Cause of Death

Birth Weight and Causes of Infant Death

by Robert B. Hartford, Ph.D.

Birth weight is considered to be the single most important risk factor associated with the major pregnancy outcomes, infant morbidity and mortality. However, despite the close association between birth weight and infant mortality, low birth weight is only an indication of risk; it is not--ICD codes notwithstanding--a cause of death. Moreover, the risk of death associated with low birth weight is not the same for all causes of death. The presentations this morning discussed the importance of birth weight to infant survival, while the presentations to follow in this session will examine some of the major causes of infant death. This presentation is intended to bridge the two topics to show the relation between birth weight and causes of infant death. This will provide a context for a better understanding of differences in cause-specific mortality among the ICE countries. Specifically, we will show that for some causes birth weight is an extremely high risk factor for mortality but is relatively unimportant for other causes. To remove the confounding influence of differing twinning rates, this presentation focuses on single births only. All data are based on births and infant deaths of known birth weight; analyses are carried out using 300-gram birthweight categories.

Figure 1 depicts the familiar patterns, shown in presentations earlier, of mortality by birth weight. In all cases the probability of dying within the first year approaches 1.0, that is, a rate of 1,000, as birth weight declines. Also evident is a "best weight for survival"; although not evident from this graph, this "best weight" tends to be several hundred grams greater than the median birth weight in the respective populations.

To study the relation of birth weight with mortality by cause, we will first remove the effect of differing mortality levels among the populations by using relative risks as seen in figure 2. This figure suggests that birth weight is much less important to mortality at lower weights among U.S. blacks than in the other populations shown. However, Dr. Kleinman's presentation this morning clearly demonstrated the pitfalls in such interpretations based solely on absolute birth weight, rather than some population-specific, relative measure such as a Z-score.[1]

Using U.S. whites as an example, the birthweight-specific relative risks of infant mortality for six major cause categories developed by the ICE are shown in figure 3. Clearly, there are extremely large differences in the birthweight-specific risks among the causes, varying from as low as 10 (for the maximum birthweight-specific value) for SIDS to about 10,000 for immaturity-related conditions. The figure suggests that causes more closely associated with neonatal mortality (immaturity- and asphyxia-related causes) have the highest risks, while the risks more typical of the postneonatal period (SIDS and external causes) have the lowest. Dividing the deaths into neonatal and postneonatal periods shows that birth weight is a much higher risk factor in the neonatal than in the postneonatal period (see figure 4). This is due to the fact that almost all immaturity- and asphyxia-related deaths, which have extremely high birthweight-specific risks, occur in the neonatal period. The maximum risk for immaturity-related conditions is about 50 times than for infections, which is about 2-1/2 times the maximum risk for congenital conditions. Neonatal/postneonatal differences in birthweight-specific risks for congenital conditions and infections also contribute to the higher overall risk in the neonatal period. Unlike immaturity- and asphyxia-related conditions, congenital causes and infections are important in both periods. As seen in figures 5 and 6, the maximum risk for congenital conditions is about 80 in the neonatal period as compared with just over 50 in the postneonatal period. For infections the difference is somewhat less--about 210 in the neonatal period as opposed to 190 in the postneonatal period.

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[1]Kleinman, J. Implications of differences in birthweight distribution for comparisons of birthweight-specific mortality.

Except in the very low birthweight range, <1500 grams, the relative risks of dying are very similar for SIDS and external causes in the postneonatal period. Of all causes, SIDS has the lowest maximum relative risk--about 10.

It will be very cumbersome to compare all of these results with similar data from the other countries. Therefore, we shall introduce a summary measure that will allow direct comparison of the relative strength of the relation of birth weight with the various causes in the countries under study. This measure was designed to meet the following criteria: it is independent of the level of mortality, and it takes into account the relative distribution of deaths by birth weight. The desired measure, which we shall call the "mean relative risk," $\bar{R}$, is defined as the mean of relative risks over the birthweight distribution weighted by the relative distribution of deaths, viz.:

$$\bar{R}=\sum R_i(d_i/d), \text{ where } R_i=r_i/r_{min}$$

where R_i is the relative risk in weight category i, d_i is the number of deaths in category i, and d is the total number of deaths; r_i is the mortality rate in weight category i, and r_{min} is the minimum birthweight-specific mortality rate for the given cause. $\bar{R}$ may be cause-specific, in which case the constituent variables--R_i, d_i, and d--also are cause-specific, or it may apply to all causes. If the mortality rates, r_i, are uniform, the value of $\bar{R}$ is 1.0. Hence, the closer the value of $\bar{R}$ is to 1.0, the weaker the relation of birth weight to mortality; a value of 1.0, which is the minimum possible value, indicates no relation. This measure provides a convenient way of comparing the relative importance of birth weight to the causes of infant death in the ICE populations.

Figure 7 shows the distributions of the four major causes of neonatal death for the ICE countries. Birth weight consistently shows the highest risk for immaturity-related causes, the value of $\bar{R}$ varying from 2500 to 6400, except in the case of Japan where the value is only 722. Moreover, the $\bar{R}$ appears to be relatively invariant with the cause-specific neonatal mortality rate, particularly for immaturity-related conditions. Infections show considerable scatter, but this may be due to the small number of cases in most countries.

As seen in figure 8, birth weight is much less important in the postneonatal period than in the neonatal period for all causes or when the same cause (infections and congenital conditions) are compared.[2] Infections have $\bar{R}$ values on the order of 100 in the neonatal period but only about 10 in the postneonatal period. Likewise, $\bar{R}$-values for congenital conditions are about 30 in the neonatal period as compared with about 7 to 10 in the postneonatal period.

According to these results, birth weight shows the strongest association with neonatal, immaturity-related causes. The values for $\bar{R}$ range from 722 in Osaka to 6225 for the U.S. white population. High values for immaturity-related causes are to be expected, because infants of extremely low birth weight and/or of extreme prematurity typically die of immaturity-related causes, which include specific causes such as respiratory distress syndrome. However, the strength of the relation between birth weight and mortality, as measured by $\bar{R}$, varies considerably among the study populations. This is attributable to either of two causes: either to greater birthweight-specific differences in the relative rates, or to the differences in the concentration of deaths at lower weights.

Figure 9 shows the distributions of relative risks by weight for immaturity-related cause mortality in the neonatal period. Japan, which has the lowest $\bar{R}$ value, also shows a slightly flatter distribution of relative risk than other countries. However, figure 10 shows that the relative distribution of immaturity-related deaths by birth weight also varies considerably from population to population. The two U.S. populations have an extremely high proportion of deaths at very low weights. More than 90 percent of black and 82 percent of

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[2]Survivors from the neonatal period are used in calculating mortality rates and relative risks for the postneonatal period.

white infants in the United States dying of immaturity-related causes weigh less than 1200 grams, as compared with 69 percent of infants in England and Wales, 55 percent of Swedish infants, and only 41 percent of infants in Osaka. Therefore, the stronger association of birth weight with immaturity-related mortality in the two United States populations is due to a combination of a stronger birthweight-specific gradient of the relative risk, and a much higher concentration of infant deaths in the extremely low weight groups. The latter is in accordance with Dr. Eva Alberman's findings of the extremely high proportion in the United States of infant deaths below 500 grams, as presented in her paper this morning.[3]

At the other end of the spectrum, we have seen that birth weight shows a relatively weak relation with postneonatal deaths due to SIDS and to the external causes of death, or E-codes. For E-codes, the values of $\bar{R}$ range from 2 to 9. That there is any birthweight-related risk for E-code mortality may seem at first a bit puzzling; however, two mechanisms come to mind. First, a low birthweight infant who is seriously injured is probably at higher risk of dying than a heavier, and presumably healthier, infant. Second, there is a correlation between low birth weight and lower socioeconomic status. This may produce an upward bias in the lower birthweight mortality rates and in the corresponding relative risks as well.

SIDS mortality shows an even weaker relation with birth weight. The values of $\bar{R}$ range from 1.7 to 5.3, suggesting that much of the observed relation of birth weight to SIDS is by way of a socioeconomic bias, rather than through some biological mechanism. It should be noted that the two populations that seem to be relatively free from SIDS deaths, Hungary and Osaka, are the ones with the highest value for $\bar{R}$; all other populations have values of 3.2 or less.

In summary, using the summary measure, $\bar{R}$, we have shown that birth weight is a much greater risk factor for mortality in the neonatal period than in the postneonatal period. Birth weight is an exceptionally high risk factor for the leading neonatal causes of death, immaturity- and asphyxia-related conditions. Birth weight is also a high risk factor for infections and congenital conditions, with the risks being substantially higher in the neonatal than in the postneonatal period. SIDS, a leading cause of postneonatal death and external causes of death, shows the least association with birth weight. While low birth weight does increase the risk of death due to these two causes, their birthweight gradients of relative risks are quite low and relatively few of the deaths due to these causes are to low birthweight infants. While low birth weight per se may indicate a predisposition to SIDS or vulnerability to death once an accident has occurred, socioeconomic factors--which are highly correlated with low birth weight--are very likely producing an upward bias in the value of the $\bar{R}$ for these two causes. That is to suggest that if the effects of socioeconomic risk factors were removed, the value of $\bar{R}$ would be much closer to unity.

Three factors contribute to the high birthweight-related risk of mortality in the neonatal period. First, immaturity- and asphyxia-related deaths, which have very high birthweight-specific risk gradients, occur primarily in the neonatal period. Second, SIDS and deaths due to external causes, which have very low gradients, typically occur in the postneonatal period. Third, the birthweight-associated risks of death due to congenital conditions and infections, which figure prominently throughout both age periods, are much higher in the neonatal period.

The concept of using the mean relative risk, $\bar{R}$, as an index of the strength of the relation between birth weight and mortality can be extended to length of gestation as well. This would provide a method for comparing the relative importance of birth weight and gestation to infant mortality.

In closing I would like to comment on the measure, $\bar{R}$. The values one obtains will be affected by the weight categories used. As mentioned earlier, I have used 300-gram categories for this presentation. However, I have experimented with various other categories--100, 200, and 500 grams. While the values of $\bar{R}$ are influenced

[3]Alberman E., et al. Survival in very low birthweight infants.

by the categories used, the rank ordering for the $\bar{R}$ seems to be preserved and the conclusions reached remain unchanged. Ideally, the true r_{min} should be estimated by fitting a curve to the distribution of the r_i, setting the derivative to zero, and solving for the corresponding weight and r_{min}. Additional work needs to be done with the measure to develop rules for its application. One significant question to be examined is the effect of including a weight category for unknown birth weights.

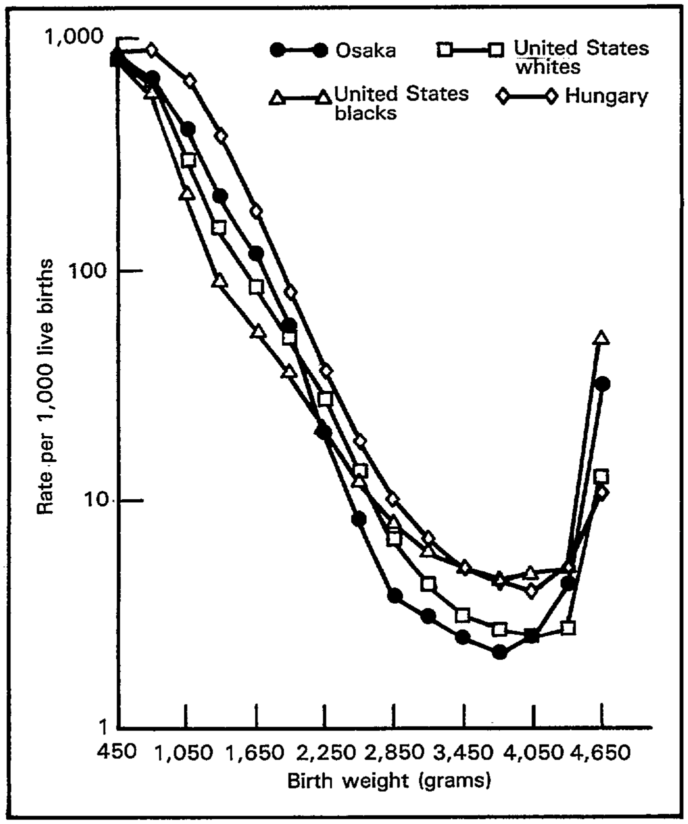

Figure 1. Birthweight-specific infant mortality: selected countries

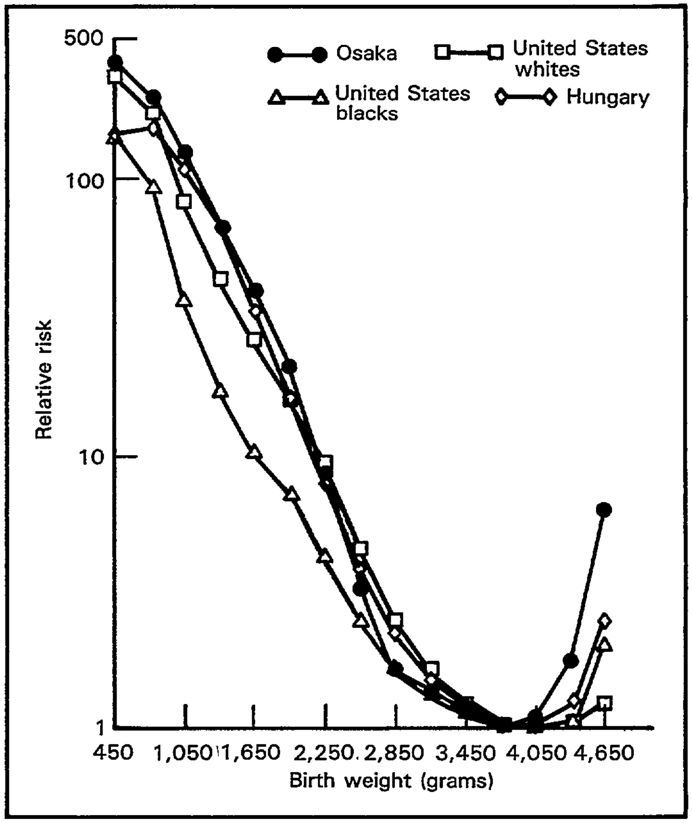

Figure 2. Birthweight-specific relative risk of infant mortality: selected countries

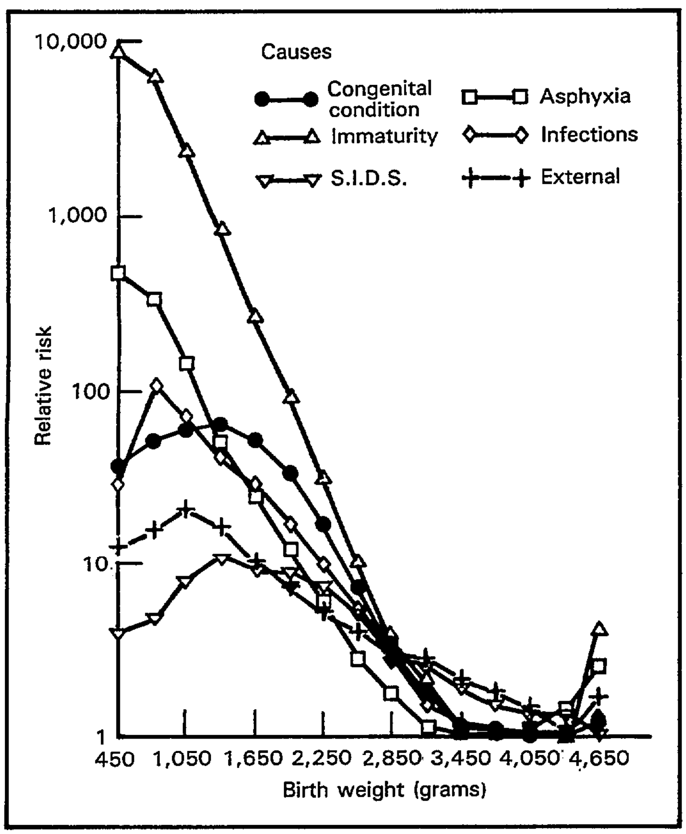

Figure 3. Birthweight-specific relative risk by cause: United States whites

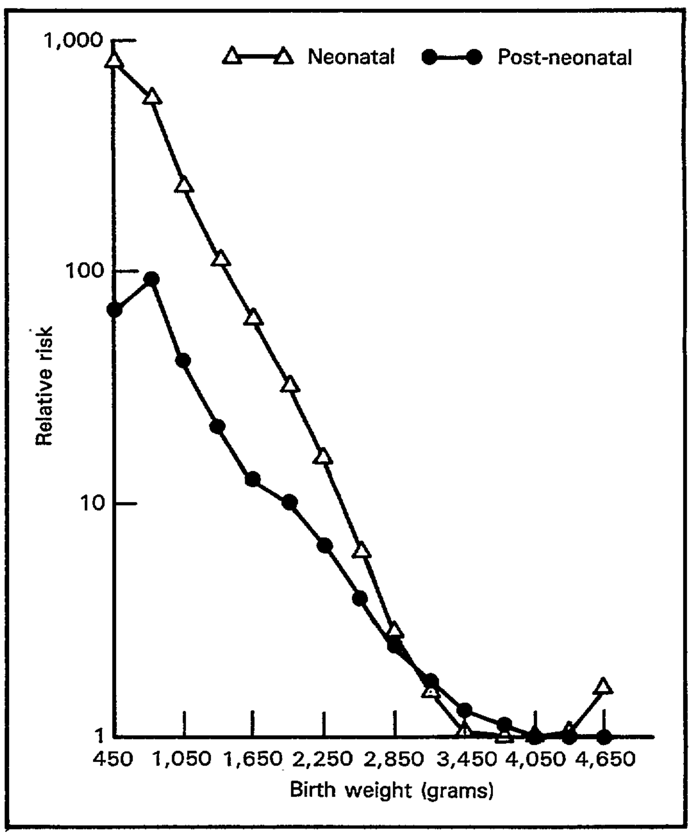

Figure 4. Birthweight-specific relative risk by age at death: United States whites

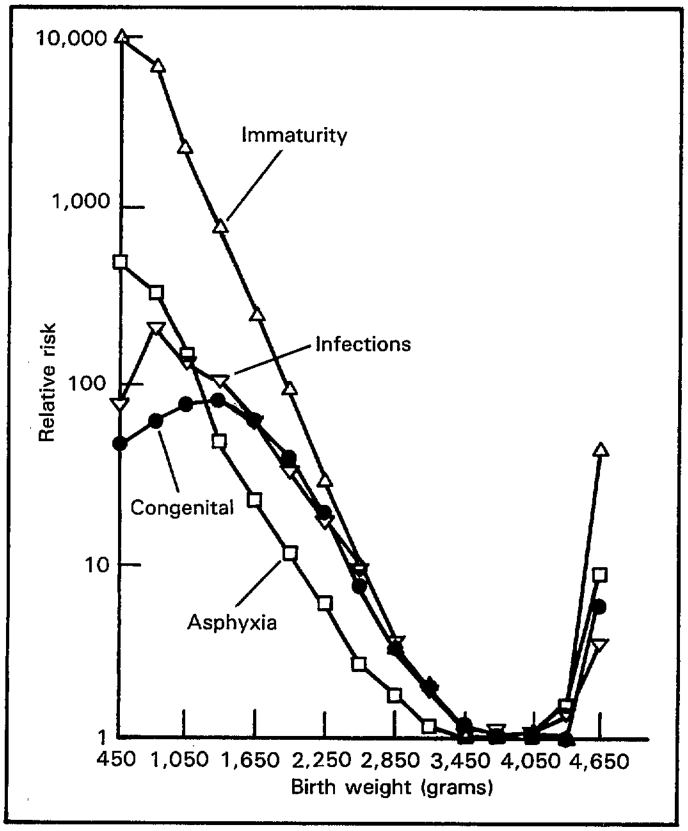

Figure 5. Birthweight-specific relative risk by cause for neonatal deaths: United States whites

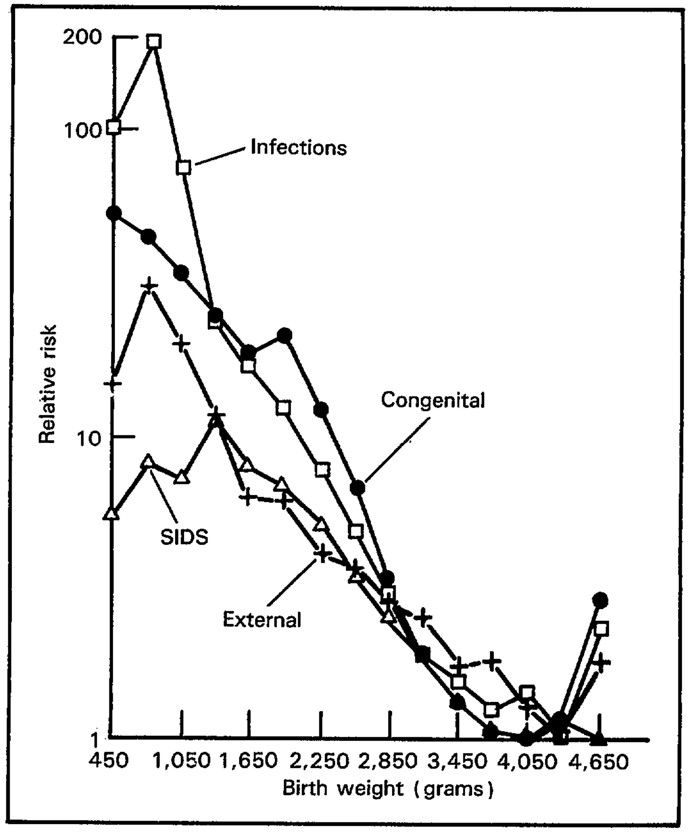

Figure 6. Birthweight-specific relative risk by cause for post-neonatal deaths: United States whites

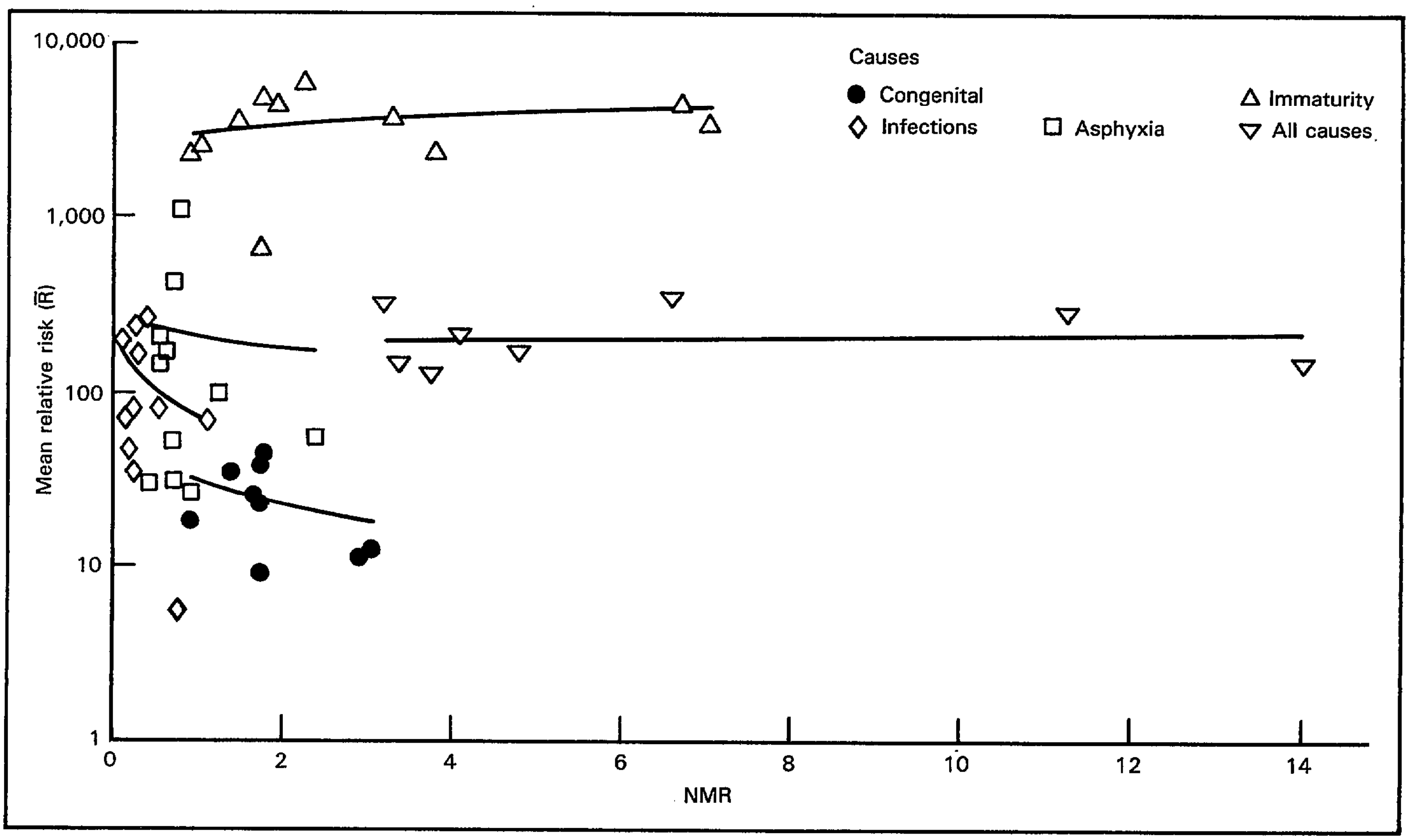

Figure 7. Mean relative risk ($\bar{R}$) for selected causes by the neonatal mortality rate (NMR): selected countries

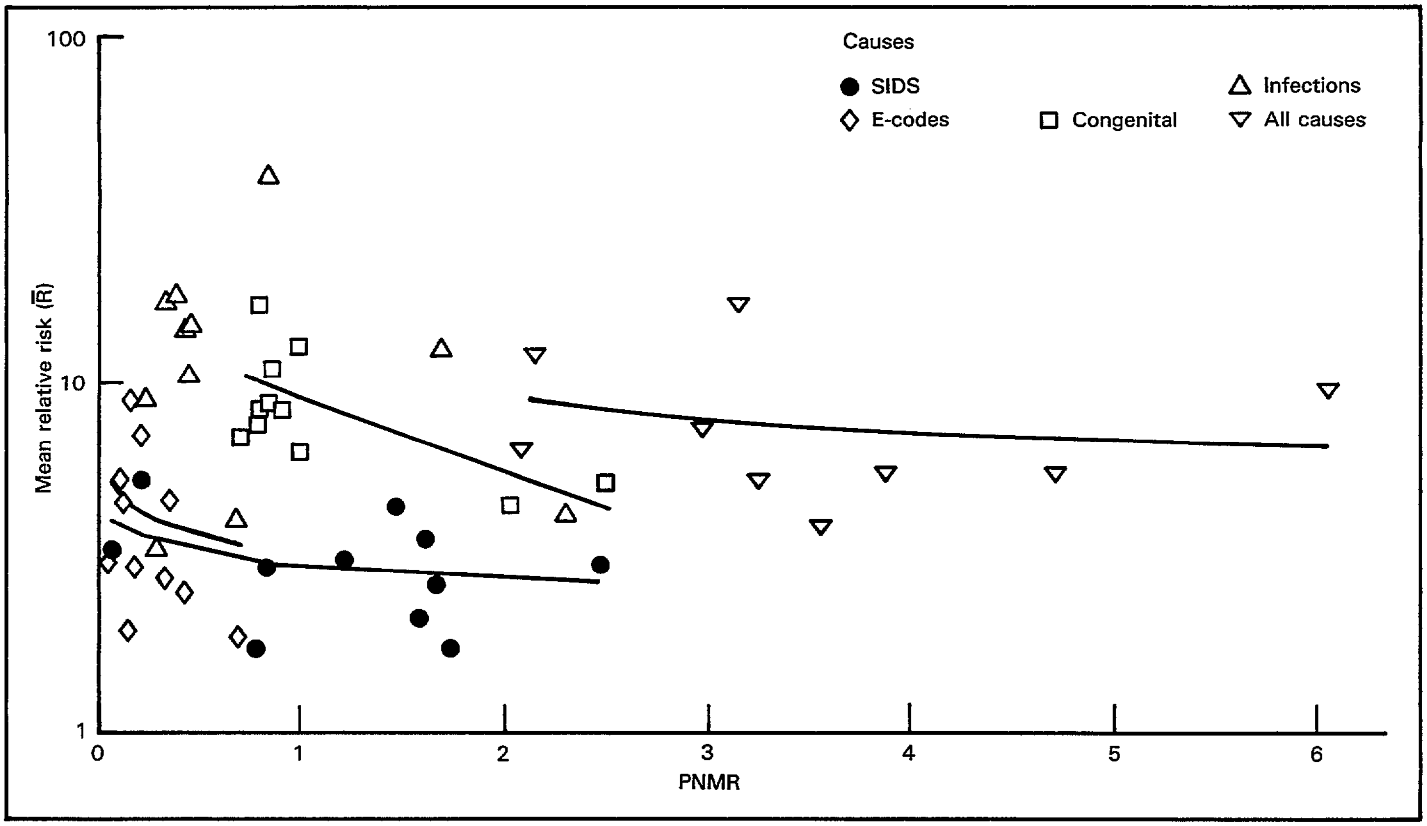

Figure 8. Mean relative risk (R̄) for selected causes by the post-neonatal mortality rate (PNMR): selected countries

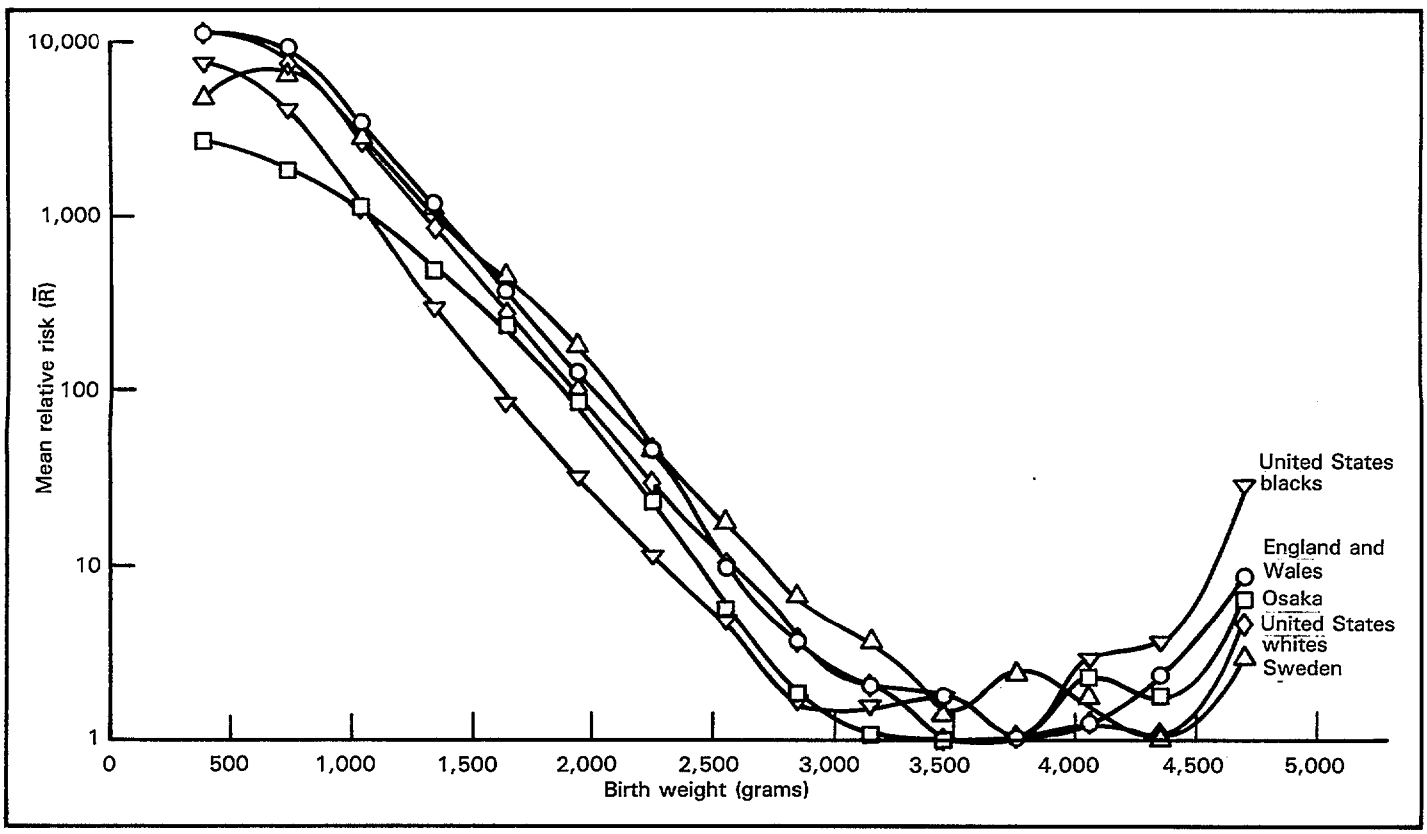

Figure 9. Mean relative risk (R̄) for immaturity-related causes by birth weight: selected countries

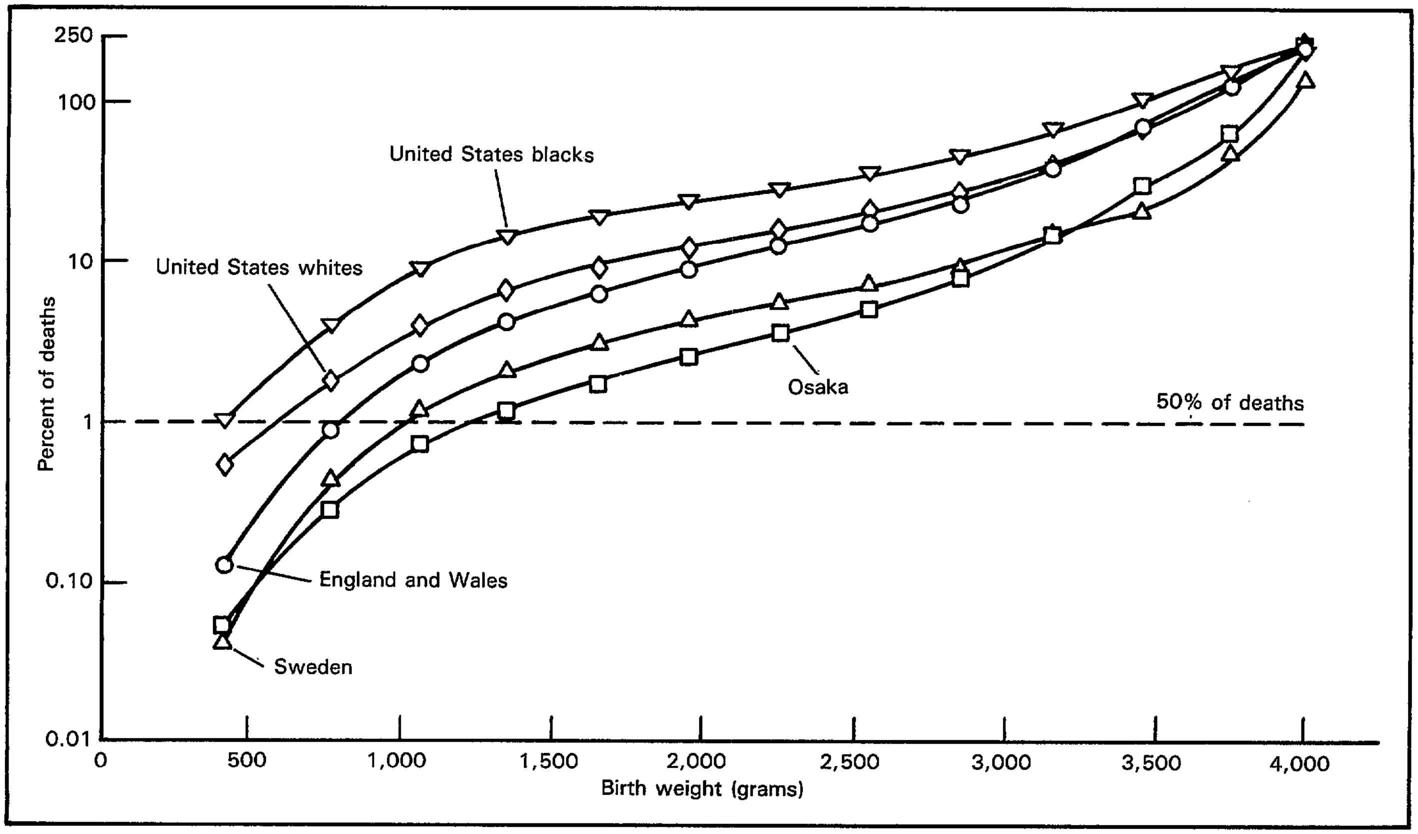

Figure 10. Cumulative distribution of immaturity-related neonatal deaths by birth weight: selected countries

Discussion

DR. HOGUE: We have time for a few questions. I think everyone was stunned. That is an extremely interesting, and I think, unique approach.

DR. LYNBERG: I have a little difficulty translating to the mean relative risk. I have done some work in birth defects, and particularly in the white population of the United States, birth defects are listed as the leading underlying cause. Maybe other people are more familiar with how cause of death is attributed in these ICE categories, but for example, suppose a baby had immaturity and birth defects. Is the same algorithm applied by all countries or are different algorithms applied as to which is the cause of death?

DR. HARTFORD: All ICE countries follow WHO standards, definitions, guidelines, and recommendations. However, how countries interpret or implement these may vary considerably. I do not think that there is much of a problem with a cause category like congenital conditions. SIDS is another question. We have noted variations in the ICE countries that are quite marked. Japan and Hungary on the one hand have virtually no SIDS but there are relatively high rates reported in the United States, Germany, England, and Scotland. The very low autopsy rate in Japan may account for the low SIDS rate, although this does not prevent a high rate being reported in Israel where the autopsy rate is also low. We do not know yet why Hungary is so different; it could be due to different diagnosis practices or to a different disease pattern. We simply do not know at this point. A second example relates to the relative importance of asphyxia-related conditions and immaturity-related conditions. In most countries asphyxia-related mortality is low as compared with the immaturity-related conditions. The one major exception is Norway, where asphyxia-related mortality is reported more frequently than immaturity. Examination of detailed causes of death show that respiratory distress syndrome (RDS), a major constituent of immaturity, is a relatively uncommon diagnosis in Norway.

DR. LYNBERG: Infections are not among the top three causes of death among whites in the United States?

DR. HOGUE: This is relative to the base rate for infections. It is not relative in terms of the relative importance of the cause of death but for a given cause of death, the relative importance of birth weight or the relative importance of gestation or the relative importance of both.

Comparison of Neonatal Mortality by Cause, Length of Gestation, and Birth Weight

by Per Bergsjø, M.D., Petter Karlberg, M.D., and Oddny Brun, R.N., M.Sc.

One activity of the International Collaborative Effort has been to devise a method of grouping underlying causes of death to aid national and international comparisons. Out of necessity this must be based on an internationally accepted classification system. With Dr. Robert B. Hartford as the driving force, we allocated each code in the eighth and ninth revisions of the World Health Organization's International Classification of Diseases to one of eight diagnostic groups (figure 1).

The system is not unlike the one used by the U.S. National Infant Mortality Surveillance (NIMS) project, which published its findings while our work was in progress (1). Our system was presented by Dr. Susan Cole at the APHA Annual Meeting in New Orleans in 1987 (2) and published in the *Acta Obstetricia et Gynecologica Scandinavica* in 1989 (3). Without going into detail, I shall make a few remarks on each of the groups before looking at their distribution in neonatal mortality.

Congenital anomalies includes both structural and biochemical anomalies, including hereditary anemias, muscular dystrophies, and chromosomal disorders. We also allocated cerebral palsy to this group, based on the recognition that in most cases the roots go back in pregnancy and are not based on birth trauma.

Based on reported codes, it is to some extent difficult to distinguish between asphyxia and immaturity as causes of death. However, asphyxia is generally associated with conditions arising during, or shortly before, the onset of labor and delivery, so that prevention must concentrate on that period. Birth trauma is also included here. Allocation of diagnoses to immaturity was done with maternal conditions generally associated with preterm birth and with conditions in the child associated with short gestation and/or low birth weight.

Infection comprises all the diagnoses of infection. Most of the deaths in this group were due to respiratory and gastrointestinal infections.

Other specific conditions comprise all neoplasms, some endocrine disorders, noninfective enterocolitis, and several others. Sudden infant death includes sudden death of unknown cause and other unknown causes of mortality (codes 798 and 799). Cases labeled under the chapter on external causes as accidental mechanical suffocation (E913) were also placed here.

External causes include all deaths due to accidents, poisoning, and violence, plus cases with specified nutritional deficiencies.

Finally, there are a number of codes that cannot logically be ascribed to any of the seven groups. This group of remaining causes comprised 4.4 percent of all cases when we tested the system on a population of infant deaths in the United States from 1983 to 1984.

In passing, I should like to mention that this ICE classification system will be utilized by the Nordic birth registration group in comparisons of infant mortality in the Nordic countries. As three of the five Nordic countries are among the ICE members, some comparisons will also be made at this meeting.

The statistics to be presented concern neonatal death, that is, live births who die within the first completed 27 days of life. The rates signify the number of deaths per 1,000 live births. We decided to restrict this presentation to singleton live births and to set aside multiple births for later analysis.

We have the necessary data on the diagnostic groups from eight countries. As the population of United States is divided into whites, blacks, and others, there are 10 data sets for comparison.

The birthweight allocation is relatively complete for all 10, except England and Wales, where 12.5 percent of birth weights are missing (table 1). Among those who died, the percentages of missing birth weights are generally at least 20 times higher. This is presumably as it should be, since very ill newborns are often given intensive treatment without regard for obligatory statistical requirements.

We have looked into the incidence and distribution of causes of death within this category of unknown birth weights. We found that they tend to follow the pattern of low birth weights and short gestational lengths, which agrees well with the proffered explanation. Sweden, among its neighbors, has remarkably high rates of unknown birth weights, both for live births and neonatal deaths. In England and Wales, the high percentage of missing weights is likely to be connected with the "old" system of recording weight in pounds and ounces.

With 10 data sets, 10 groups of 500-gram weight, and 8 groups of causes of death, plus totals, we could easily produce countless tables and graphs. Giving a similar presentation for gestational length will make it even worse. We chose to simplify the presentation by combining the weight groups into three categories, below 1499 grams, 1500 to 2499 grams, and 2500 grams and over. The gestational age groups are below 27 weeks, 28 to 36 weeks, and 37 weeks and over.

Each country has provided data for a succession of 5 to 7 years, but not covering the exact same time spans (table 2). While Norway provided data from 1979-84, Denmark reported data from 1982-87. We have not studied time trends by single years, but used each data set as a whole. This gives total numbers of live births ranging from 260,000 in Denmark to 5,500,000 among U.S. whites. The corresponding number of neonatal deaths ranged from 1,364 to 30,000. Total neonatal mortality in the given periods ranged from 3.8 in Osaka (very close to the national Japanese average) to 11.6 among U.S. blacks. These figures should be compared with caution, since the time periods differ and mortality rates were falling during the time span of the study.

Table 3 shows the distribution of the 8 diagnostic groups among the 10 data sets. There are a few interesting points to be noted. The highest individual rate in the whole table is 6.9, which represents immaturity for U.S. blacks. This is a towering rate, which will, somewhat artificially, disappear when we look at birthweight-specific rates. Another interesting point is the almost identical rates displayed by Scotland and England and Wales.

We shall now present comparisons for each individual group of causes, or combinations of groups, mainly by birth weight and with a few examples for gestational age.

Figure 2 shows the birthweight-specific neonatal death rates for congenital anomalies. In this and all the following graphs, the data bases follow the same sequence: Denmark, Norway, Sweden, Scotland, England and Wales (in the upper row), and Israel, Osaka, U.S. whites, U.S. blacks, and U.S. others (in the lower). For each country the left row represents birth weights up to and including 1499 grams, the middle 1500-2499 grams, and the right 2500 grams and more. Not unexpectedly, for each country the left column rates are the highest and the right the lowest. However, since the denominator increases sharply from left to right, the low columns are more important than they appear to be in this picture. The scale of the upper and lower parts is the same, but in succeeding figures the scale will change according to the magnitude of the group rates to be displayed. For example, the left column for Norway, showing 50.3 very low birthweight deaths per 1,000 very low birthweight births, represents 13 neonatal deaths per year, whereas the right column of 1 per 1,000 represents 50 deaths per year. I shall make two other general comments, which will be pertinent to all of the succeeding graphs.

First, these intercountry comparisons give a completely distorted picture of the total rates among the countries. For example, the total rates for Denmark and Israel are almost identical (2.16 and 2.13, respectively), and the total rate for U.S. blacks is about twice that of Osaka (1.82 versus 0.95). This distortion is partly an effect of differing birthweight distributions between the countries. An illustration from a previous ICE symposium will make this clear (figure 3, showing Norway, Japan, and U.S. blacks). A shift to the left of the birthweight distribution means a higher share of biologically mature and normal low birthweight babies, and as a result lower mortality in these groups, despite higher total rates.

The other general comment is that the columns on the left are especially vulnerable to differences in reporting very low birthweight births. The cutoff lines in terms of gestational age and birth weight differ across countries, as do rules and practices of defining live birth versus stillbirth.

Based on these considerations, I placed more emphasis on the comparison between the "above 1499 gram columns" than on the columns on the left and also to the relative distribution on the three columns for each diagnostic group.

Figure 4 shows the rates for asphyxia. The vertical scale is one-third larger than in figure 2, so the columns should be enlarged by one-third to be comparable to the earlier figure. Nevertheless, the total rates for asphyxial deaths are much lower than for congenital anomalies. This is explained by the middle and right columns, which have much lower rates than the corresponding columns for anomalies. Note also the relatively high rates for Denmark and Norway in the very low birthweight group, and compare these rates to the corresponding rates in the next group, immaturity (figure 5). The comparatively low rates for immaturity in Denmark and Norway here raise the suspicion that there are different practices of diagnostic labeling. Such differences may be due to clinical practice or to central coding, or both. You will recall that U.S. blacks had a very high rate of deaths from immaturity, which is camouflaged in this picture, where Israel has higher rates for very low and low birth weights and an equal rate to U.S. blacks for the highest birth weights. The total for Israel is 3.62 versus 6.90 for U.S. blacks, another example of the distortion phenomenon.

A combination of asphyxia and immaturity may be more robust to different coding practices than each group individually (figure 6). The upper limit of the scale here is 350 per 1,000. Sweden has the lowest rate for very low birthweight births. However, as you will recall, Sweden had a very high percentage of missing birth weights (18 percent), which may go toward an explanation.

I mentioned earlier that we also looked at gestational age-specific rates, choosing 28 and 37 completed weeks as dividing points. Figure 7 shows the same combination of diagnostic groups, asphyxia and immaturity, by length of gestation. (Data from two countries are missing.) The picture here is quite different, both in absolute rates within the chosen categories (not too surprising) and also in relative distributions between and within the countries. This serves to demonstrate that the two parameters--birth weight and gestational age--are profoundly different as yardsticks for measuring neonatal mortality.

Switching back to the former picture (figure 6), I reiterate that low rates may conceal high numbers. In this figure, the column rate of 5.6 for U.S. whites in the 1500 to 2499 gram weight range represents 1,166 neonatally dead children. This category of intermediate birth weight is conceivably less influenced by reporting peculiarities than the very low birthweight group. A comparison of rates within this single birthweight category may therefore give a more realistic picture (figure 8). This then, is a blowup of the middle columns, which represent nearly 4,000 (3,988) neonatal deaths when all the countries are combined. All of the West European countries (the five to the left) have fairly similar rates, with Scotland slightly lower than the other four. Israel and Osaka have higher rates in this weight range, despite the fact that Osaka both totally, and for asphyxia and immaturity, exhibits very low rates. The contrast between U.S. blacks and Osaka is particularly interesting. It reflects the different shapes of the two birthweight distributions, which I have already shown. The favorable rates for U.S. whites and others, compared with the higher European rates is a matter for conjecture. Could it be due to a generally higher quality of neonatal intensive care? If so, it is not reflected in the rates for very low birthweight births, which are higher than the corresponding West European rates.

Infections should largely be preventable (figure 9). Here again, the lowest birthweight babies are the most vulnerable. Norway and Scotland have particularly high rates. In total rates, Scotland is one-third higher than Norway. U.S. blacks have the highest and Israel the second highest total rate for infection, but this point is lost in the comparison of birth-specific rates. Again selecting the middle bars (1500 to 2499 grams) for comparison, we see that Norway, Scotland, and Israel have the highest, and Denmark and Osaka the lowest (figure 10). I shall not even attempt to explain.

External causes of death are rare in the first month after birth (figure 11). Israel had a higher total rate than the others, and it is apparent that all three weight categories are affected. In actual numbers, however, the left column represents 5, the middle 15, and the right 38 individual deaths during 6 years. With the addition of 5 deaths of unknown birth weight, this represents 10 neonatal deaths from external causes in Israel per year. Still, some of these were presumably preventable.

Instead of going through the remaining groups one by one, we have put them together, on the justification that individual rates are low, and that the major impact is made by the group "all other codes" (figure 12). One word on the sudden infant death syndrome. Sudden infant death generally occurs in the second through fifth months of life and is therefore relatively unimportant in the neonatal period. Israel and U.S. blacks had a number of cases each, the others very few. Norway's high mortality rate for "all other causes" may be due to the erroneous shifting of deaths from the immaturity group to the "all other causes" category. Such a shift would help to explain the low death rate from immaturity found in Norway.

Here the story ends. To repeat the exercise by showing rates according to length of gestation will only confuse the issue. In theory, gestational age is a better discriminator than birth weight for this type of comparison, on condition that gestational age is measured according to rigid, and similar, rules. At present, with the mixture of menstrual dates, ultrasound measurements, and best clinical estimates, this is hardly the case. In a later presentation, we shall return to this issue.

I apologize if I have added to the confusion by presenting small pieces out of one whole. However, some interesting patterns have emerged. Not unexpectedly, the babies of lowest birth weight and shortest gestation are most vulnerable to each and all of the eight grouped causes of death. A high relative proportion of low birthweight babies lowers the relative risk of neonatal death when analyzed in birthweight-specific groups, which gives a false impression of the overall risk.

I have made a few comments, in passing, on possibly preventable deaths. The task for clinicians and health administrators alike, is to identify, each for his own population, those causes that can be attacked with preventive measures. To this end, I hope that this presentation will serve as a useful instrument.

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3. Cole SK, Hartford RB, Bergsjø P, McCarthy B. International Collaborative Effort (ICE) on Birth Weight, Plurality, Perinatal, and Infant Mortality. III. A method of grouping underlying causes of infant death to aid international comparisons. Acta Obstet Gynecol Scand 68:113-7. 1989.

Table 1. Proportion of cases with unknown birth weight

Country	Live births	Neonatal deaths
	percent	
Denmark	0.11	4.5
Norway	0.22	7.2
Sweden	0.68	17.8
Scotland	0.14	9.6
England/Wales	12.45	14.5
Israel	1.47	8.0
Osaka (Japan)	0.02	1.1
U.S. whites	0.14	3.5
U.S. blacks	1.18	3.3
U.S. others	0.18	5.7

Table 2. Time span and size of data sets, singleton births

Country	Time span '79 '87	Live births	Neonatal deaths	Neonatal mortality rate
Denmark		258,774	1,367	5.28
Norway		298,278	1,302	4.37
Sweden		651,268	2,652	4.07
Scotland		450,713	2,651	5.68
England/Wales		3,769,823	21,389	5.67
Israel		569,934	4,559	8.00
Osaka (Japan)		542,026	2,084	3.84
U.S. white		5,465,345	29,521	5.40
U.S. blacks		896,122	10,387	11.58
U.S. others		351,999	1,839	5.22

Table 3. Neonatal death rates distributed by diagnostic groups

Country	Congenital	Asphyxia	Immaturity	Infection	SIDS	External	Other specific	Remain-ing	Total
Denmark	2.16	0.95	1.84	0.13	0.07	0.00	0.09	0.05	5.28
Norway	1.92	0.86	0.96	0.30	0.03	0.00	0.11	0.18	4.37
Sweden	1.65	0.68	1.34	0.23	0.08	0.01	0.07	0.01	4.07
Scotland	1.97	0.78	2.14	0.41	0.11	0.04	0.15	0.10	5.68
England/Wales	1.99	0.81	2.16	0.31	0.12	0.04	0.13	0.12	5.67
Israel	2.13	0.71	3.62	0.42	0.40	0.11	0.22	0.39	8.00
Osaka (Japan)	0.95	0.44	1.86	0.24	0.01	0.07	0.14	0.14	3.84
U.S. whites	1.75	0.63	2.30	0.25	0.10	0.03	0.10	0.25	5.40
U.S. blacks	1.82	1.26	6.90	0.53	0.25	0.06	0.15	0.60	11.68
U.S. others	1.84	0.52	2.04	0.31	0.12	0.05	0.12	0.23	5.22

1. Congenital conditions
2. Asphyxia related conditions
3. Immaturity related conditions
4. Infections
5. Sudden infant death
6. Deaths due to external cause
7. Specific conditions other than the above
8. All other causes

Figure 1. Functional classification for infant deaths

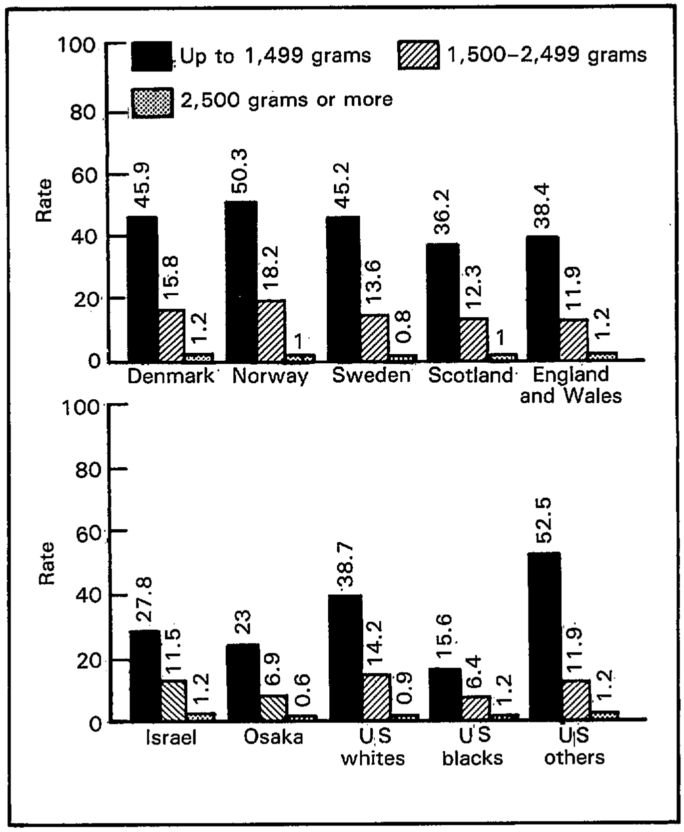
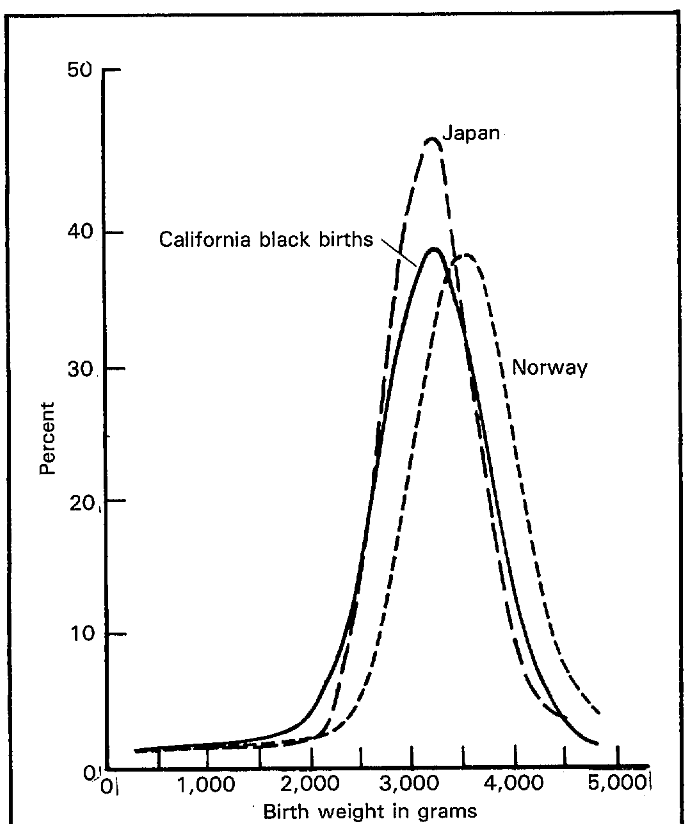


Figure 2. Birthweight-specific neonatal mortality rates, for deaths due to congenital malformations: selected countries



SOURCE: Alberman, E. and S. Evans. Trends in birth weight distribution: 1970–83. In: *Proceedings of the International Collaboration Effort on Perinatal Intant Mortality, Volume II/1988.*

Figure 3. Birth weight distributions of singleton live births: California blacks, Japan, and Norway, 1981

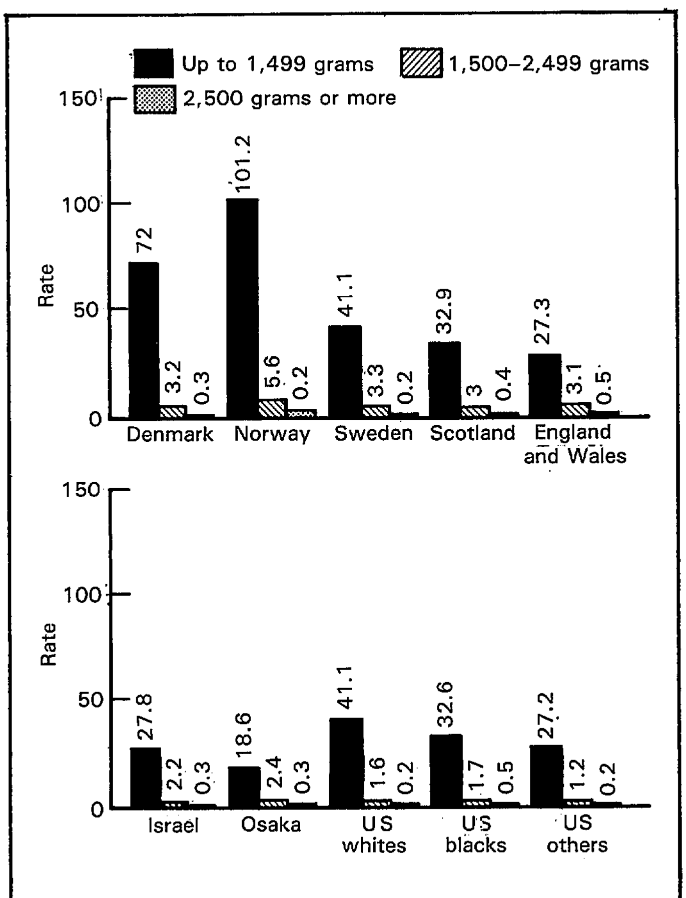


Figure 4. Birthweight-specific neonatal mortality rates for death due to asphyxia: selected countries

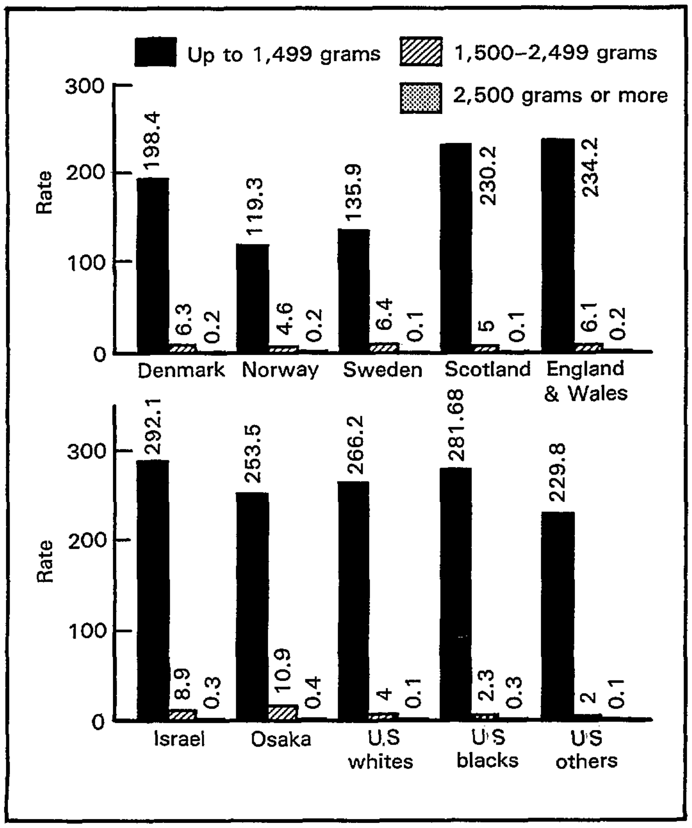


Figure 5. Birthweight-specific neonatal mortality rates, for deaths due to immaturity: selected countries

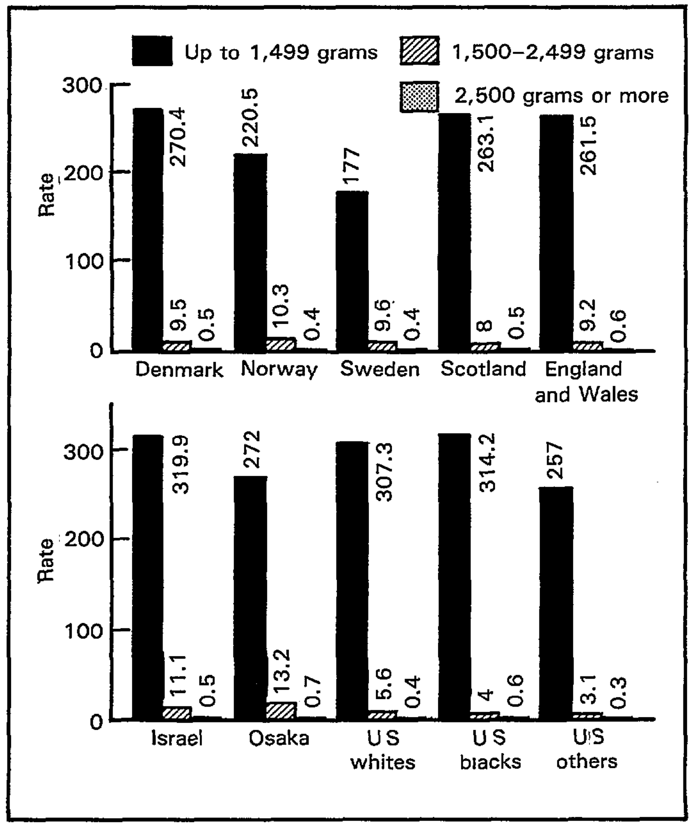


Figure 6. Birthweight-specific neonatal mortality rates, for deaths due to ashyxia or immaturity: selected countries

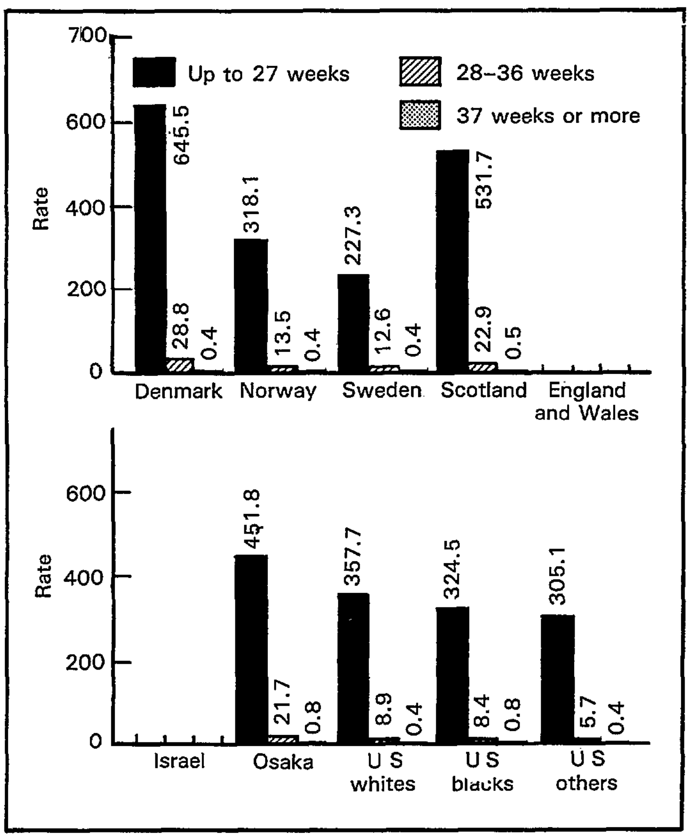


Figure 7. Gestation-specific neonatal mortality rates, for deaths due to asphyxia or immaturity: selected countries

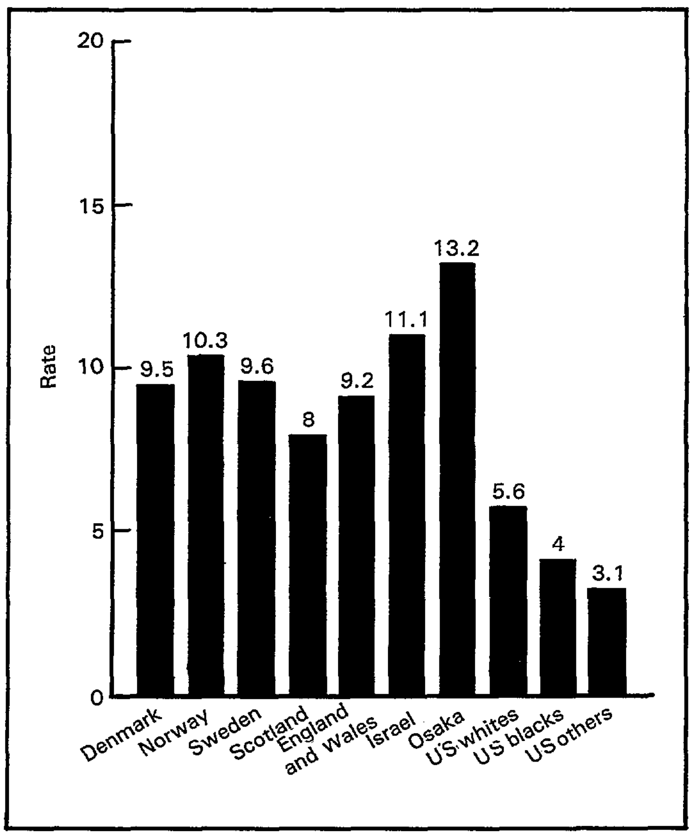


Figure 8. Neonatal mortality rates, for deaths due to asphyxia or immaturity with birth weight 1,500–2,499 grams: selected countries

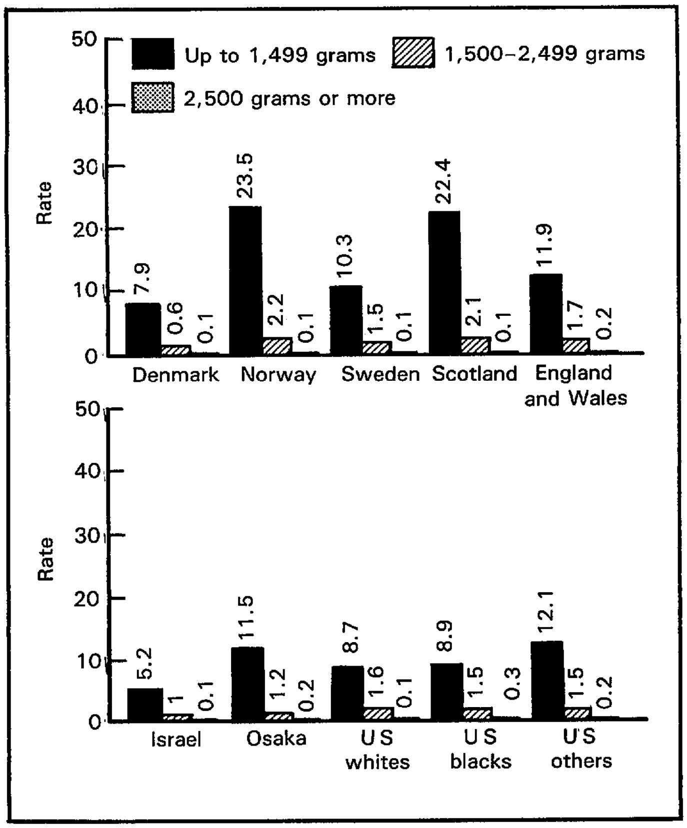


Figure 9. Birthweight-specific neonatal mortality rates, for deaths due to infections: selected countries

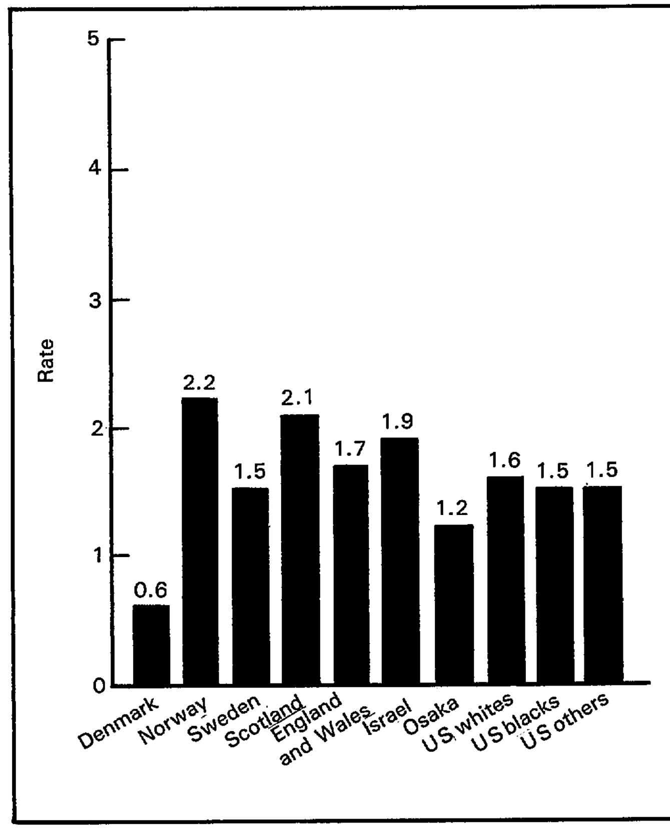


Figure 10. Neonatal mortality rates for deaths due to infections with birth weight 1,500–2,499 grams: selected countries

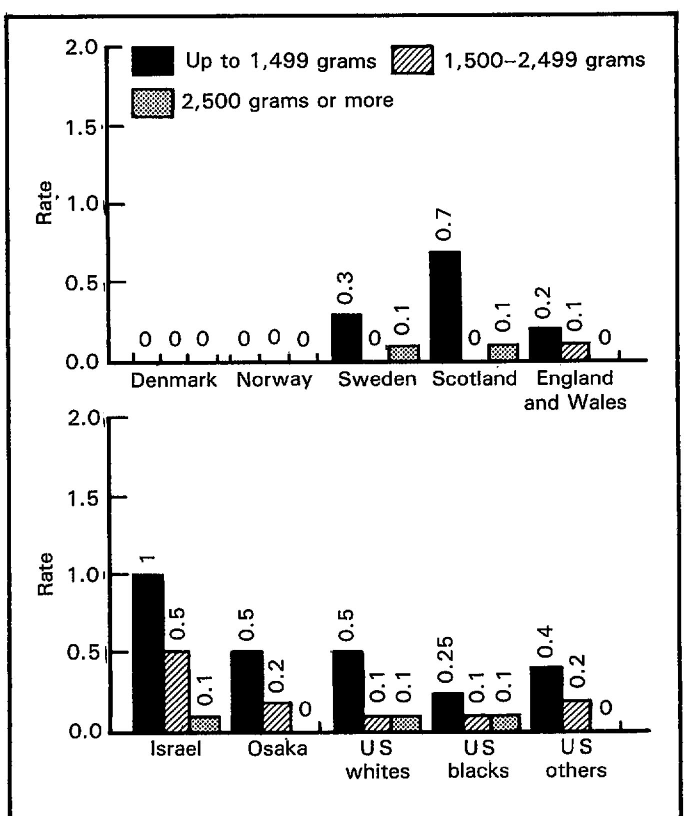


Figure 11. Birthweight-specific neonatal mortality rates, for deaths due to external causes: selected countries

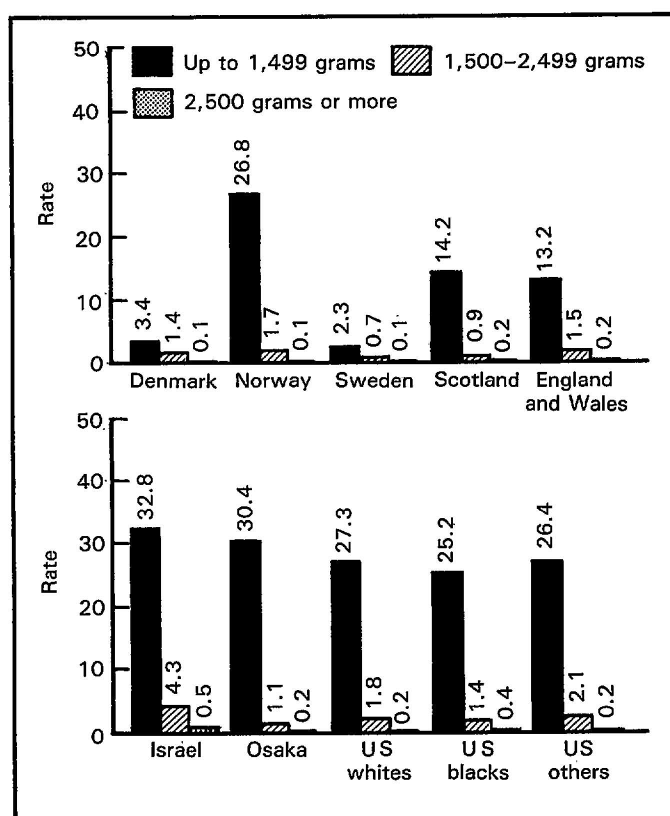


Figure 12. Birthweight-specific neonatal mortality rates for deaths in the category combining SIDS, external causes, other specific conditions, and all other causes: selected countries

Discussion

DR. CNATTINGIUS: I want to clarify the issue of Swedish births with no birth weight reported. You are quite right about that. Among these births there are many low birthweight infants, and there are also reasons for that, but I will not comment on that further. Thus birthweight-specific mortality among low birthweight infants in Sweden should be higher than it is in this file. The explanation for the high proportion of live births with missing birth weight is that the basis for this file is not the medical birth registry, but the vital statistics file. Births in Sweden consist mostly of events recorded in the medical birth register, and also a small number from home deliveries and Swedish infants delivered abroad, which are recorded only by the vital statistics system. These other births are about 0.61 percent of total births.

Cross-Country Comparison of Postneonatal Mortality by Cause, Length of Gestation, and Birth Weight

by Vita Barell, M.A., Pnina Zadka, M.P.H.,
Ayala Lusky, B.Sc., and Angela Chetrit, B.Sc.

Introduction

The main purpose of this report is to compare postneonatal mortality by cause of death, birth weight, and length of gestation (table 1). Country data for gestational age of postneonatal deaths was available for seven populations. Birth weight was available for an additional three populations. Cause of death was available for all 11 populations in the data set.

Infant mortality rates ranged from 6.3 per 1,000 in Osaka (representing Japan) to 20.9 per 1,000 among Israeli non-Jews (table 2). Populations with high ranking postneonatal mortality were North Rhine-Westphalia, Germany (5.1), U.S. blacks (6.3), and Israeli non-Jews (9.6).

The postneonatal mortality rates were approximately one-third of all infant deaths in Osaka, Sweden, and U.S. populations (figure 1). In Norway, England and Wales, North Rhine-Westphalia, and among Israeli non-Jews the postneonatal rates were 40 percent of all deaths.

Causes of death were grouped originally into eight categories. As our emphasis was on postneonatal mortality, these were re-grouped into four categories: congenital malformations, sudden infant death syndrome (SIDS), infections, and other diseases. The latter included immaturity-related conditions; asphyxia-related conditions; external causes; and all other causes. These conditions are relatively rare after the first month of life.

Malformation was the major cause of postneonatal death in Osaka, Sweden, and among both Israeli groups (figure 2). In all other countries (Denmark, Norway, both U.S. populations, England and Wales, Scotland, and North Rhine-Westphalia) SIDS was the major cause of postneonatal death. The proportion of postneonatal deaths from "other diseases" varies from about 13 percent in Norway, Sweden, and England and Wales to one-third in Osaka, U.S. blacks, and Israeli non-Jews. In both Israeli populations and in U.S. blacks, 3 out of every 10 postneonatal deaths were due to other causes, and these tended to be distributed relatively equally over immaturity, external causes, other specified causes, and the residual category.

In discussing the relationship between cause of death, birth weight, and gestational age, a distinction must be made between congenital malformations on the one hand and infectious diseases and SIDS on the other hand. Vulnerable infants with weight significantly lower than their population norms, or born before the full term of pregnancy has been completed, may be at significantly higher risk for many types of disease or for more severe or lethal manifestations of illness. However, malformations are generally determined early in pregnancy. A severe malformation may lead to low birth weight and preterm delivery at an early gestational age. In addition, different malformations affect intrauterine development differently, and it is likely that the types of malformations differ over populations.

Congenital malformations

All populations, with the exception of Israeli non-Jews, have similar congenital malformation postneonatal mortality rates--0.7 (U.S. whites) to 1.1 (North Rhine-Westphalia) per 1,000 (figure 3). Congenital malformations account for about one-quarter of all postneonatal deaths in most populations, with the significant exception of Osaka and Sweden, with about 40 percent, and U.S. blacks with about 16 percent. Malformation was the single major cause of postneonatal death in Osaka, Sweden, and among the two Israeli populations. The high malformation rate among Israeli non-Jews is associated with extremely high consanguinity coupled with poor compliance to prenatal diagnostic services and resistance to terminate pregnancies of affected fetuses.

Among most of the countries under study here, about one-third of the congenital malformation deaths occur postneonatally. Significant exceptions are Osaka (47 percent) and Israeli non-Jews (44 percent). Danes and U.S. whites have about 28 percent. Whether this implies different incidence or type of malformations, different cultural approaches to the desirability of lifesaving intervention, or a different approach to care or artifactual causes such as under-reporting of live births with lethal malformation, is unclear.

Postneonatal mortality from congenital malformations is inversely related to birth weight in all countries, with a similar relative risk as can be seen on the logarithmic scale graph (figure 4). The birthweight-specific rates for all countries are similar, with the possible exception of Sweden where, perhaps due to under-registration of very low birthweight infants, it appears that greater than expected very low birthweight babies with congenital malformations are surviving the neonatal period and dying postneonatally.

The two United States and two Israeli subpopulations are presented separately because of technical reasons (figure 5). It can be seen that the postneonatal malformation rates of U.S. whites, U.S. blacks, and Israeli Jews are similar for all birth weights, while for Israeli non-Jews the rates are higher at each weight group.

Among the populations with gestational age data available, congenital malformations were the major cause of postneonatal death among preterm births in Sweden (3.3) and Denmark (3.5) (figure 6.) At very young gestational age, less than 34 weeks, Swedish infants have the highest malformation rates. In Osaka, the congenital malformation death rate almost doubles (to 1.5 per 1,000) among postterm births relative to term.

When classifying live births into four risk groups (above and below 2500 grams and preterm and term in each population), a clear relationship with postneonatal mortality becomes evident (figure 7). The highest death rates can be seen among low birthweight preterm infants in most countries, where postneonatal mortality ranges from 5 to 10 times higher than among full term good birth weight infants. This is most particularly clear in Sweden (6.1 as compared with 0.6 among good birth weight term babies). In Osaka, U.S. whites, and Norway, we see excess mortality among low birthweight term infants.

When presented in four risk groups, it can be seen that the effect of malformation on birth weight is greater than its effect on gestational age (figure 8). There are no country differences among good birthweight term infants.

Sudden infant death syndrome (SIDS)

In most populations the major cause of postneonatal deaths was SIDS. Most of the SIDS-ascribed deaths occurred postneonatally (figure 9). These rates range from a high of over 2 per 1,000 (U.S. blacks, North Rhine-Westphalia, and Scotland) to a low of 0.1 in Osaka. However, there are probably two types of misclassification errors in this grouping. SIDS, as defined by the ICE Committee, included ill-defined and unknown causes of mortality (ICD-9 799.9). Inclusion of these causes artificially inflated Israeli non-Jewish rates, because about two-thirds (63 percent) of those classified as SIDS are ill-defined conditions. The fact that among both the Israeli populations about one-third of the SIDS-ascribed deaths occurred neonatally supports this hypothesis. This grouping may also be affecting the U.S. black-white rate ratio of 2. It is obvious that medical definition and registration artifacts are responsible for the improbably low SIDS rate in Osaka (0.1).

Birth weight appears to have relatively little to do with the occurrence of SIDS (figure 10). SIDS rates are slightly higher at low birth weight and the rates tend to flatten at 3.0 kilograms or more. Among very low birthweight infants, rates are lower in Sweden, Denmark, and Scotland. Population differences in SIDS rates are greatest at the very low birthweight range (<1.5 kilograms) and may be artifacts. SIDS rates tend to converge as weight increases. Sweden tends to have the lowest SIDS rate at almost all weight groups, the Osaka SIDS rates being considered unreliable. U.S. blacks have the highest SIDS rate at almost all birth weights (figure 11).

Gestational age is inversely associated with the SIDS postneonatal mortality rate, with a slight increase postterm in some population groups (figure 12). Sweden has the lowest postneonatal SIDS rate at each gestational age. In Scotland and Norway SIDS was the major cause of preterm postneonatal death (4.0 and 3.2 per 1,000 preterm live births).

The combined gestational age and birthweight grouping suggests that low birthweight infants, both term and preterm, are at a higher risk for SIDS with low gestational age affecting the risk, mostly among good birthweight infants (figure 13). Denmark, Sweden, Scotland, and U.S. blacks have somewhat higher postneonatal mortality rates at low birthweight term than preterm, suggesting that small for gestational age infants (SGA) are more at risk for SIDS than are the appropriate weight for gestational age group (AGA).

The greatest differences between the countries are observed in the low birthweight group (figure 14). SGA infants (low birthweight term births) were at relatively high risk for SIDS, with the possible exception of U.S. whites and Norway. Most countries have very low postneonatal mortality from SIDS among good birthweight term infants.

Infections

Of the five populations with the highest postneonatal rates, four have infectious disease postneonatal mortality rates of 0.7 and above (figure 15). Most infectious disease deaths occur after the first month of life, ranging from 50 percent in most countries to two-thirds or more in England and Wales, North Rhine-Westphalia, U.S. blacks, and Israeli non-Jews.

In general, the effect of birth weight on infections was relatively slight except at very low birth weights (figure 16). There was an exceptionally low rate for Danish and Swedish babies at less than 1.5-kilograms (possibly an artifact). A number of countries have an increased postneonatal mortality rate at 4 kilograms or more. Israeli non-Jews have by far the highest rate at each weight group from 1.5 kilograms on (figure 17).

Gestational age tends to affect patterns of postneonatal mortality for infections among extremely preterm infants (less than 34 weeks of gestation) (figure 18). In Sweden and Denmark even for the preterm infants there was no difference in the rate of infectious disease mortality. For more mature babies, there is no difference over the gestational age range.

The combined effect of low birth weight and preterm birth has a striking effect in all populations (figure 19). Low birthweight preterm infants have almost 10 times the rate of good birthweight term infants in each of the countries, with U.S. blacks ranging from 4.4 per 1,000 for low birthweight preterm to 0.5 for good birthweight full term infants and U.S. whites dropping from 2.3 to 0.2. Low birthweight preterm births in Osaka and among U.S. blacks have relatively high postneonatal mortality rates compared with other populations.

It can be seen that only among low birthweight preterm infants are there differences among the countries in infectious disease postneonatal mortality (figure 20). There is almost no variation among good birthweight full term babies, where the rates range from 0.2 to 0.5. Low birth weight has by far a stronger effect on mortality due to infections than does early gestational age.

Other diseases

The "other disease" category is composed primarily of deaths due to immaturity and asphyxia-related conditions and are mostly delayed neonatal deaths in all countries (figure 21). In most populations about 15 percent of deaths from other diseases occur postneonatally, with the prominent exception of Israeli non-Jews with about one-third. These are postponed immaturity and asphyxia related deaths, with the exception of Osaka where the residual "other" group, which could not be subdivided, accounted for most of the deaths.

There is a large excess of postneonatal mortality from this group of diseases among infants weighing less than 2.5 kilograms (figures 22 and 23), although above this weight range the rates plateau in most countries with the exception of the United States, Norway, and Israeli non-Jews. The latter countries have the highest postneonatal mortality from other diseases at all birth weights. It can be seen that the U.S. reduction in postneonatal mortality above 3 kilograms is restricted to the whites.

At very low gestational age, the postneonatal mortality rates are much higher for all countries, flattening out among term births (figure 24). Osaka shows up here with the highest rates at each gestational age (due to the residual "other" category).

Again, differences between countries tend to become negligible among full term good birthweight infants (figure 25). The combined effect of low birth weight and preterm delivery clearly shows the most at risk infant in all populations to be among the low birth weight preterm. Reducing one of these risk factors improves survival rates in all countries. Almost all of the deaths seem to occur in the highest risk category (figure 26). Among good birthweight term infants there is almost no variation between countries.

Discussion

In all populations, of course, postneonatal mortality decreases as birth weight increases. The optimum birth weight in all populations, insofar as postneonatal mortality is concerned, is 4 kilograms or more. In all populations, in all four major cause groups, postneonatal mortality was highest preterm. Generally, the higher the gestational age the lower the postneonatal mortality rate. Infant mortality in all of these populations was lowest at 40-41 weeks. This tends to suggest that length of full term pregnancy tends to be similar in all populations and not population-specific as in birth weight.

In general, postterm mortality after the first month of life was higher than term only for Osaka, both U.S. populations, and Scotland, although the differences are not very great. However, in the two U.S. populations, with their very high proportion of births at 42 weeks or more (whites, 16.8 percent and blacks, 14.0 percent), these may be an important contribution to excess mortality.

Standardizing gestational age

The impact of gestational age distribution on postneonatal mortality is an interesting question since it obviously has a strong effect on mortality and is more amenable to intervention than birth weight.

Adjusting the U.S. black gestational age distribution to that of U.S. whites, for example, lowering the very high preterm proportion among the blacks, would lower the postneonatal infant mortality from 6.3 per 1,000 to 4.9--a reduction of 22.2 percent. If all populations had the same gestational age distribution as Denmark, then the U.S. black postneonatal mortality rates would be reduced by 25.4 percent, U.S. whites by 12.9 percent, and Scotland by 9.5 percent. It is not clear what the nature of the association is between disease and preterm gestational age at birth; whether there are common causes for both or the extent to which the preterm birth contributes to the onset of the disease. Standardization of gestational age is a statistical technique and it does not follow that cause-specific mortality will be proportionally changed. However, if the high proportion of U.S. black preterm births were reduced, and if preterm birth is a risk factor for SIDS, then it may follow that there would be a reduction in the SIDS mortality rate.

The lowest postneonatal mortality rates tend to be at the highest gestational age (42 weeks or more) combined with high birth weight of 4 kilograms or more (Denmark, Osaka, Norway, Sweden, and U.S. blacks). These may be reflecting older mothers of parity 2-3. The highest postneonatal mortality rates are at low birth weight and at either preterm or at postterm gestation, the latter being SGA infants.

In inspecting the postneonatal mortality rates for all causes by risk category, we see among U.S. whites, for instance, the postneonatal rate among low birthweight preterm infants reaches 17.5 per 1,000 as compared with 2.2 per 1,000 among term babies weighing 2500 grams or more at birth (figure 27). The effect of these combined risk factors is strongest among "other" diseases (primarily immaturity), but the infectious disease postneonatal mortality differential is also extremely high (a relative risk of 12.5 among U.S. whites and 10 among the Japanese infants from Osaka). It would appear from the combined country data sets that the effect of low birth weight on postneonatal mortality is stronger than the effect of early gestational age, although there is obviously a joint effect as well.

If we inspect the postneonatal rates for all causes in the best risk category, good birthweight term, and extend the scale maximally, we can see that the rates range from 1.7 (in Sweden and Osaka) to 3.0 in Scotland and 4.0 among the U.S. blacks (figure 28). The major differences are in the SIDS rates which, except for Osaka, vary from 0.7 in the Sweden to 2.0 in U.S. blacks. It is important to note that Norway, U.S. blacks, and U.S. whites have the lowest proportion of their infant populations in this optimal group--U.S. blacks having only 74.3 percent, U.S. whites 86.1 percent, and Norway 87.8 percent; all others have 90 percent or more.

In summary, the major patterns that can be seen are:

1. Postneonatal deaths are caused primarily by three main groups of conditions: congenital malformations, SIDS, and infections.

2. Low birth weight seems to be a stronger risk factor for postneonatal death than gestational age.

3. Low birthweight postterm infants are at highest risk for postneonatal mortality; at lowest risk are babies of 42 or more weeks of gestation weighing 4 kilograms or more.

4. Among good birthweight term infants, the differences among the countries are almost negligible, and rates are very low.

5. A major difference among the countries is the relative proportion of high risk low birthweight preterm births.

Table 1. Country data available for analysis of postneonatal mortality

Country	Years	No. of livebirths	PN mort.	GA	BW	Cause
Osaka (Japan)	1980-84	548,628	2.2	x	x	x
Sweden	1980-85	562,904	2.3	x	x	x
Denmark	1982-86	264,340	3.1	x	x	x
Norway	1980-84	252,624	3.4	x	x	x
USA						
total	1980-85	6,886,542	3.5			
whites	1980-85	5,575,268	3.1	x	x	x
blacks	1980-85	918,881	6.3	x	x	x
Scotland	1980-85	394,707	4.2	x	x	x
England/Wales	1980,82-85	3,204,534	4.1	-	x	x
Israel						
total	1980-85	582,985	4.8			
Jews	1980-85	443,787	3.2	-	x	x
non-Jews	1980-85	139,198	9.6	-	x	x
North Rhine (Germany)	1980-85	993,459	5.1	-	-	x

Table 2. Mortality rate per 1,000 live births by cause of death

Population	Infant mortality rate	Postneonatal mortality rate				
		All causes	Malfor-mation	SIDS	Infec-tion	Other causes
Osaka (Japan)	6.3	2.2	0.9	0.1	0.4	0.8
Sweden	6.8	2.3	0.8	0.8	0.3	0.4
Denmark	7.9	3.1	0.8	1.5	0.3	0.5
U.S. whites	9.2	3.1	0.8	1.3	0.3	0.7
Israel Jews	11.1	3.2	1.0	0.8	0.5	1.0
Norway	8.0	3.4	0.9	1.6	0.5	0.4
England/Wales	10.2	4.1	1.0	1.7	0.8	0.6
Scotland	10.9	4.2	1.0	2.0	0.5	0.7
North Rhine (Germany)	12.3	5.1	1.1	2.1	0.7	1.2
U.S. blacks	19.4	6.3	1.0	2.6	0.9	1.8
Israel						
non-Jews	20.9	9.6	2.4	1.6	2.3	3.2

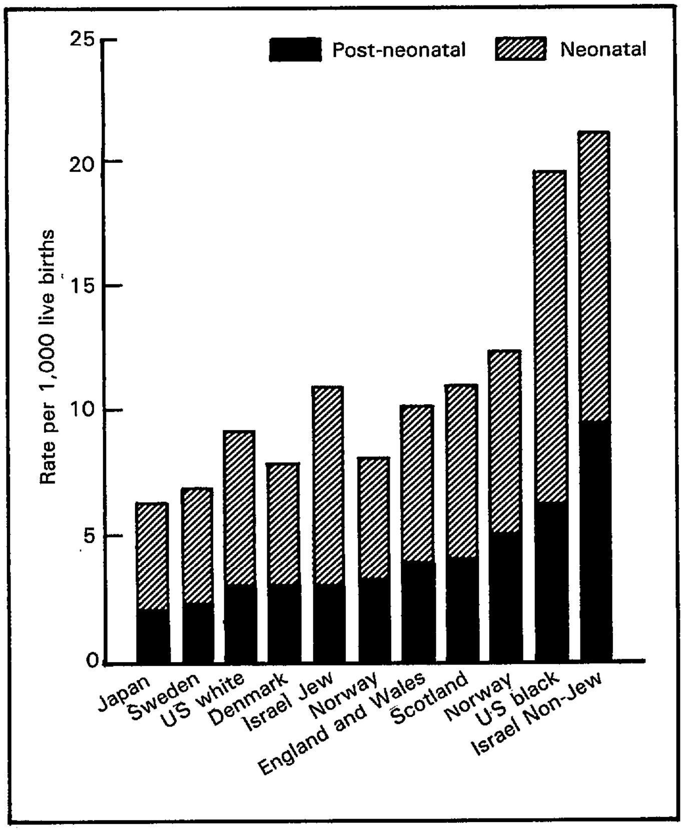


Figure 1. Neonatal and post-neonatal mortality rates: selected countries

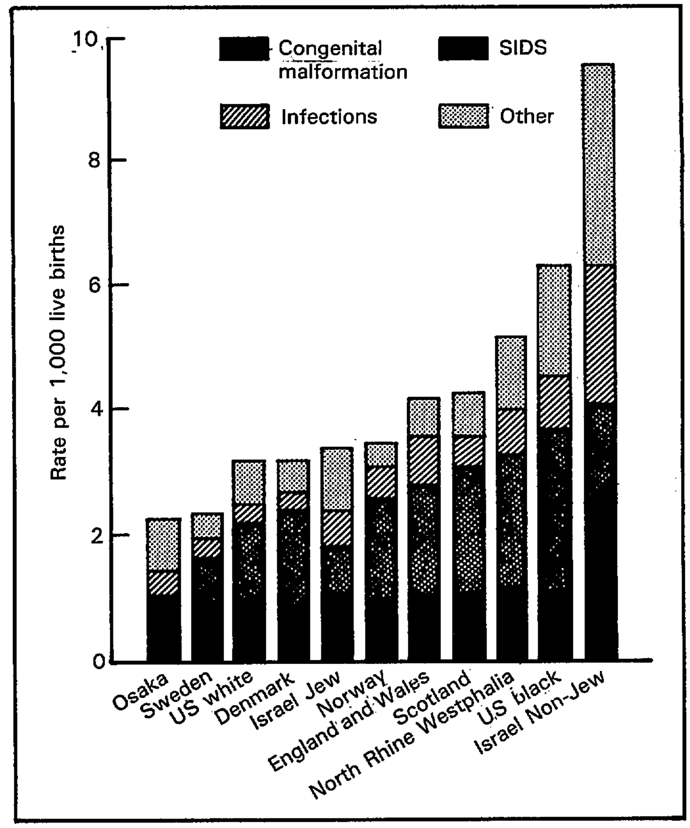


Figure 2. Post-neonatal mortality rate by cause of death: selected countries

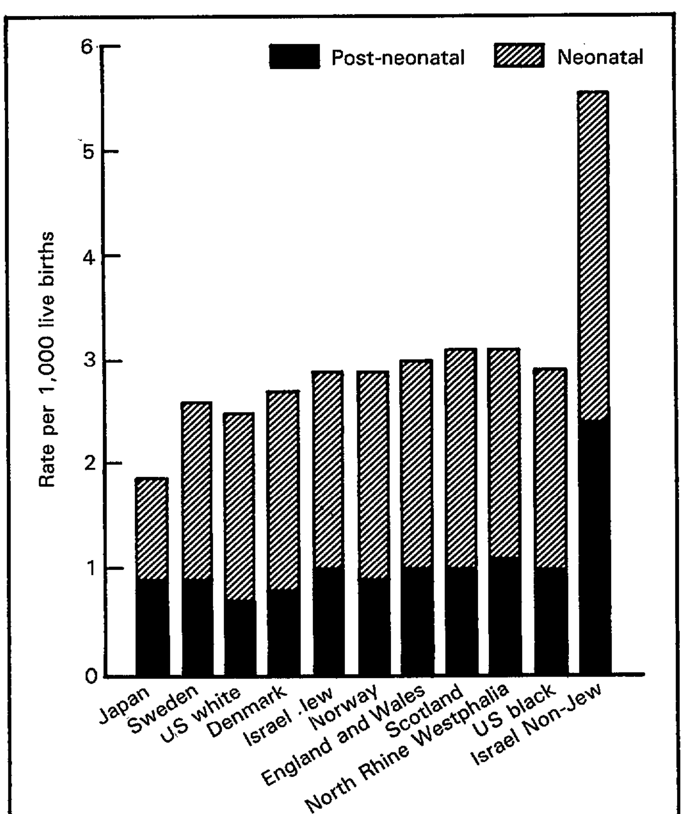


Figure 3. Neonatal and post-neonatal mortality rates for deaths due to congenital malformations: selected countries

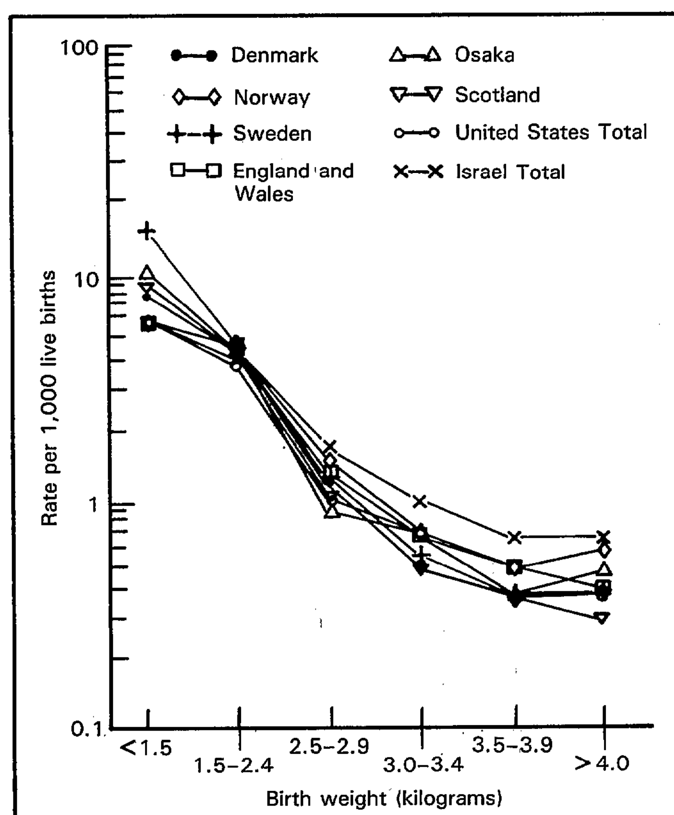


Figure 4. Post-neonatal mortality rate by birth weight: selected countries

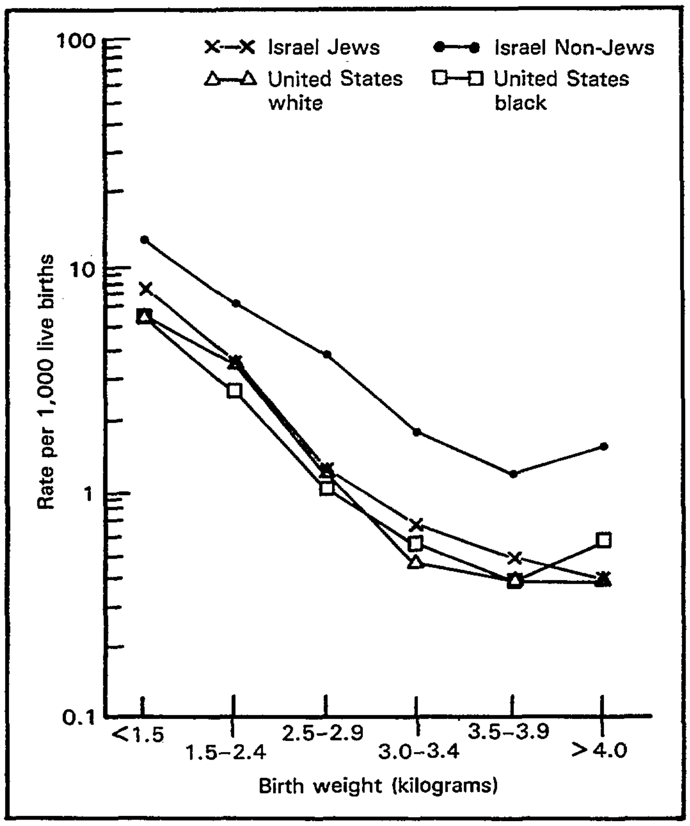


Figure 5. Post-neonatal mortality rate for deaths due to congenital malformations, by birth weight: selected countries

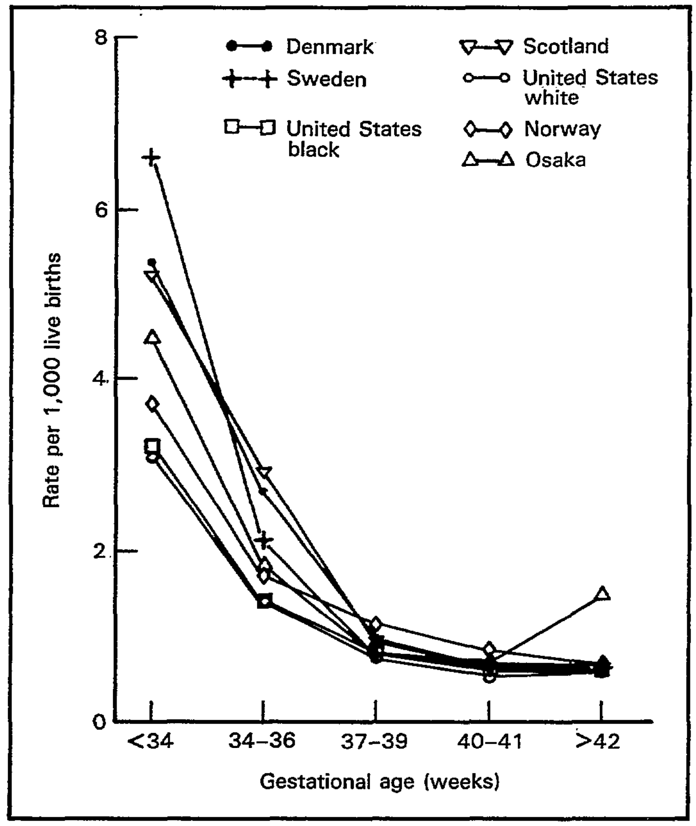


Figure 6. Post-neonatal mortality rates for deaths due to congenital malformation, by gestational age: selected countries

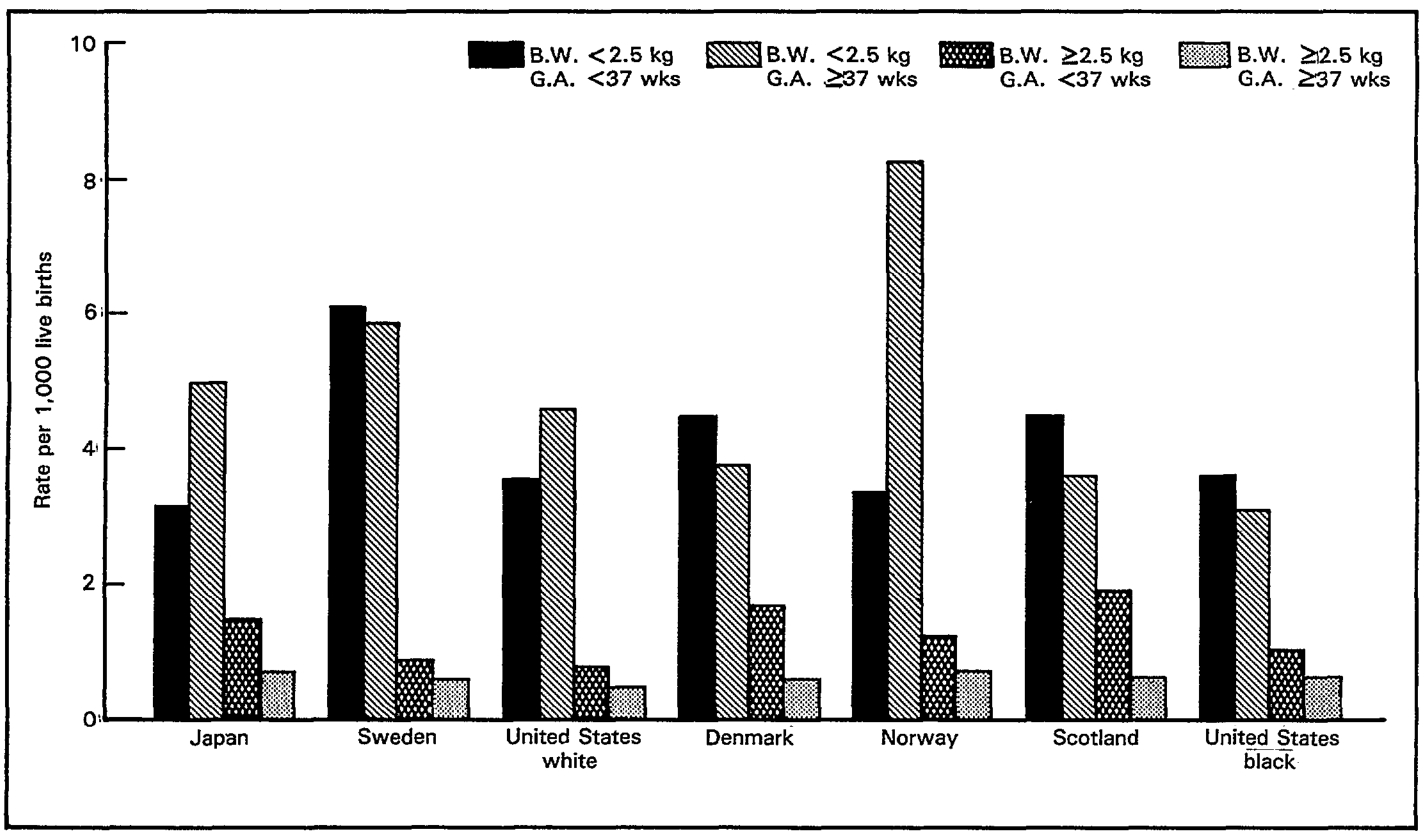


Figure 7. Post-neonatal mortality rates for deaths due to congenital malformations, by birth weight and gestational age: selected countries

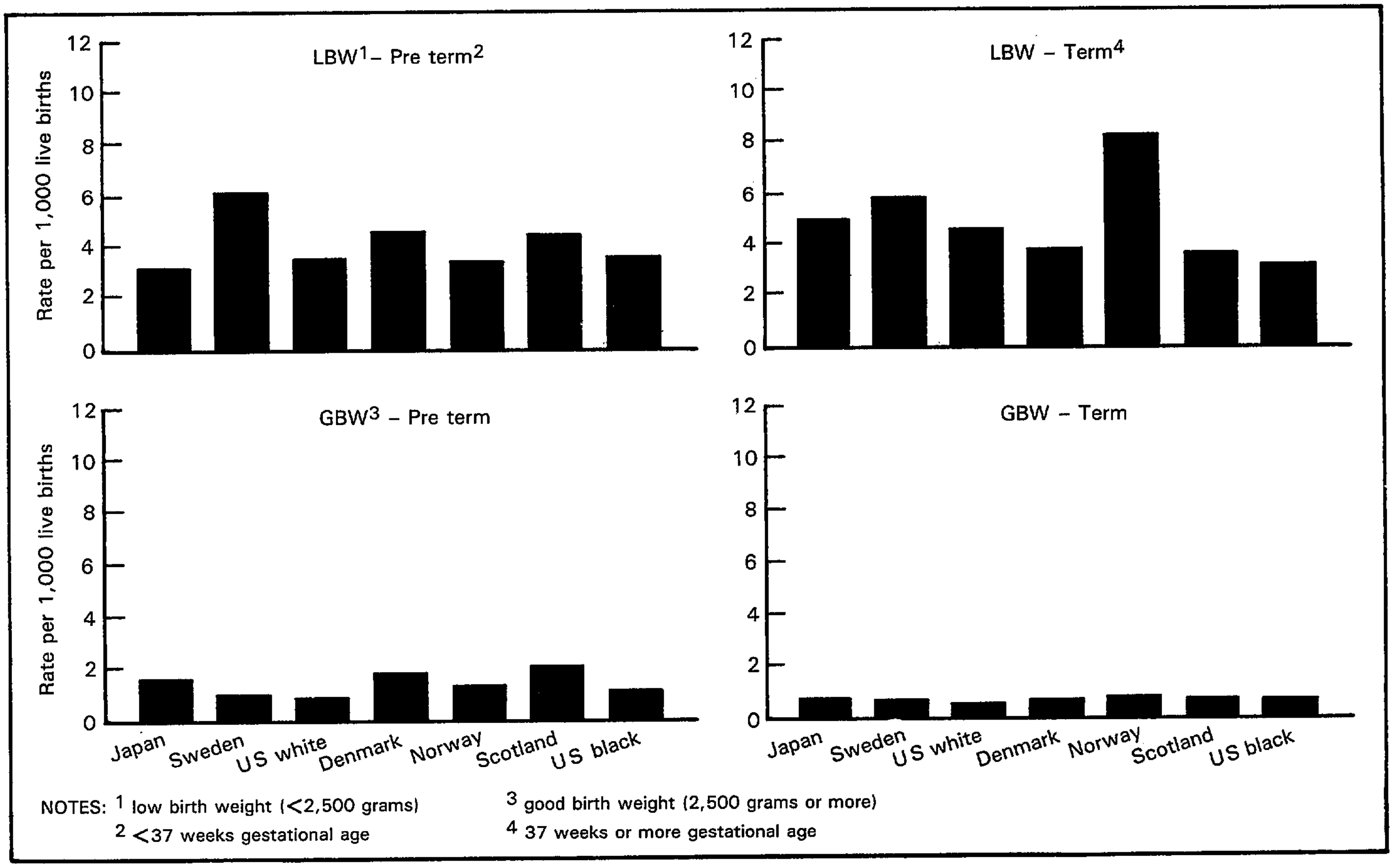


Figure 8. Post-neonatal mortality rates for deaths due to congenital malformations, by birth weight and gestational age: selected countries

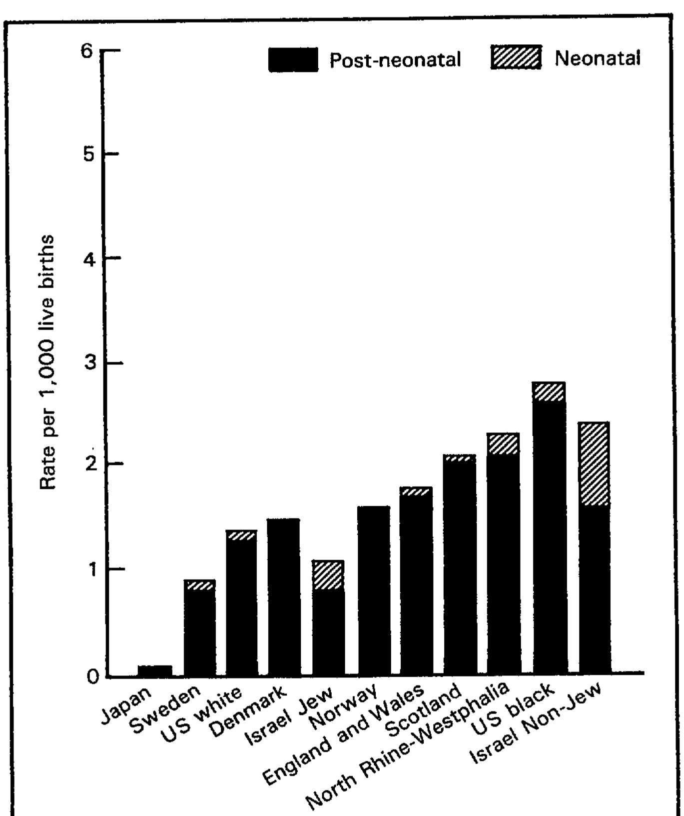


Figure 9. Neonatal and post-neonatal mortality rates for deaths due to SIDS: selected countries

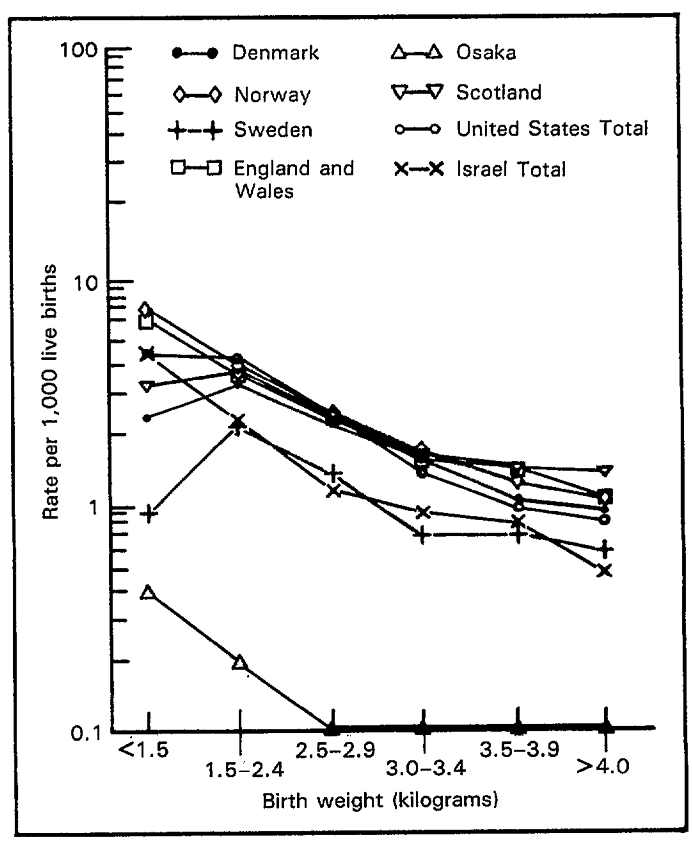


Figure 10. Post-neonatal mortality rates for deaths due to SIDS, by birth weight: selected countries

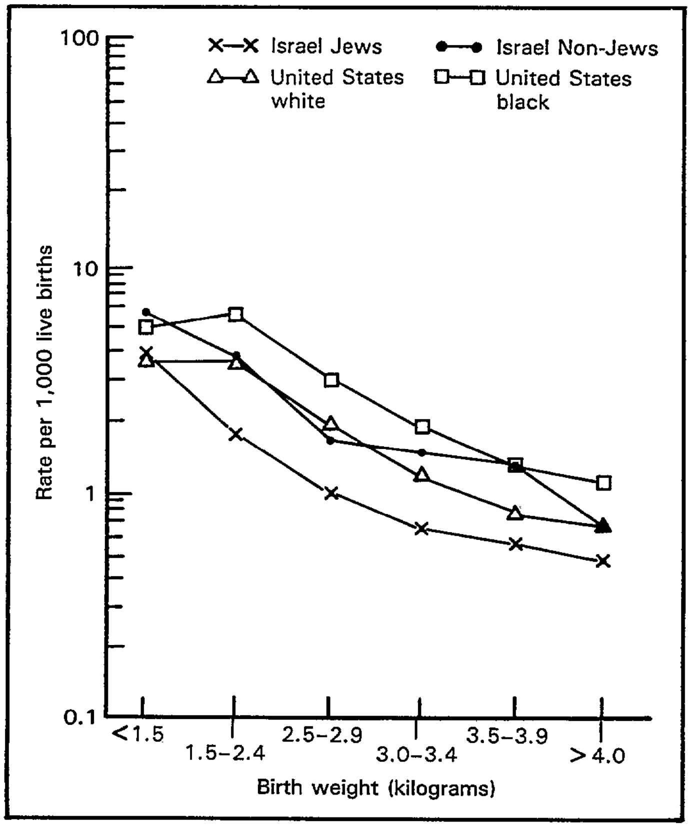


Figure 11. Post-neonatal mortality rates due to SIDS by birth weight: selected countries

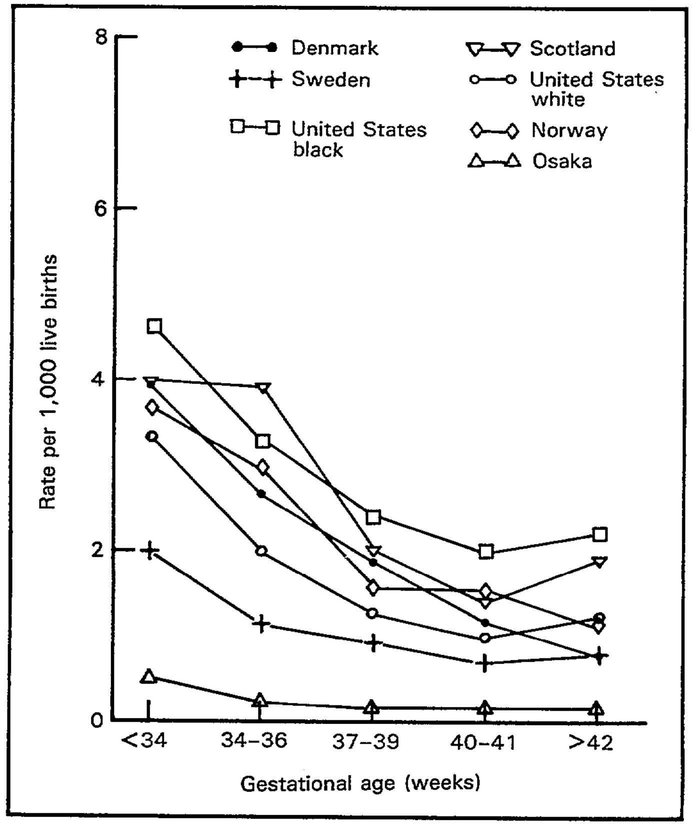


Figure 12. Post-neonatal mortality rates for deaths due to SIDS by gestational age: selected countries

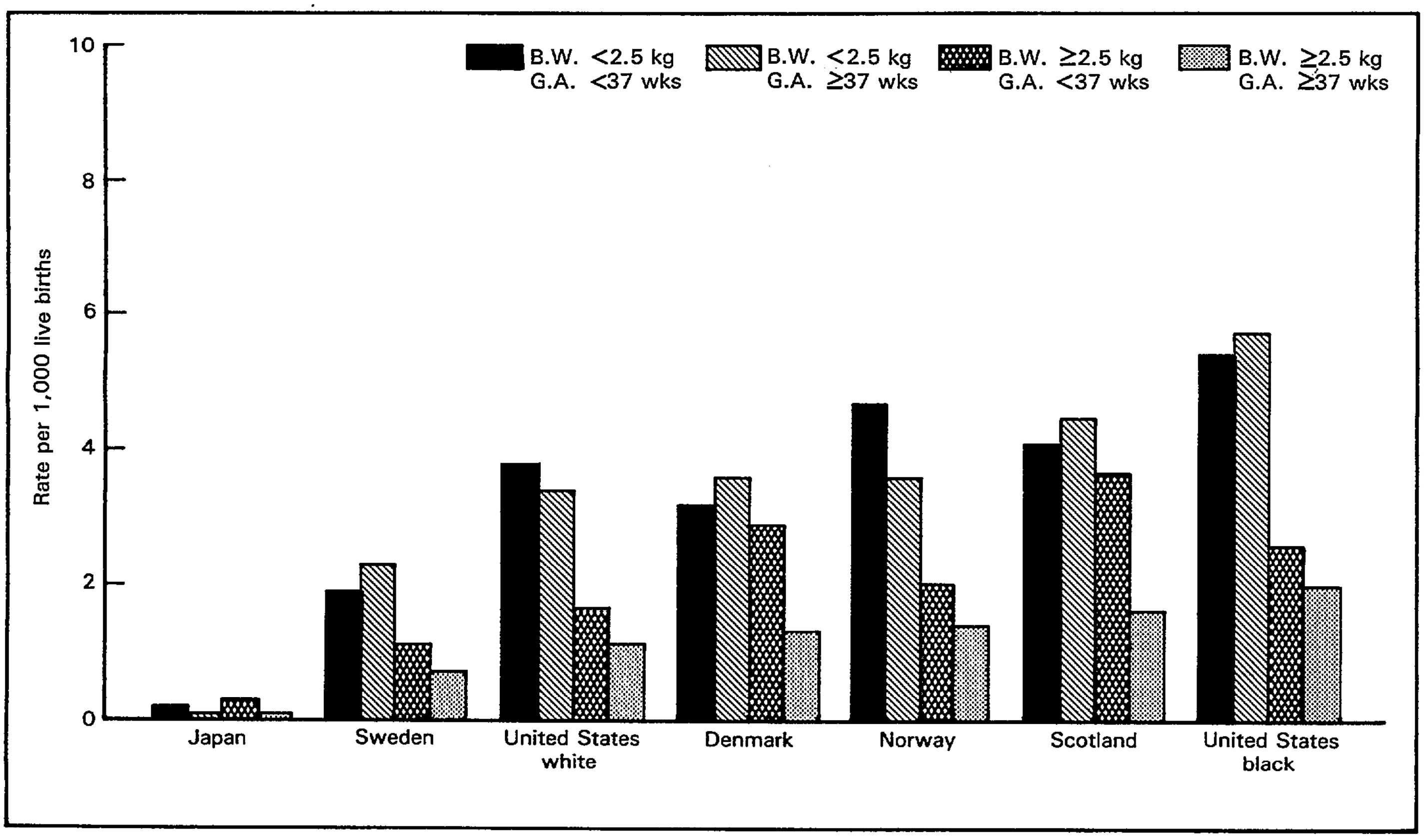


Figure 13. Post-neonatal mortality rates due to SIDS, by weight and gestational age: selected countries

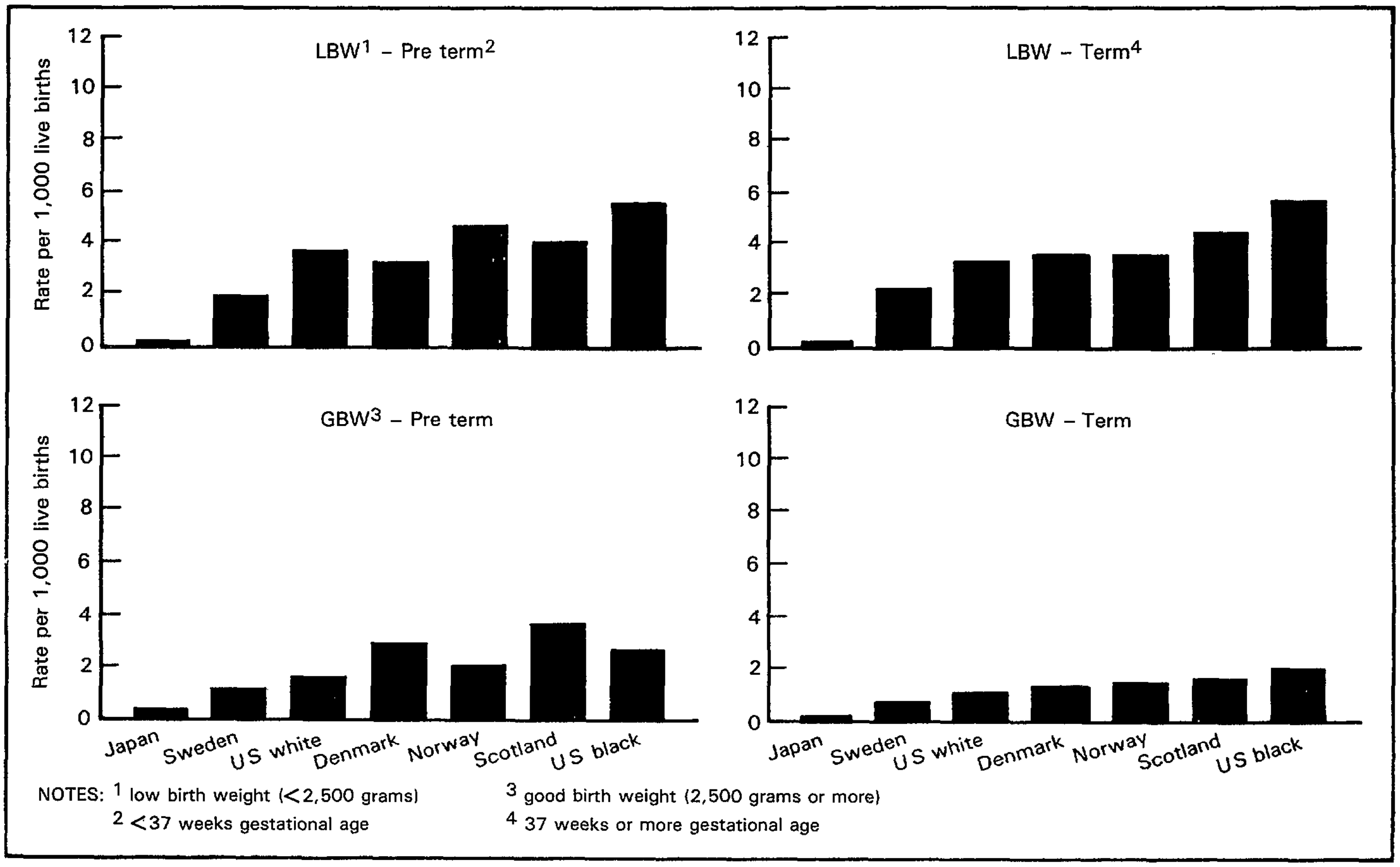


Figure 14. Post-neonatal mortality rates due to SIDS by weight and gestational age: selected countries

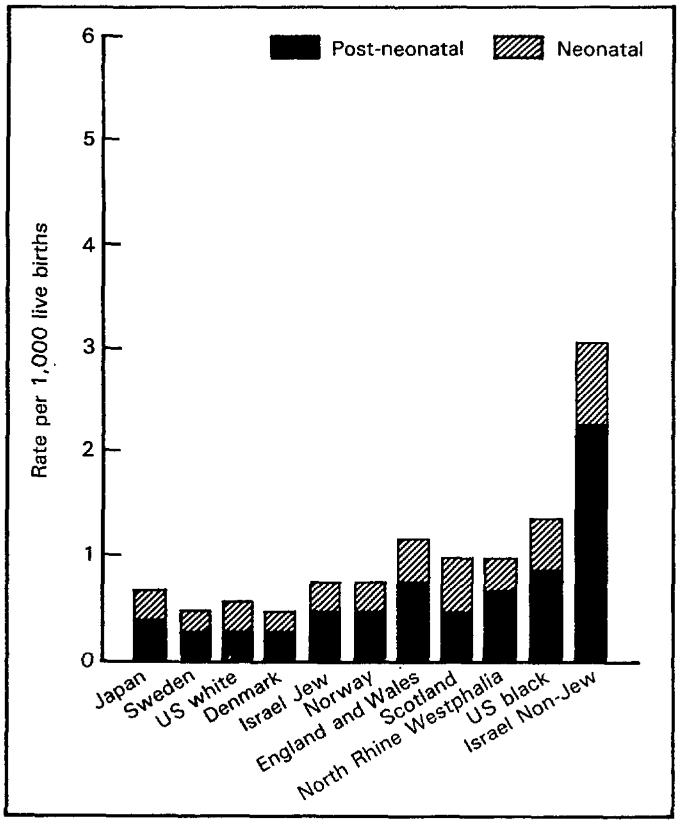


Figure 15. Neonatal and post-neonatal mortality rates for deaths due to infections: selected countries

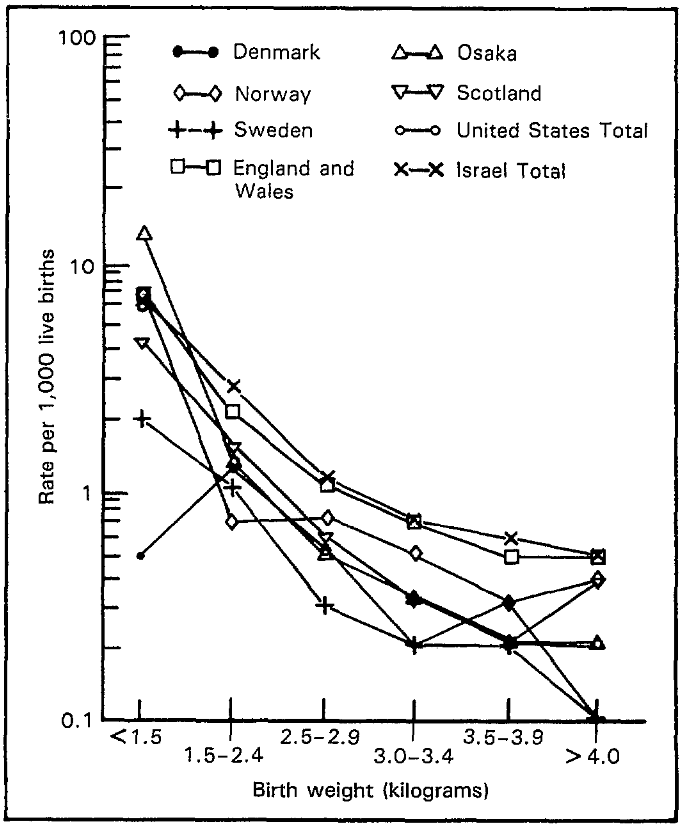


Figure 16. Post-neonatal mortality rates, for deaths due to infections, by birth weight: selected countries

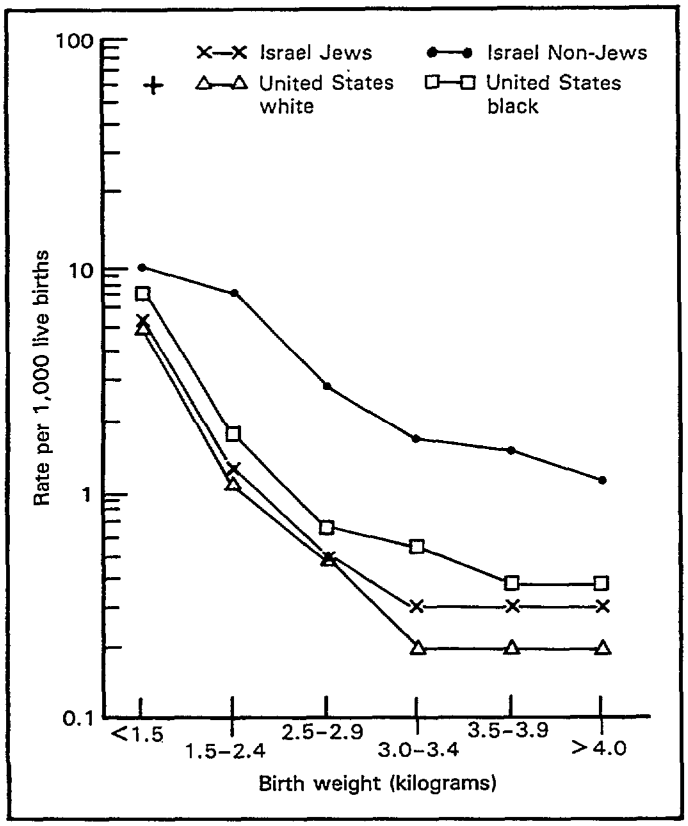


Figure 17. Post-neonatal mortality rates for deaths due to infections, by birth weight: selected countries

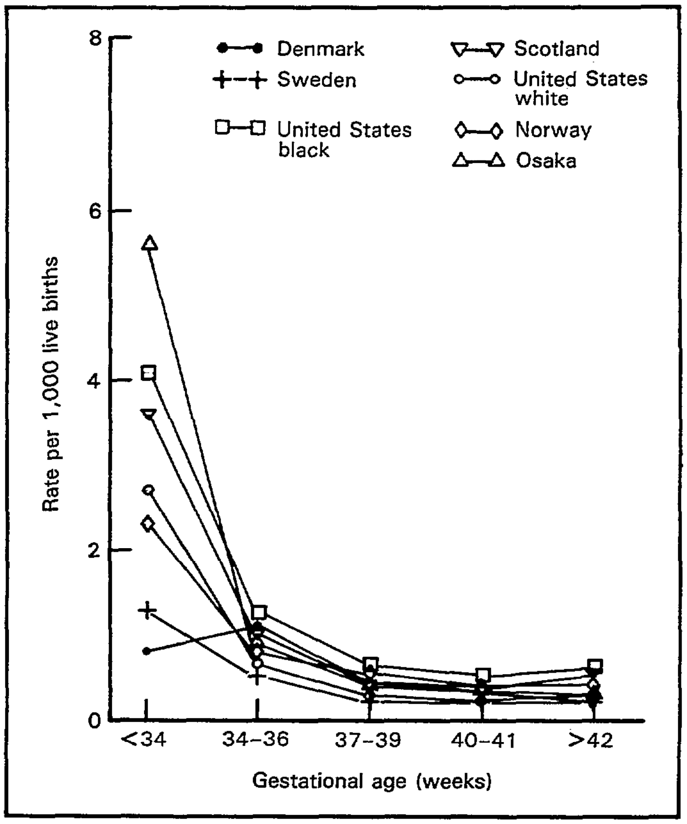


Figure 18. Post-neonatal mortality rates for deaths due to infections, by gestational age: selected countries

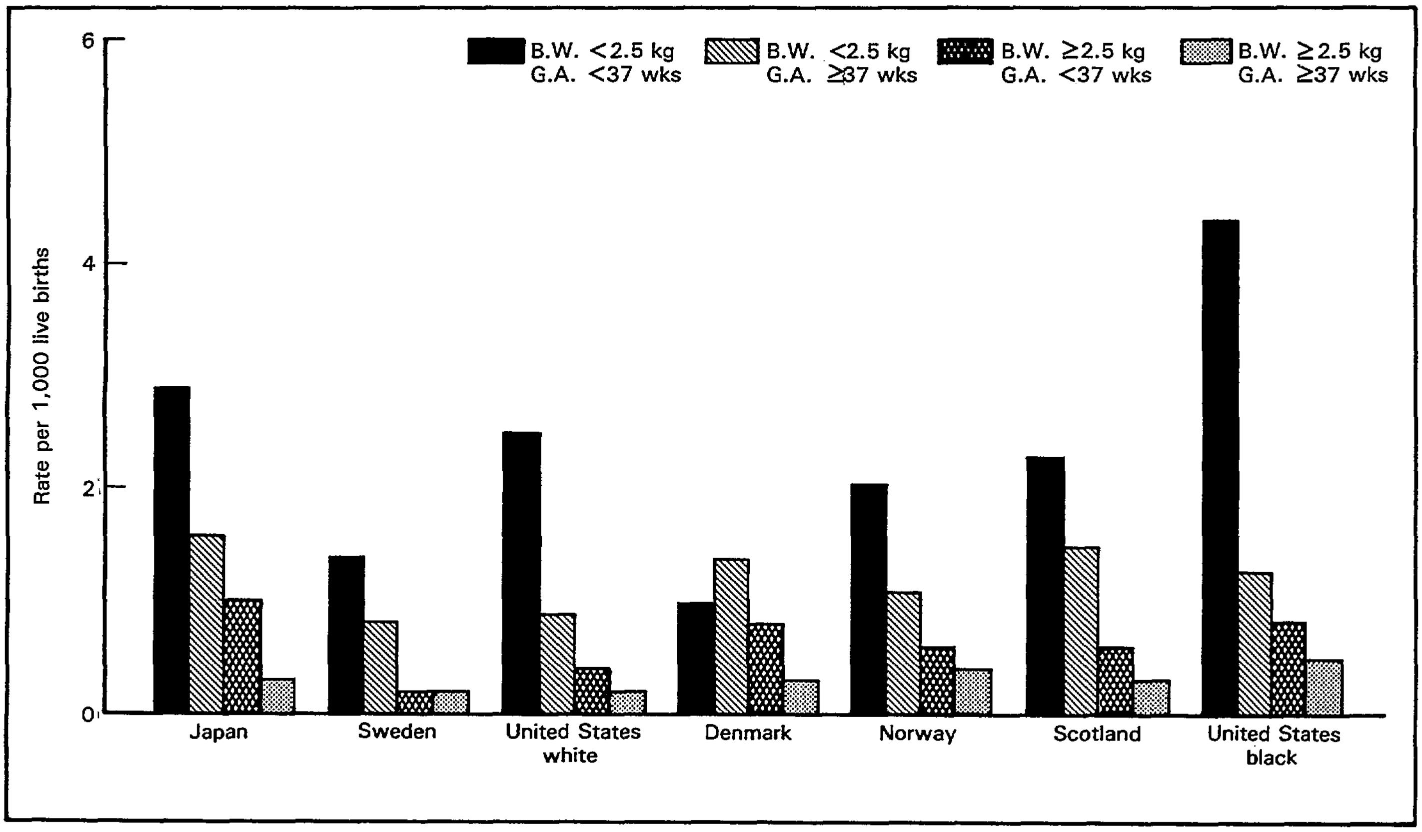


Figure 19. Post-neonatal mortality rates due to infections, by weight and gestational age: selected countries

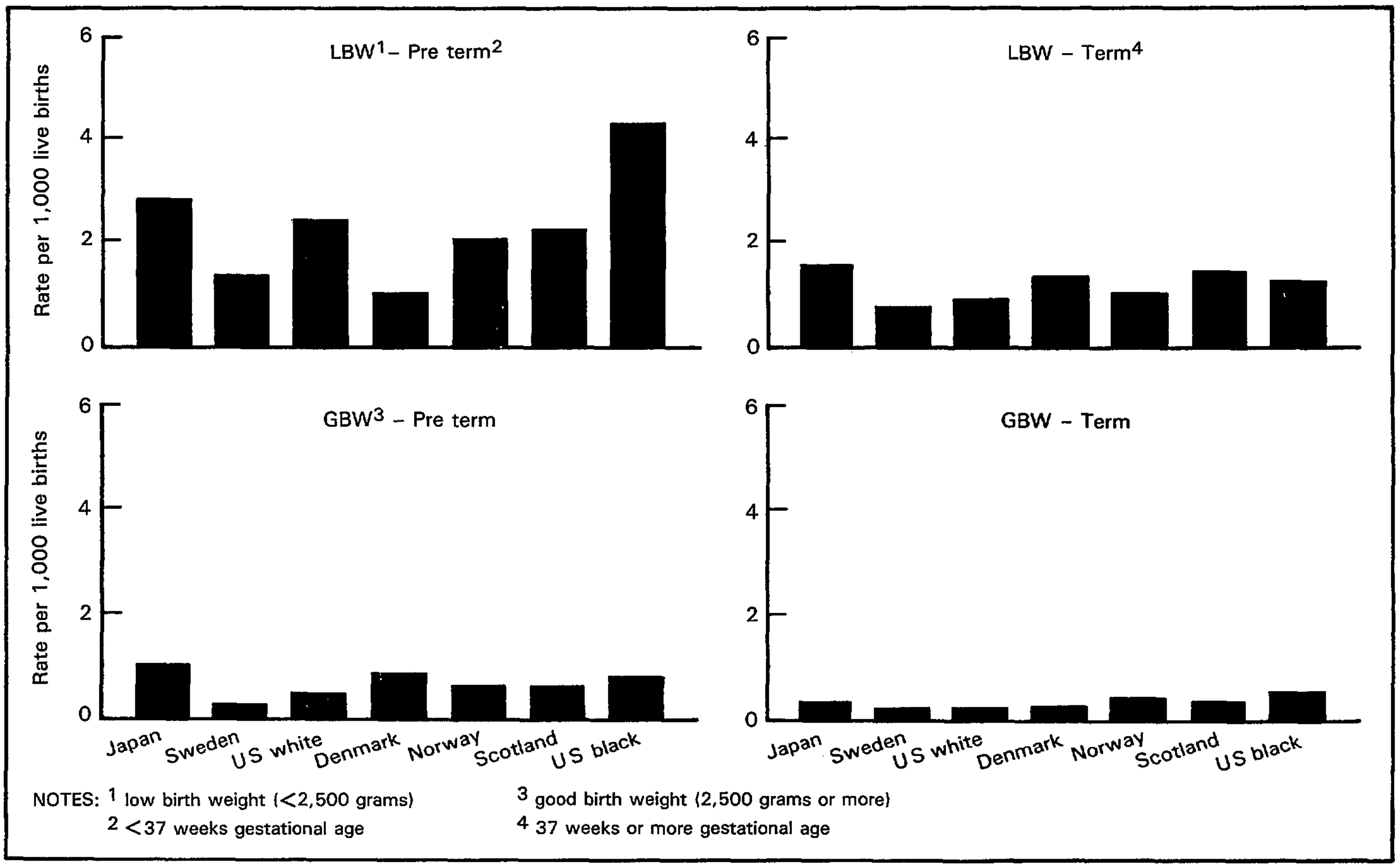


Figure 20. Post-neonatal mortality rates due to infections, by weight and gestational age: selected countries

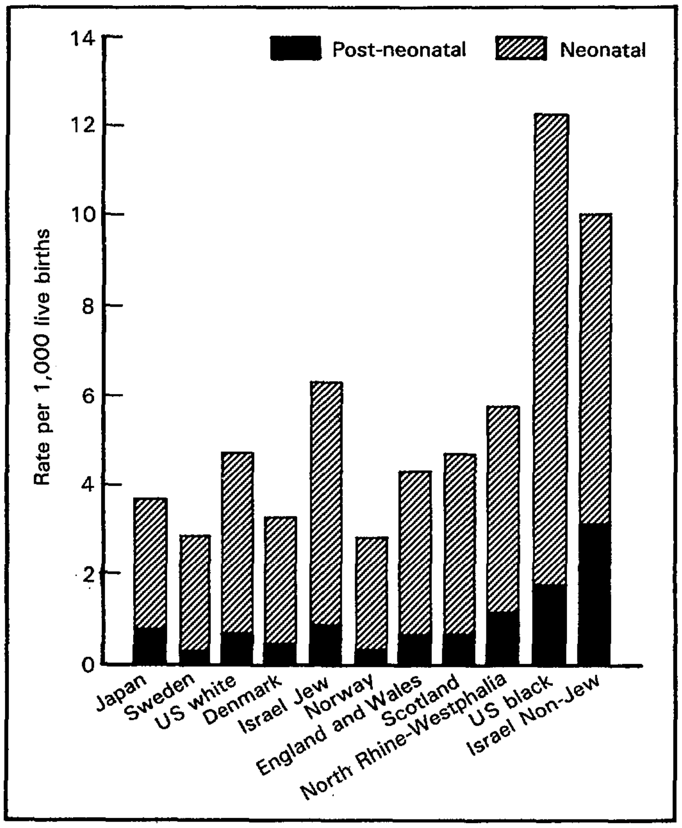


Figure 21. Neonatal and post-neonatal mortality rates for deaths due to other causes: selected countries

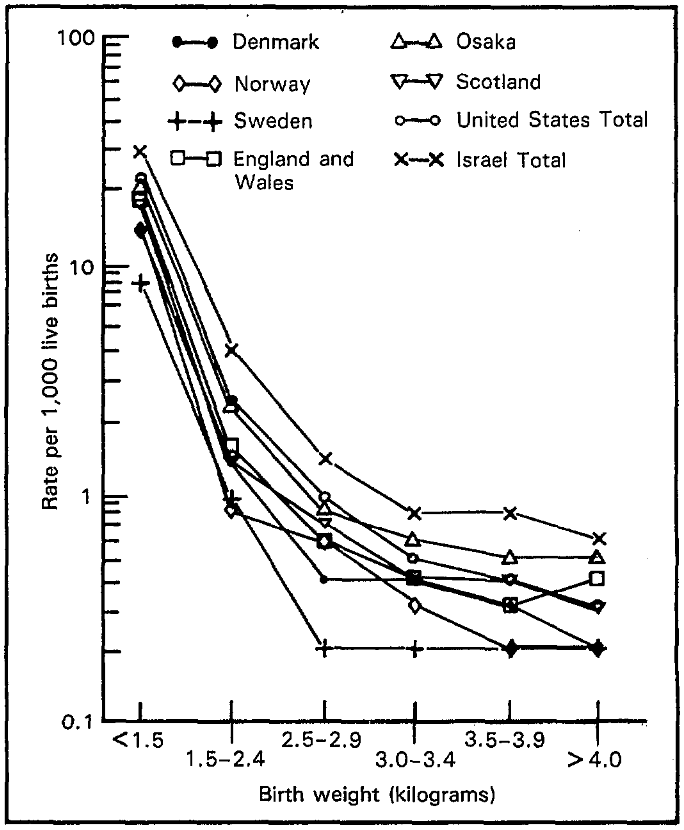


Figure 22. Post-neonatal mortality rates for deaths due to other causes, by birth weight: selected countries

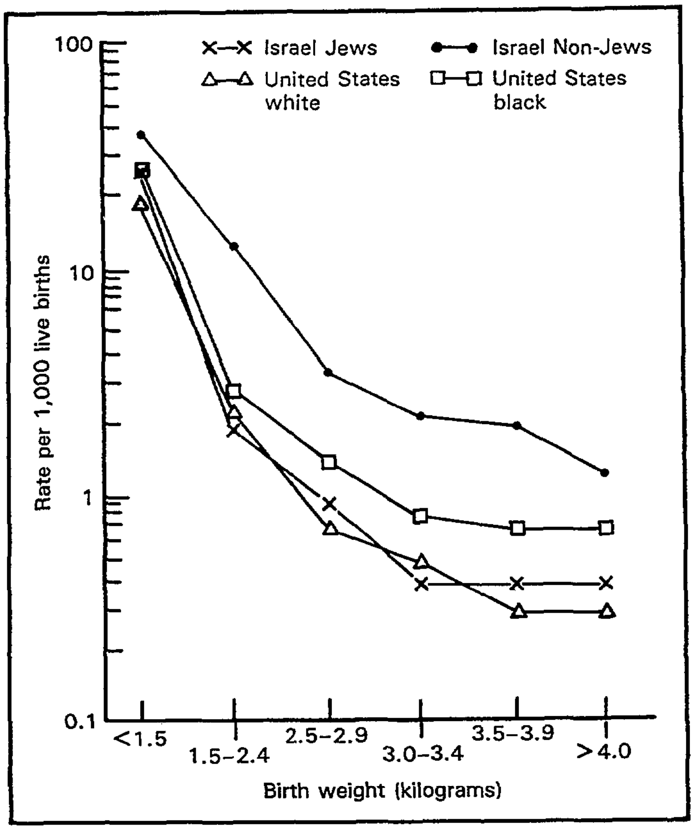


Figure 23. Post-neonatal mortality rates for deaths due to other causes, by birth weight: selected countries

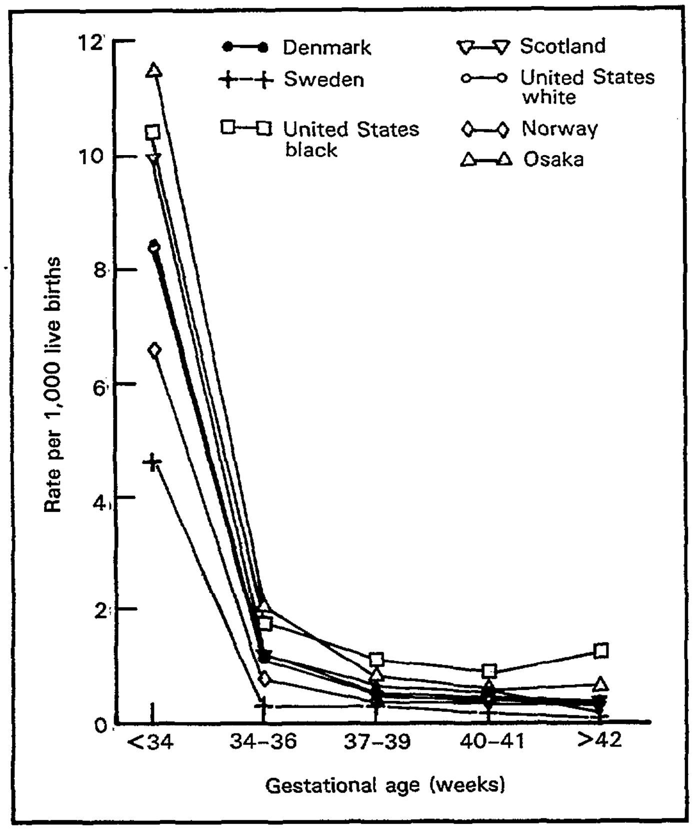


Figure 24. Post-neonatal mortality rates for deaths due to other causes, by gestational age: selected countries

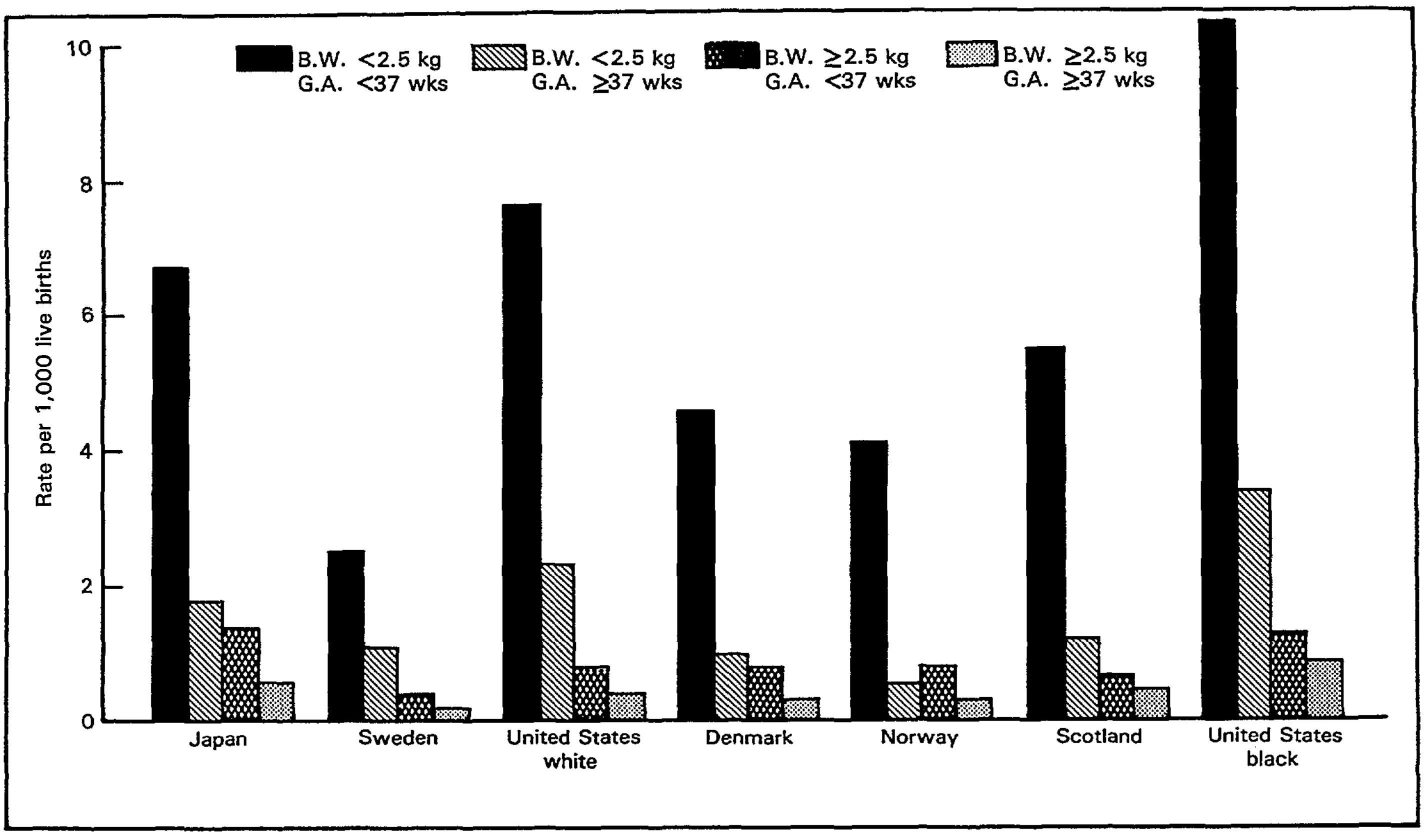


Figure 25. Post-neonatal mortality rates for deaths due to other causes: selected countries

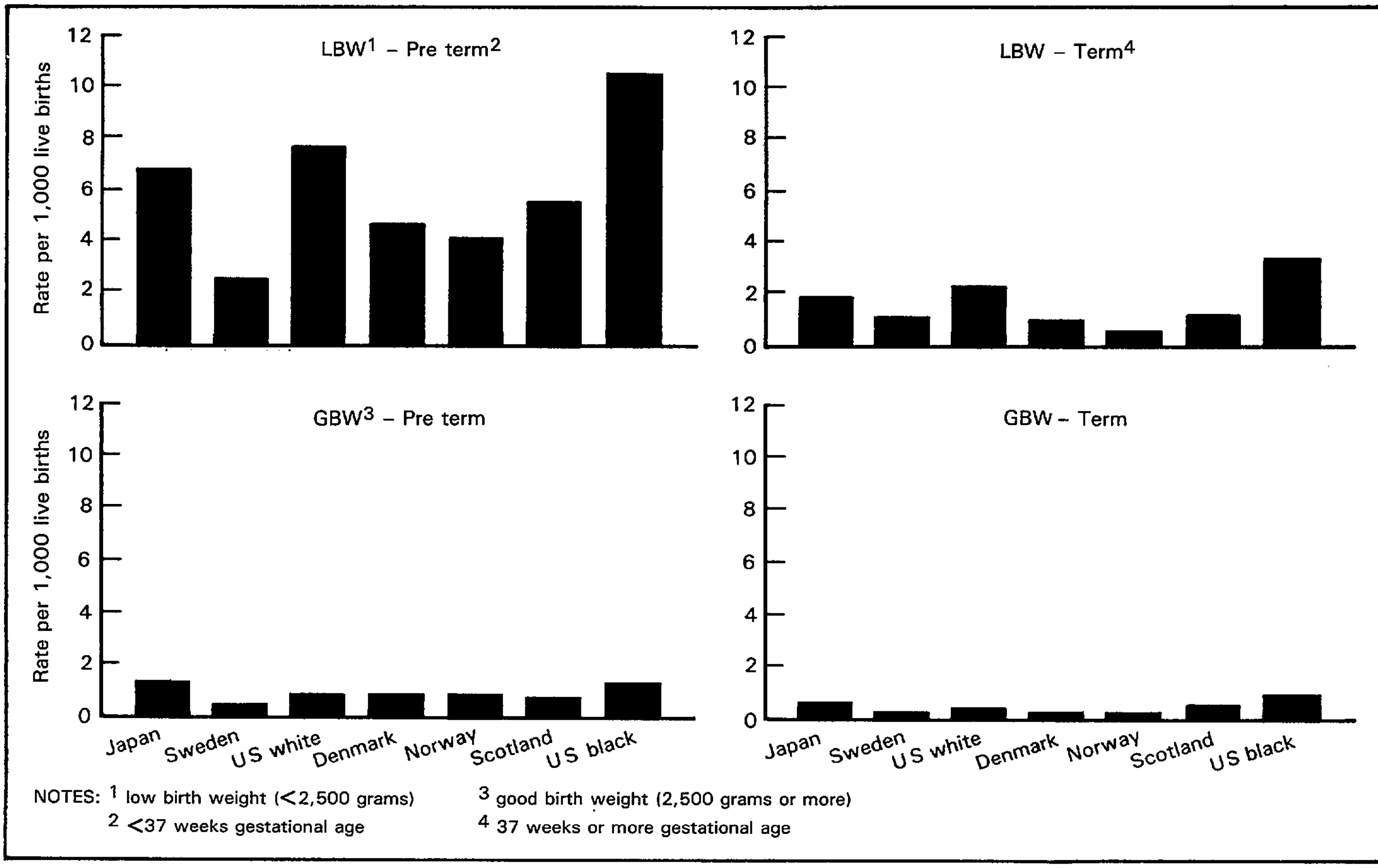


Figure 26. Post-neonatal mortality rates for deaths due to other causes: selected countries

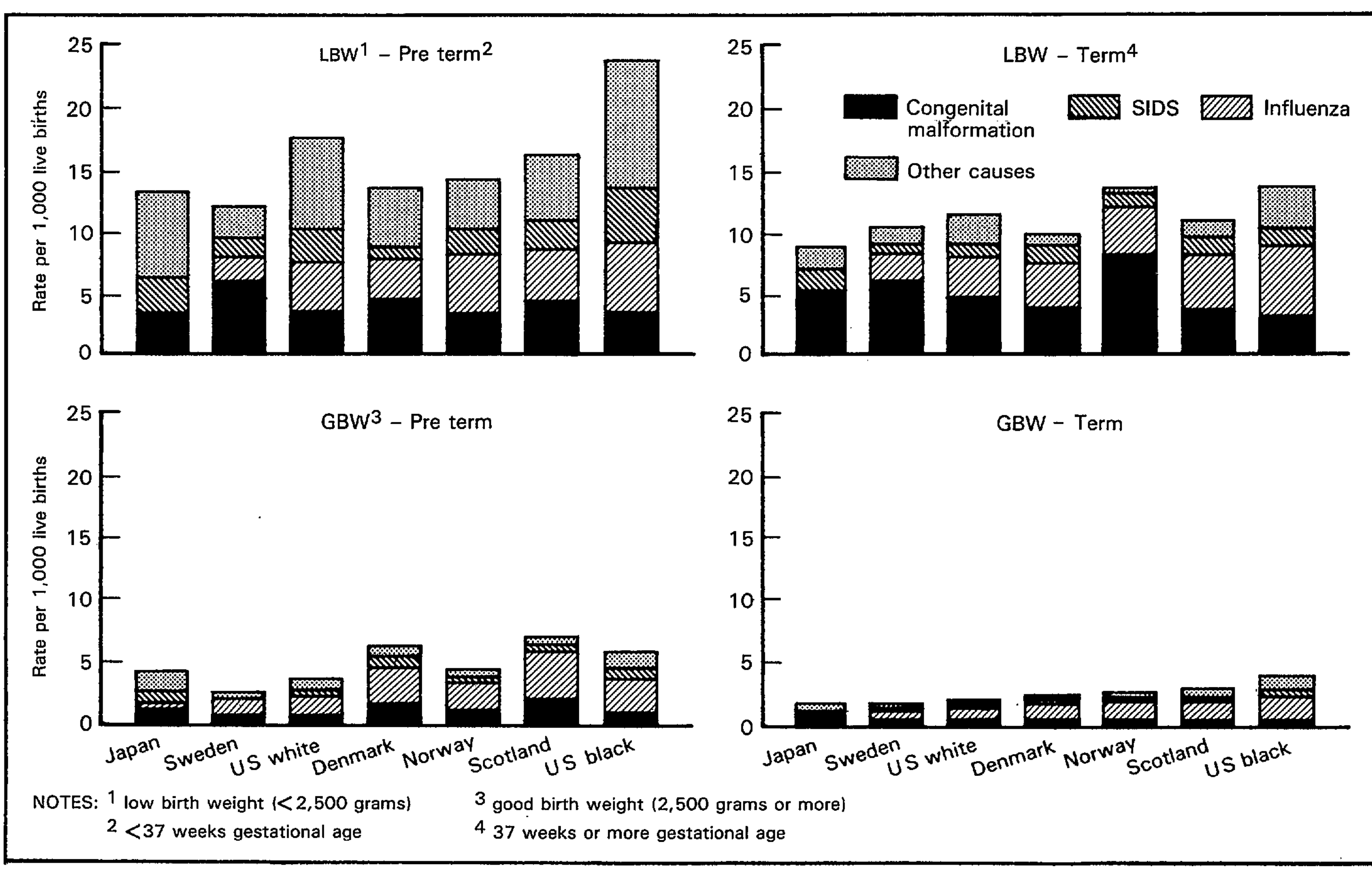


Figure 27. Post-neonatal mortality rates for deaths due to selected causes: selected countries

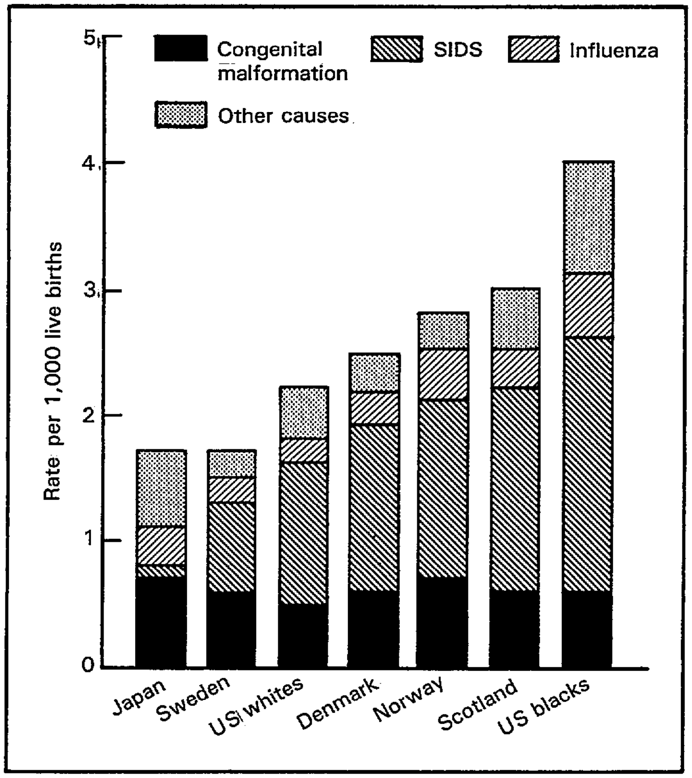


Figure 28. Post-neonatal mortality rates for deaths due to selected causes for births with birth weight over 2.5 kg and over 37 weeks of gestation: selected countries

Discussion

DR. KLEINMAN: In the United States, babies with gestation recorded as preterm who weight more than 2500 grams include a lot of mistaken gestations. This misclassification is going to have an effect on the implied risk of that group. Is this a problem? It is going to lower the risk of that group artificially, and so it is not giving a true picture of the impact of gestation on postneonatal or indeed on any of the mortality measures. Is this a problem in the other countries as well, and was there any attempt to try to omit any gestations that were obviously incompatible with the birth weight?

MS. BARELL: That is what we are going to be doing, but we were not very happy with these results. We found this a very crude grouping and are quite sure that it can be improved, both in terms of cleaning up misclassifications in that group and perhaps separating out the postterm in some of the groups where it can be seen from their curves or the very high birth weight. Basically I am presenting the methods as a way to handle all these parameters at once.

DR. HARTFORD: This is in response to Dr. Kleinman's comment. Time, unfortunately, did not permit us to purge the data. I have some fairly high detailed cross classifications of birth weight by gestation for each of the data sets, and it is clear that there is some static out there. One of the first things we want to do subsequent to the Symposium is to find a way to deal with this statistical noise or miscoding noise, but you are right. It is there.

DR. KARLBERG: I would like to briefly discuss the "light-for-date" group, the end product of slow fetal growth. Analyses of ICE data from Sweden and data from another 5-year cohort of Swedish births illustrate the importance of this factor, which we should not ignore. However, this sort of analysis requires information on births cross-classified by birth weight and gestational age and evaluated from a reference standard applicable to the actual perinatal population. (See Karlberg presentation in Workshop for further details.)

DR. HOGUE: I think that is a very important contribution. The national infant mortality surveillance project did publish birth weight and gestation-specific mortality by race and found some very similar rates. There were some corrections for implausible combinations.

When one looks at vital records, of course, it is a judgment call about what is plausible and what is not plausible. It would be very interesting to conduct case reviews of the "implausible" cases, especially small for gestational age deaths. They could be cases with congenital anomalies.

In summary, it is worth remembering that these causes of death were not chosen at random. Perinatal conditions is a composite of several causes. Congenital conditions is a composite of several causes, and SIDS may or may not define a specific cause of death. These three "causes" of death are in reality the major categories of death for infant mortality. So, focusing in on these three includes, depending on the country, upwards of one-half to two-thirds of all infant deaths.

The Case for an Extended Perinatal Mortality Rate

by Susan Cole, M.D.

The perinatal mortality rate is defined as the number of live born infants dying in the first week of life, plus the number of stillborn infants (of a gestational age of 28 weeks or over), divided by the number of live and stillbirths.

This rate is no longer adequate, as more infants are being treated successfully, but in many instances, death is only deferred and the antecedent causes of death that are found in the perinatal period are also occurring in the late neonatal and postneonatal periods. At the other end of the spectrum, about 35 percent of early neonatal deaths occur in infants born before 28 weeks gestation, when dead born fetuses are not included. I will use data collected in Scotland to illustrate that both these groups are at different ends of a continuum of perinatal mortality that should be extended to include them (1).

Scotland is a small country with a population of 5 million and about 65,000 births a year. In the mid-1980's there were about 340 stillbirths and 310 neonatal deaths a year. This small manageable number has allowed us to maintain an annual survey with the allocation of each death to one of several "maternal" factors and also to the immediate pathology causing the infant death. (Appendix I gives a brief description of the categories and definitions used.)

Table 1 shows the perinatal mortality rate in 1987 split into gestational age groups, with 37 percent of the first week deaths occurring before 28 weeks gestation.

In our survey the two sets of causes are considered, the maternal factors that led to the perinatal death, and the fetal or infant pathology involved. Well-recognized obstetrical complications are involved in only about 25 percent of the stillbirths and early neonatal deaths (table 2). Congenital anomaly in the infant accounted for 12 percent of stillbirths and 29 percent of early neonatal deaths in 1987; but in the greater proportion of infants there was no obvious clinical reason in the mother for the eventual outcome of the pregnancy. I will refer later to the actual events that occurred in relation to this large group.

The pediatric pathology associated with these deaths (table 3) shows that in most of the stillbirths no explanation could be found for the (mainly antepartum) anoxia at autopsy. For early neonatal deaths, many were associated with lethal congenital anomalies, 37 percent ran into respiratory difficulties associated with immaturity, and 11 percent were so immature that respiration could not even be established. Infection and a variety of other specific conditions were associated with 4 percent of stillbirths and 16 percent of early neonatal deaths.

Deferred deaths

Management of the neonate has improved greatly over the last 10-20 years. Many infants that previously died in the perinatal period now survive successfully, but some die from the perinatally acquired conditions after the first week in life. I believe that the majority of late neonatal deaths come under this category, and in 1987 (table 2) the percentage distribution of late neonatal deaths by obstetrical antecedents looks remarkably similar to the distribution of early neonatal deaths. Only 15 percent of late neonatal deaths were judged to have died from purely postnatally acquired conditions. I accept that the definition of perinatal mortality used in many countries (but not internationally), which includes stillbirths and all deaths in the first month of life, is valid.

Some deaths, however, are postponed beyond the neonatal period, and these are probably increasing in number (table 4). The underlying cause of death on the death certificates of infants dying after the first month of life have been grouped into functional causes, akin to the pathological causes that we use in our stillbirth and neonatal death survey, where direct allocation to similar groups are made on the basis of clinical information. The perinatally associated deaths have increased from 0.8 per 1,000 live births (22 percent) in 1986 to 1.2 (32 percent) in 1988. Because these postneonatal deaths are not included in our clinical survey, I have no information on the obstetrical antecedents, but they can be linked to hospital-based data. These data have information available on birth weight and gestational age.

Table 5 shows the gestational ages of the postneonatal deaths, and more of the perinatally related deaths (deaths associated with congenital anomaly, birth asphyxia, and immaturity) were extremely premature at birth.

The effect of adding in these deferred deaths from the late neonatal and postneonatal periods would be to increase by 12 percent the perinatal mortality rate from 8.9 to 11 per 1,000 total births.

Fetal deaths

We now turn our attention to those deaths which, in our country, do not even make it to the level of official recognition--the fetal deaths. I have to acknowledge that, again, an arbitrary decision has to be taken about how early to start counting them. WHO suggests a weight criterion of 500 grams. I feel uncomfortable about that because we have registered births and neonatal deaths currently included that would then be excluded. For the purpose of this talk, I have decided to go down to a gestational age that seems likely to include all the currently registered events--namely 20 weeks. These fetal deaths are also included in our annual national survey of deaths. Three-quarters of the fetal deaths occurred between 20-23 weeks and about one-quarter between 24-27 weeks.

Table 6 shows the obstetrical antecedents of these fetal deaths from 20-27 weeks, in comparison with those of the stillbirths plus neonatal deaths. The percentage distributions are remarkably similar.

The unexplained group, with no obvious obstetrical antecedents are, again, not dissimilar clinically in their mode of presentation (table 7).

I have tried to demonstrate the clinically obvious continuum of events around the currently restricted definition of perinatal mortality. If it was accepted that the extended rate was a valid concept, the current rates for perinatal mortality would obviously increase. As far as we, in Scotland, are concerned, the addition of late neonatal mortality would lead to an increase of 10 percent (table 8). Including the wider range that I have been discussing would increase our rates by 84 percent from 8.9 to 16.3 per 1,000, but the statistically uncomfortable hole that is currently present in our perinatal mortality statistics would be filled (table 9).

Reference

1. Whitfield CR, Smith NC, Cockburn F, Gibson AAM. Perinatally related wastage-a proposed classification of primary obstetric factors. 1986. Br J Obstet Gynaecol 93: 694-703.

Table 1. Perinatal mortality rates by gestational age, Scotland 1987

	Gestational age					Perinatal mortality rate
	20-23	24-27	28-36	37+	Not known	
Stillbirths		[ ]	2.6	2.3	[ ]	8.9
1st week deaths	0.2	1.2	1.5	0.8	0.1	

Table 2. Stillbirths and neonatal deaths--maternal antecedents: percentage distribution, Scotland 1987

		Deaths	
Cause	Still-births	1st week	2nd-4th week
		percent	
Congenital anomaly	12	29	32
Pregnancy hypertension	3	3	12
Antepartum haemorrhage		14	98
Maternal conditions	5	5	2
Other	5	9	7
Unexplained: Under 2500 gm	37	40	40
2500 gm or over	24	4	2
Postnatal cause only		[-]	15

Table 3. Perinatal mortality: pathological factors--percentage distribution, Scotland 1987

Cause	Stillbirths	1st week deaths
	percent	
Congenital anomaly	12	29
Anoxia	83	18
Lung immaturity	-	11
Hyaline membrane disease	-	26
Infection	1	4
Other	3	12

Table 4. Postneonatal deaths: rate per 1,000 live births, Scotland

Cause	1986	1987	1988
All	**3.6**	**3.8**	**3.7**
Congenital anomaly	0.6	0.8	0.8
Birth asphyxia/Immaturity	0.2	0.3	0.4
Infection	0.2	0.2	0.2
Accidents	0.2	0.2	0.1
Sudden death	2.2	2.0	2.0
Other	0.2	0.2	0.1

Table 5. Postneonatal deaths: percentage distribution, Scotland 1987

Cause	Gestational age					
	20-23	24-27	28-31	32-36	37+	Not known
	percent					
Perinatally related	-	2	4	3	21	3
Other	-	1	1	8	51	7

Table 6. Fetal (20-27 weeks) and perinatal deaths: percentage distribution, Scotland 1987

Cause	Fetal deaths	Perinatal deaths
	percent	
Congenital anomaly	14	19
Pregnancy hypertension	4	3
Antepartum haemorrhage	17	12
Maternal conditions	4	5
Other	2	6
Unexplained	60	54

Table 7. Unexplained fetal and perinatal deaths, Scotland 1987

Cause	Fetal deaths	Perinatal deaths
All unexplained	60	54
Ruptured membranes	11	6
Premature labor	27	12
Unexplained IUD	23	31
Fetal distress	-	5

Table 8. Perinatal related losses, Scotland 1987

	Percent increase	Rate per 1000
Perinatal mortality	100	8.9
+ late neonatal	110	9.8
+ perinatal-related postneonatal	124	11.0
+ fetal deaths 24-27 weeks	140	12.4
+ fetal deaths 20-23 weeks	184	16.3

Table 9. Total perinatally-related loss rates per 1000, Scotland 1987

	Gestational age					
	20-23	24-27	28-36	37+	Not known	Total
Fetal deaths	3.9	1.4				
Stillbirths	-	[ ]	2.6	2.3	[ ]	16.3
1st week deaths	0.2	1.2	1.5	0.8	0.1	
Deferred deaths	-	0.3	0.6	1.1	0.2	

Congenital Anomaly Mortality in the ICE Countries, 1976-85

by Eve Powell-Griner, Ph.D. and Albert Woolbright, Ph.D.

Unlike the other presentations at this symposium, our data are not from the ICE data set. Dr. Albert Woolbright and I use published vital statistics data to examine trends in congenital anomaly deaths for a small subset of countries. We are delighted to present our early findings here.

The data, however, should be similar to other data used in the presentations made at this conference. Our work builds on some of the excellent presentations we have heard, by comparing trends from 1976-85 in seven broad categories of congenital anomalies for the nine ICE countries.

Just as infant mortality has declined over the last few decades, declines have also occurred in congenital anomaly mortality rates. However, the decline in congenital anomaly mortality has not been as rapid as infant mortality from all causes of death combined. Therefore, in most of the countries represented, an increasing proportion of all infant deaths are attributed to congenital defects.

We are concerned about this because of the deaths themselves, and also because of the morbidity that is so often associated with congenital anomalies among surviving infants. The broad categories of anomalies that we examined involve the central nervous system (CNS), cardiovascular system, respiratory system, digestive system, urinary system, musculoskeletal, and all other. The "all other" category includes chromosomal abnormalities.

In addition, we examined anencephalus separately from other CNS defects; anencephalus is a lethal defect, and is screened for in many countries. Anencephaly may be important in understanding some of the differences across countries.

Our data involve three ICD revisions. We have made the data for the different years as comparable as possible by coding cause of death according to the Ninth ICD revision.

Figure 1 shows the rates for the nine countries. The trend lines are crossed, and it is hard to see any clear-cut pattern. However, there are clearly two groups of countries at the beginning of the period in terms of the level of infant mortality rates. Israel, Scotland, England and Wales, Germany, and the United States had infant mortality rates of 1,400 or more per 100,000 live births; Denmark, Norway, Sweden, and Japan had rates below 1,000. However, by the end of this period, the rates have converged considerably. One exception is Japan, where the relatively low mortality rates continued to decline. During the 10-year period, the infant mortality rate declined in all of the countries; specifically, rates decreased 55 percent in Denmark, 49 percent in Germany, 41 percent in Japan, 39 percent in Israel, 37 percent in Scotland, 34 percent in England and Wales, 30 percent in the United States, and 23 percent in Sweden.

Figure 2 shows the infant mortality rates due to congenital anomalies. Over the same 10-year period these rates also declined. However, they did not decline as rapidly as mortality due to all causes combined. Infant mortality from congenital anomalies decreased 13 percent in the United States, 19 percent in Denmark, 20 percent in Japan, 29 percent in England and Wales, 34 percent in Scotland, and 39 percent in Germany. As a result of this differential decline, the proportion of infant deaths due to congenital anomalies increased from 1976-85 in these nations. However, mortality rates from congenital anomalies decreased more rapidly than infant mortality from all causes in three countries: Israel, Norway, and Sweden.

Certain types of congenital anomalies have been more easily preventable than others. Figure 3 shows that infant mortality rates from congenital anomalies of the CNS have declined dramatically in Scotland and England and Wales but less so in other countries. The trend lines for the United States and Japan, which are the lower two lines on the graph, are relatively flat. However, even these two countries experienced a 50 percent decrease in mortality rates over the 10-year period.

Figure 4 shows the mortality rates from cardiovascular anomalies. These mortality rates have also decreased over the study period. However, the rate of decline has been slower than that for CNS defects. Cardiovascular anomalies account for between 38 percent and 46 percent of infant deaths attributed to congenital anomalies in the ICE countries. Thus, this particular defect is the single most important form of birth defect.

Figure 5 shows a ranking of the nine countries in terms of the proportion of infant deaths attributed to congenital anomalies in 1976. Sweden, Denmark, and Norway had the largest proportion of infant deaths due to congenital anomalies; Japan, Germany, and the United States had the smallest.

The same information for 1985, shown in Figure 6, indicates little change in terms of ranking. Japan moved from seventh to third and Israel from fourth to eighth. Sweden remained first and the United States last, in terms of the proportion of deaths due to congenital defects.

Figure 7 shows the number of deaths from all causes and the number of congenital anomaly deaths in each of the countries. These numbers are particularly important because they alert us to the variation in deaths in the nine countries. Since we have broken congenital anomalies into the seven broad categories, some of the numbers get very small. It is important to keep that in mind when looking at the series of country-specific distributions in Table 1. It is also important to remember that congenital anomaly mortality, like infant mortality in general, has declined in all of the countries over the period considered here. Table 1 reflects the shift over time in the distribution of defects by type. This table summarizes information on the percent distribution of infant deaths from the seven broad categories of congenital anomalies, in 1976 and 1985.

Germany experienced a reduction in the proportion of CNS anomalies; both anencephaly and other CNS anomalies decreased. There was a reduction in the proportion of cardiovascular anomalies. There was an increase in the proportion of deaths due to respiratory, urinary, and musculoskeletal anomalies.

For the Jewish population of Israel, the proportion of deaths from anencephaly decreased, but deaths from other CNS anomalies remained about the same. There was a slight reduction in the proportion of cardiovascular system anomalies, and increased proportion of deaths attributed to respiratory system anomalies.

Japan also experienced a reduction in the proportion of anencephaly and CNS anomaly deaths. Note the very large shift in the digestive congenital anomaly category in Japan between 1976 and 1985. The proportion of cardiovascular anomalies remained relatively unchanged during the period. There was an increase in the proportion of deaths from respiratory and musculoskeletal anomalies.

Norway experienced a reduction in CNS anomaly deaths (including anencephaly), in cardiovascular system anomalies, and the digestive system anomalies. There was some increase in the proportion of infant deaths due to urinary system anomalies.

Scotland had a large reduction in the percent of deaths attributed to CNS anomalies, including anencephaly. There was an increase in the proportion of deaths involving respiratory and chromosomal anomalies.

Sweden experienced a reduction in the proportion of deaths from CNS anomalies, including anencephaly. There was an increase in the proportion of deaths due to cardiovascular, respiratory, musculoskeletal, and chromosomal anomalies.

Denmark had a slight increase in CNS anomaly deaths and no change in anencephaly. However, Denmark's numbers are very small and the percentages shown here may reflect yearly fluctuations more than true changes over time. There was a slight decrease in the proportion of cardiovascular system deaths and those attributed to other anomalies. The proportion of deaths due to respiratory and musculoskeletal anomalies increased in Denmark.

In England and Wales, a considerable reduction in the proportion of deaths attributable to CNS defects occurred between 1976-85, including decreases in anencephaly. Increases occurred in the proportion of infant deaths due to cardiovascular, respiratory and musculoskeletal anomalies.

The United States experienced a reduction in the proportion of deaths from CNS anomalies, although the reduction primarily involved conditions other than anencephaly. The proportion of deaths due to anencephaly fell from 9.1 percent in 1976 to 8.1 percent in 1985. There was an increase in the proportion of infant deaths due to respiratory, musculoskeletal, and chromosomal anomalies in the United States.

The data in Table 1 may be summarized as follows:

1. Heart defects are the most important of the anomalies, accounting for one-third to one-half of all infant deaths from anomalies.

2. Most countries have had a reduction in the proportion of congenital heart disease deaths. However, Scotland, Sweden, England and Wales, and the United States experienced an increase.

3. Aside from the residual category of chromosomal and other conditions, the category "central nervous system defects" was the second largest category of defects. All countries other than Israel and Denmark experienced a reduction in the proportion of CNS defects.

4. The proportion of congenital anomaly deaths due to anencephaly decreased markedly in most countries. The United States showed a modest decrease from 9.2 percent to 8.1 percent and Denmark showed no change. However, as mentioned earlier, Denmark's numbers were very small.

5. In all countries except Denmark, the proportion of infant deaths due to respiratory defects has increased markedly, ranging from 4 percent to 13 percent.

6. The proportion of congenital anomalies due to musculoskeletal defects has increased in each nation and ranged from 5 percent to 11 percent of the deaths in 1985.

7. On the other hand, the proportion of infant deaths due to birth defects of the digestive system has been at least halved in most of the countries. Only Denmark experienced a larger proportion of deaths attributed to this type of anomaly in 1985 than in 1976.

8. The proportion of defects due to urinary system anomalies decreased in about one-half of the countries.

9. Most countries had an increase in the proportion of deaths classified as chromosomal and other anomalies. This category typically accounted for about one-fourth of all anomalies.

Longer term trends

Figure 8 shows the changes in deaths from CNS defects from 1964-85 for England and Wales and the United States. These two ICE countries have the largest number of deaths and, therefore, the largest number of congenital anomalies.

The British Isles have traditionally had some of the highest rates of CNS defects. In 1964, the rate for England and Wales was much higher than the United States. As the figure shows, the rate declined steadily in the United States but rose rapidly between 1969-74 in England and Wales. After 1974, the rate in England began to fall sharply. During 1984-85 there was only a slight difference between the two countries in the infant mortality rate due to CNS congenital anomalies.

Figure 9 shows data for cardiovascular anomalies. Trends in the infant mortality rate due to congenital anomalies of the cardiovascular system show a somewhat different pattern. Since 1968, the rate for the United States has declined steadily while the rate for England and Wales fluctuated.

Between 1966-73 the gap between the countries increased due to a lack of decline in rates for England and Wales and a steady decrease in mortality rates from this type of anomaly in the United States. By 1974 this gap had virtually disappeared. During the late 1970's and early 1980's, the rate of decline slowed in both countries, and the English and Welsh rate remained somewhat higher than in the United States.

Summary

Our early work indicates that between 1976-85, infant mortality rates declined in all the countries included here. Although declines in infant mortality due to congenital anomalies also occurred during this period, the reductions for most of the countries were not as great as for all causes combined. As a result of this differential rate of decline, the proportion of infant deaths due to anomalies increased in six of the countries, while that of Sweden, Norway, and Israel decreased.

In each of the countries examined, one-fifth to one-third of all infant deaths were due to congenital anomalies. This level suggests that substantial reductions in infant loss in the future may depend upon reducing the incidence of birth defects and finding new means of helping affected infants survive.

Analysis of the trend of mortality from congenital anomalies of the CNS indicated that deaths from this cause declined dramatically in all countries except the United States. The very slow rate of decline in deaths attributed to anencephaly in the United States compared with that in other nations is one factor in the widening gap in infant mortality rates between the United States and the European countries. Largely due to wide-scale routine screening practices, births of infants with this lethal congenital anomaly have largely been prevented through selective abortion in many of the European countries.

Although we focused on the decreases in infant mortality that may be due to increased prenatal screening and use of selective abortion, decreases in mortality from congenital defects may arise from other factors as well, including true declines in the incidence of congenital anomalies, changes in reporting of congenital anomalies over time, or variations in the classification or registration of fetal deaths and live births.

There is evidence that the true incidence of some CNS anomalies has declined over time. For example, Leck and Rogers showed that the prevalence of neural tube defects in Northern Ireland, the United States, Australia, and England and Wales seemed to have declined (1).

Similarly, Carstairs and Cole indicated that anencephaly and spina bifida have become less common in Scotland (2). Authors of both these studies suggested that the decline is due both to increased screening and to a decrease in the true incidence of these defects.

Changes in reporting congenital anomalies over time or between countries could also affect the changes in infant mortality rates noted here.

Improvements in identification of congenital anomalies as a cause of infant death arising from changes in diagnostic techniques or the increased use of autopsy could increase the number of deaths attributed to congenital anomalies, and thereby increase the infant mortality rates from this cause, even though the prevalence of congenital anomalies remain unchanged or even decreased.

In addition, variation in classification or registration practices of fetal deaths and live births between countries or over time could also affect the infant mortality rates for this cause.

Increasing numbers of congenital anomaly deaths might be one result of improved identification of anomalies as a cause of death or of changes in classification or registration practices. Such changes could result in changes in the number of infant deaths in the numerator and the numbers of births in the denominator of the infant mortality rate. However, since the numerator is disproportionately affected compared with the denominator the mortality rates can fluctuate considerably, even though other measures--such as the proportion of live births with congenital anomalies--might remain relatively stable.

The current work that we are engaged in cannot substantially address these issues of reporting and secular change, but we do think that such issues must be kept in mind whenever we are doing comparisons either between countries or over time.

The comparison of infant mortality due to congenital defects that we have begun here suggests that some of the differences are due to screening and that probably some are due to differences in diagnosis and coding of the defects.

One of the major improvements that could be made in all of our countries is the establishment of registries for congenital defects. Currently, the United States does not have a national registry, although there are some smaller area registries. Better data are needed if we are to understand what is happening in this particular area of infant mortality. Our need for better data may also require an increase in the number of autopsied infant deaths. As you know, the United States currently does not code cause of fetal death. However, in the near future, cause of fetal death will be added to the vital statistics files. This additional information will be very useful in studying the impact of congenital anomalies on fetal and infant mortality.

References

1. Leck I and Rogers SC. 1967. Changes in the incidence of anencephalus. Br J Preventive Soc Med 21:177-80.

2. Carstairs V and Cole S. Spina bifida and anencephaly in Scotland. Br Med J 289:1182-84. 1984.

Table 1. Percent distribution of infant deaths from congenital anomalies, ICE countries, 1976 and 1985

Country	Year	Anence-phaly	Other CNS	Cardio-vascular	Respira-tory	Diges-tive	Urinary	Musculo-skeletal	Chromo-somal; Other
Germany	1976	4.4	15.1	44.9	2.2	7.5	1.5	4.2	20.2
	1985	1.5	12.7	40.9	4.4	4.0	6.1	8.7	21.7
Israel-Jewish	1976	5.1	10.1	39.7	4.8	7.2	3.3	3.0	26.9
	1985	2.7	14.2	37.7	8.2	3.3	2.7	4.9	26.2
Japan	1976	2.1	6.7	57.9	1.7	17.7	0.9	3.8	9.2
	1985	1.7	5.0	57.0	5.5	6.3	1.2	7.0	16.3
Norway	1976	2.4	18.6	45.5	3.0	8.4	4.2	5.4	12.6
	1985	0.0	12.3	40.2	4.1	3.3	18.9	7.4	13.9
Scotland	1976	5.0	27.7	33.1	2.9	7.4	3.7	6.2	14.0
	1985	1.8	13.3	38.8	9.1	5.5	3.6	7.9	20.0
Sweden	1976	4.1	12.8	36.1	2.7	8.4	8.1	7.8	19.9
	1985	0.9	6.9	40.9	8.2	3.9	6.0	11.2	22.0
Denmark	1976	2.9	14.4	54.1	2.9	7.2	2.9	8.1	7.7
	1985	2.9	15.1	46.0	2.9	8.6	8.6	8.6	7.2
England & Wales	1976	4.6	30.1	35.6	4.2	5.6	4.8	2.7	12.4
	1985	1.5	15.7	40.0	10.1	4.8	5.0	6.5	16.4
United States	1976	9.2	11.7	42.4	10.1	3.4	3.5	3.2	16.6
	1985	8.1	6.6	38.2	12.8	1.8	5.9	7.5	19.1

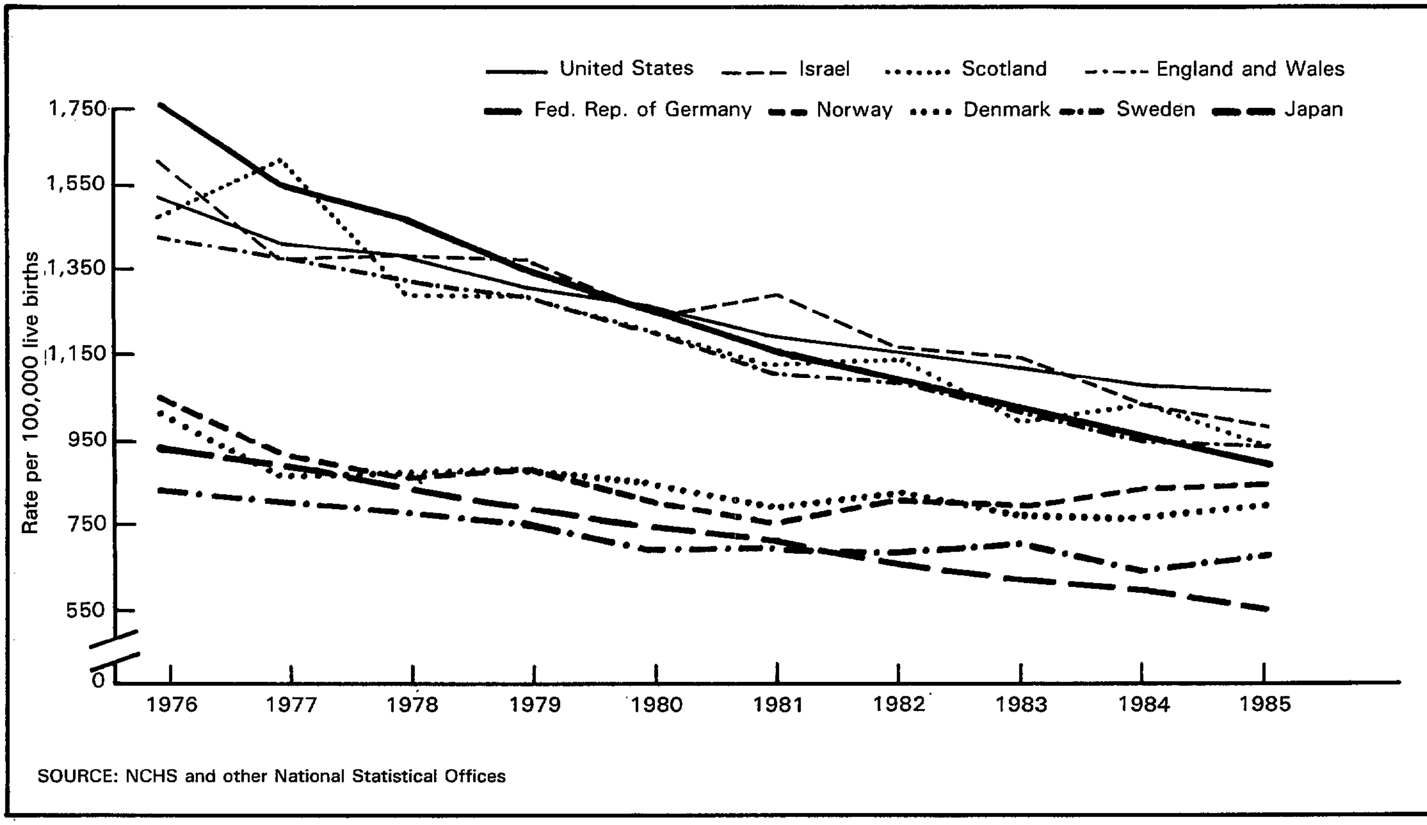


Figure 1. Infant mortality: ICE countries, 1976–85

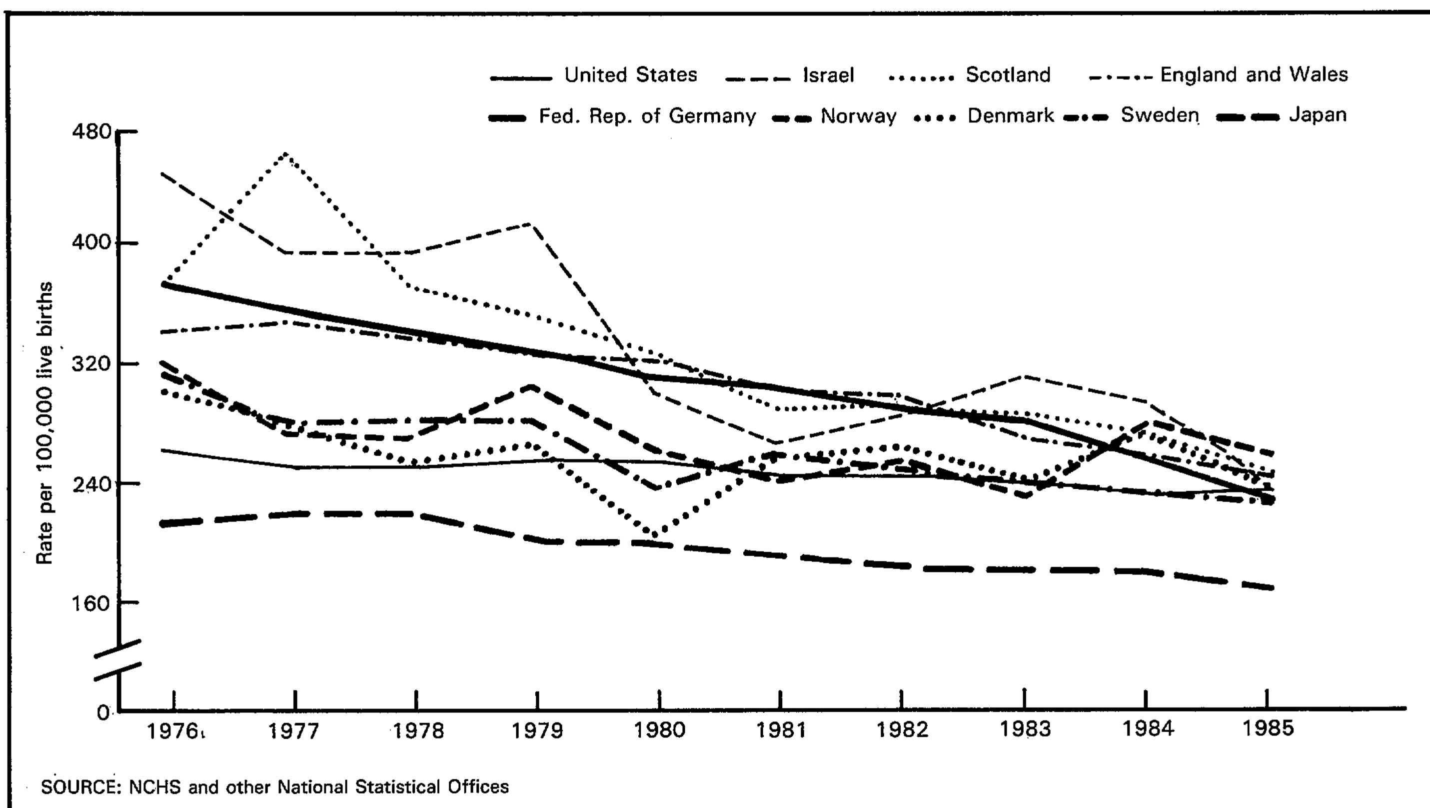


Figure 2. Infant mortality due to congenital anomalies: ICE countries, 1976–85

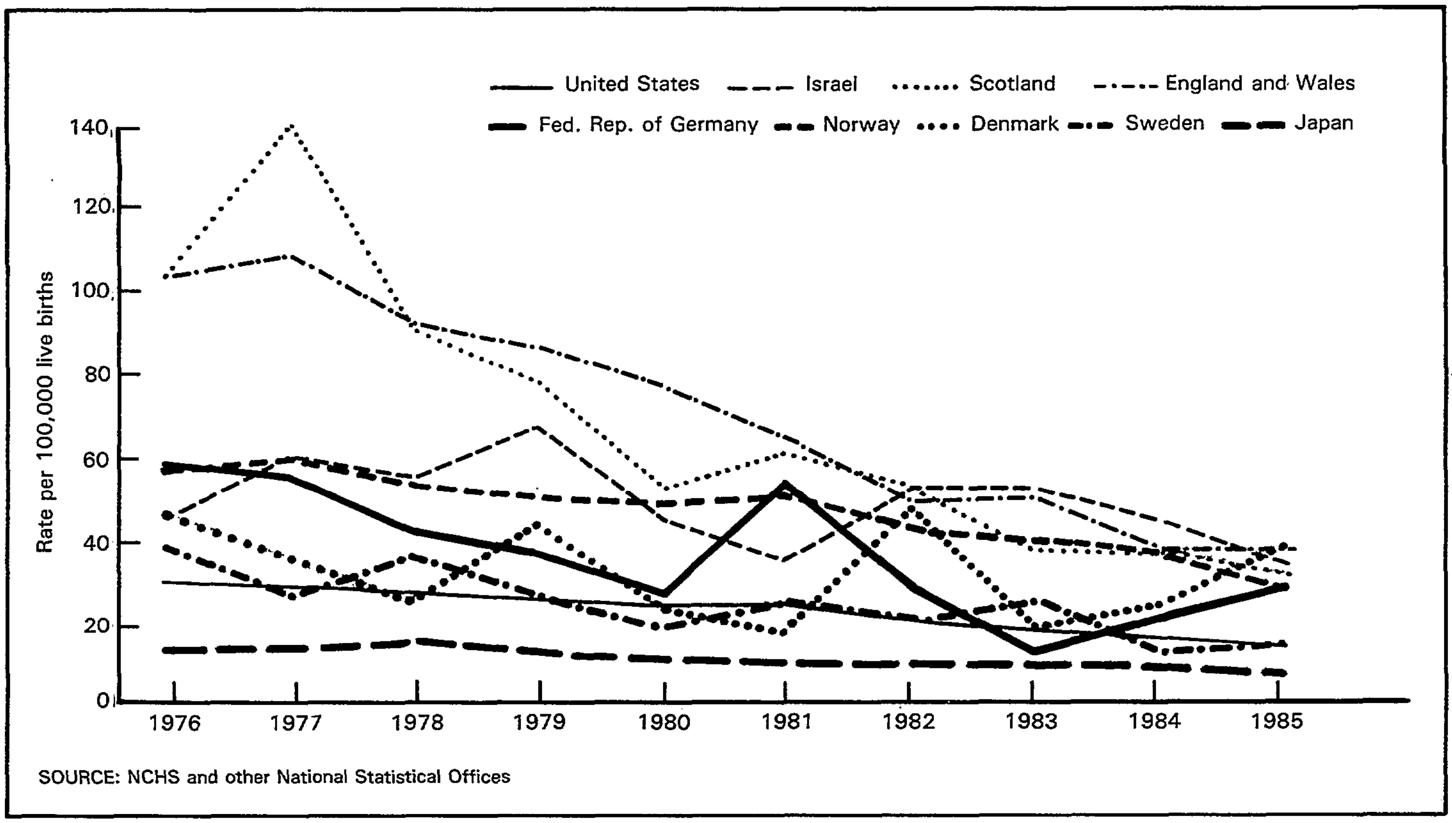


Figure 3. Infant mortality due to CNS anomalies: ICE countries, 1976–85

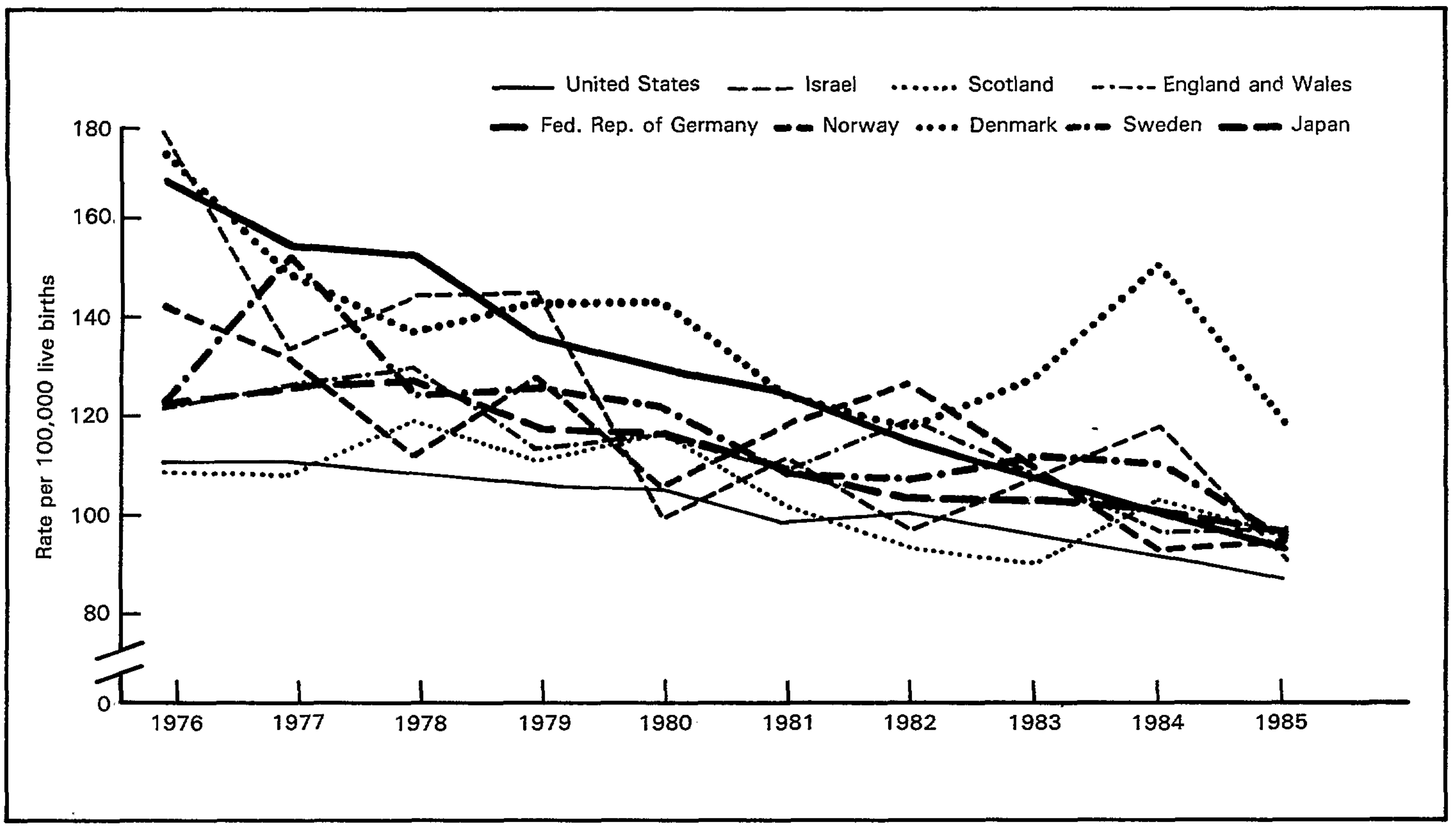


Figure 4. Infant mortality due to cardiovascular anomalies: ICE countries, 1976–85

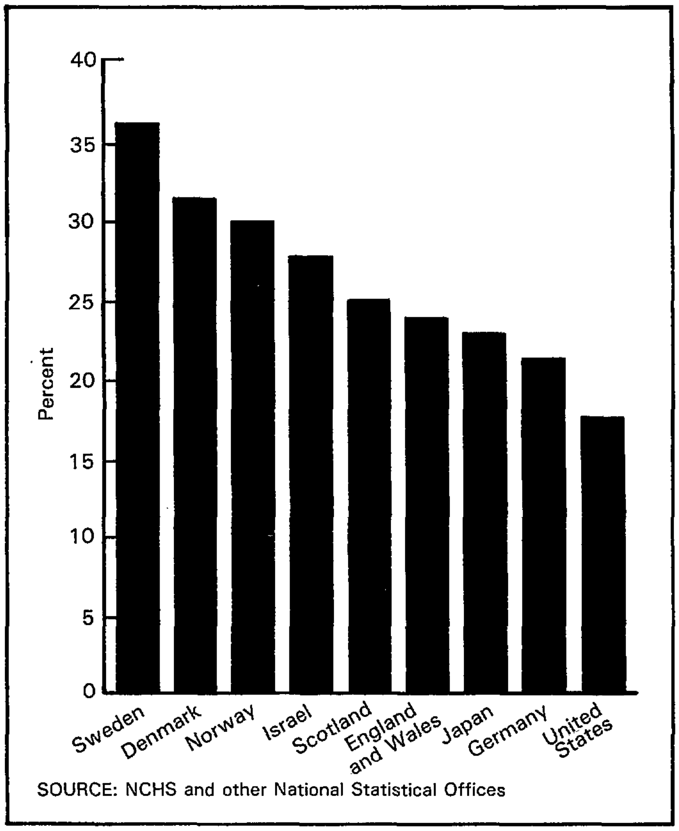


Figure 5. Percent of infant deaths due to congenital anomalies: ICE countries, 1976

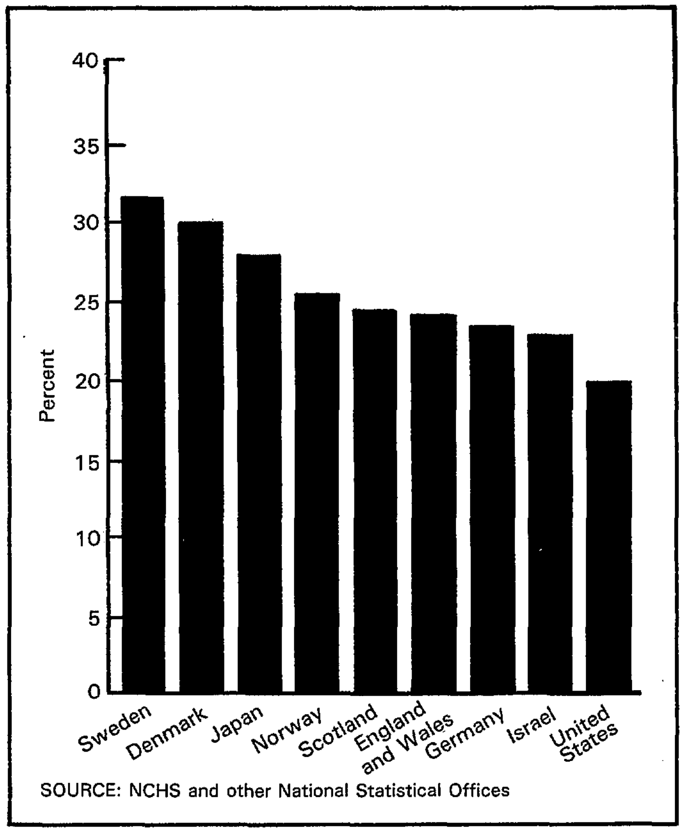


Figure 6. Percent of infant deaths due to congenital anomalies: ICE countries, 1985

	All causes		Congenital anomalies		Percent congenital anomalies	
	1976	1985	1976	1985	1976	1985
United States	48,265	40,030	8,295	8,561	17.2	21.4
England & Wales	8,334	6,141	1,995	1,600	23.9	26.1
Scotland	959	624	242	165	25.2	26.4
Sweden	818	666	296	232	36.2	34.8
Norway	561	434	167	122	29.8	28.1
Denmark	662	427	209	139	31.6	33.6
Fed. R. Germany	10,506	5,244	2,253	1,341	21.4	25.6
Israel	1,207	740	335	183	27.7	24.7
Japan	17,105	7,899	3,891	2,414	22.8	30.6

Figure 7. Number of infant deaths for all causes, congenital anomalies, and percent of infant deaths due to congenital anomalies: ICE countries, 1976 and 1985

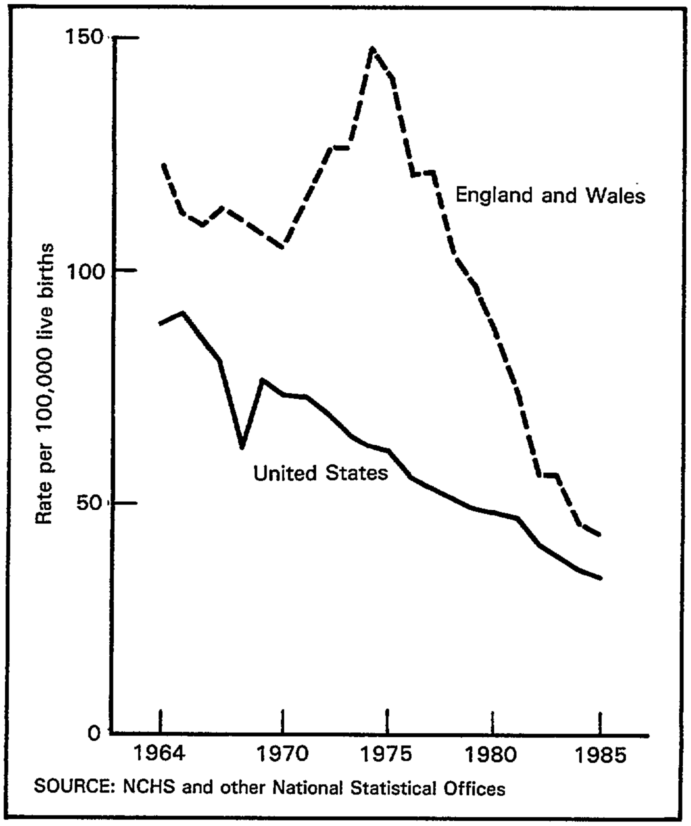


Figure 8. Infant mortality due to central nervous system defects

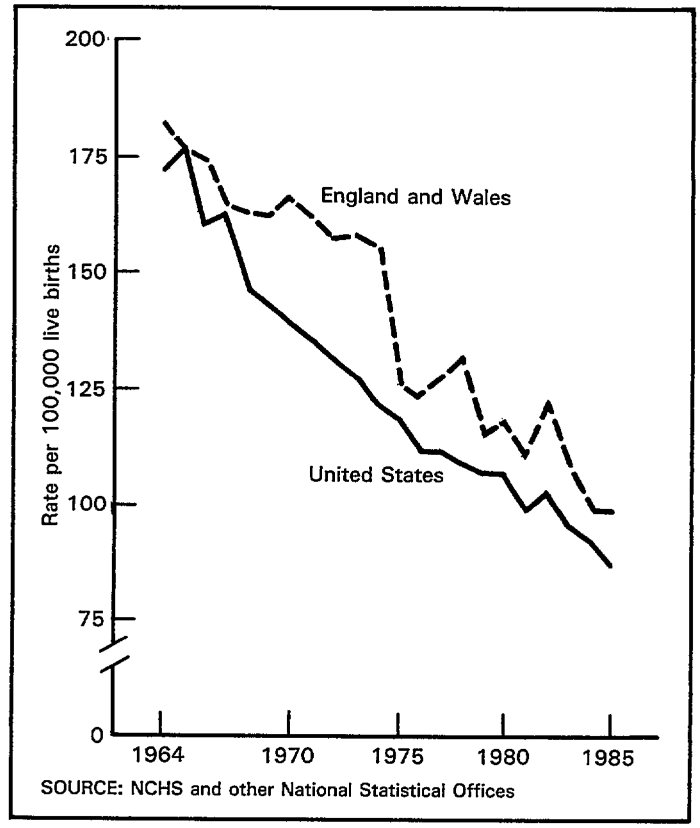


Figure 9. Infant mortality due to cardiovascular system defects

Discussion

DR. HOGUE: Thank you. I would underline the need for incidence data among live births, as well as cause of death for fetal deaths. For example, in the United States the death rate due to congenital anomalies is the same between blacks and whites, but we do not know whether incidence rates for black and white infants are the same or whether incidence rates differ inversely with death-to-case rates, making death rates similar. This question cannot be answered without birth defects registries.
We have a number of questions.

DR. BERGSJØ: I did not hear you mention changing distribution of maternal age as one possible confounder or contributory cause to the decline in congenital defects, and that is one cause you could control in the analysis.

DR. POWELL-GRINER: Yes. What we have done so far is simply take a first look at what has happened over time. We are aware of the relationship between certain demographic factors and congenital anomalies. Some of the papers presented have clearly demonstrated the relationship between selected factors and perinatal outcome. For example, the relationship between birth weight, gestation, and congenital anomalies was mentioned. As we continue our work with this project, we will statistically control some of the demographic factors that may affect outcome. Maternal age is certainly one such factor.

DR. KRISTENSEN: I would like to comment a little on this paper. In your final remarks you referred to autopsy rates and to changing coding practices, and in the Danish case we saw that there was a relatively high proportion of cardiovascular system anomalies and respiratory system anomalies.

In Denmark, about 80 percent of fetal deaths and infant deaths have an autopsy and in none of the Danish counties is the rate of autopsy less than 60 percent. This means that the chance of finding anomalies of these specific kinds is relatively high.

Another thing that may influence the results is that the coding practices in some countries, as in Denmark some years ago, are very much influenced by coding practices of adult deaths. So, when you have autopsy findings like persisting ductus arteriosus in very low gestation babies, this may sometimes lead to assigning congenital malformation as the underlying cause of death rather than something associated with extreme preterm birth. So, in fact, I am able to confirm that things like this do have influence.

DR. POWELL-GRINER: Your point is well taken. In the United States we have a very, very low autopsy rate. One result of this, in terms of infant mortality, is that we generally identify only the most obvious of the birth defects--those that are clearly evident at death--and we obviously are missing many deaths involving more subtle anomalies or other less proximate causes.

DR. COLE: I have a similar duty to Dr. Kristensen in that I will look at problem death certificates for coding. I have become aware since doing this that when pulmonary hyperplasia, which might fall into your respiratory category, is written--even when it is written down in association with immaturity or prematurity--the coding rules in ICD say, "Ignore prematurity and take the more specific cause." However, if you go to pulmonary hyperplasia, it takes you straight into the congenital chapter, and I am very concerned about the artifact that raises. Similarly with prolonged rupture of membranes: when you get pulmonary hyperplasia there, it requires movement into the congenital defects chapter. I would be very interested to tease out the nature of your respiratory category because I think it might be quite a dirty one.

DR. LYNBERG: I am from the Division of Birth Defects at the Centers for Disease Control, and we were concerned about that misclassification as well. So we looked at just the mortality data for 1986, and then using the linked 1983 birth and death tape, we looked at not just PDA's but lung hyperplasia and interventricular hemorrhage, which lead to hydrocephalus. In only 350 babies were any of those causes listed as the underlying cause out of about 35,000 deaths.

Now there were more babies that had one of those conditions listed as a birth defect, but they were not listed as the underlying cause. So those cases had really very little impact on the total number of birth defects, particularly respiratory defects. I know that does not apply necessarily to other countries, but in this data set it really had a very low influence.

DR. POWELL-GRINER: That is very interesting to know. However, I think Dr. Cole is saying that when you are moving across the ICD revisions it becomes more problematical. Now, we did look at the comparability ratios for congenital malformations as a whole. The comparability ratio between the eighth and the ninth revisions was .99 for the United States. England and Wales also double-coded some deaths in 1978, and the comparability ratio there was .97. So the comparability ratios suggest that slightly fewer deaths would have been coded as congenital anomalies in the ninth than in the eighth revision. Unfortunately, we do not have any information on the specific anomalies. The respiratory category may be one category where the comparability ratio, could you obtain it, would be much different from what you see overall. The fact that we have seen these increases in almost all of the countries lends some support to this idea.

MS. BARELL: I am a little bit concerned about presentation of CNS abnormalities in infant mortality without taking into consideration fetal deaths. A very high proportion of CNS abnormalities are actually fetal deaths and either using a feto-infant mortality ratio or a perinatal mortality would be much, much better. For the same reason actually I think that it is misleading to use proportional mortality here. I think that some kind of representation of the relative position of the rates within each country over time would have been better, perhaps somewhat more informative.

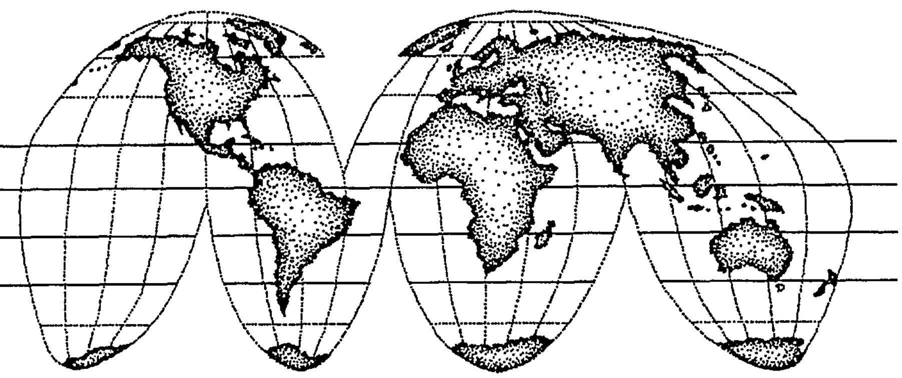
DR. POWELL-GRINER: I think that you are absolutely correct, that both of those are preferable. However, in terms of including the fetal deaths, not all countries have information on cause of fetal death and it is particularly difficult to locate cross-national data on specific types of congenital anomalies. We would prefer to use mortality rates but we do not have reliable data on congenital anomalies among live births.

We certainly recognize your point. What we have done is not the most desirable thing to do if you have better data than what we have to work with. I think some countries do, and I think that they can move beyond what our preliminary cross-national work has done. It may be that some of these issues can be addressed in individual countries through using the ICE data set. It may be possible as well to consider a subset of countries and look at this more closely.

MS. MACFARLANE: I have seen the rise and then fall in mortality or incidence of CNS malformations in England and Wales referred to as being part of a longer term cyclical variation. I was interested to see that it was not--there was no evidence of it in the United States data presented. Was there any evidence of it in data for other countries in which it may have been less clear but perhaps still apparent?

DR. POWELL-GRINER: Albert, do you want to address that?

DR. WOOLBRIGHT: We did not have data for a long-term trend for any other countries except England, Wales, and the United States. For the other countries we just had scattered volumes and years, and we had to piece them together. Bob Hartford had to call various people in the ICE countries to get volumes for us so we could fill in all the years from 1976 to 1985, and we just could not take it back any farther than that.



Infant Survival and Preventable Mortality

Survival of Infants of Very Low Birth Weight

by Eva Alberman, M.D., Eberhard Schmidt, M.D.,
and Stephen Evans, M.Sc.

Introduction

Births of very low birth weight, below 1500 grams, are of major importance in terms of the resources required for their care in the neonatal period, the large contribution they make to early deaths, and most of all in terms of their increased risk of long-term disability. Their risk of death and morbidity is closely related to their weight and gestational age, rising sharply as birth weight falls.

International comparisons are of considerable value in identifying differences in the incidence of such births and differences in outcome. Differences in incidence may be due to genetic factors or to environmental factors, or most commonly to both. Differences in outcome will depend on the extent to which the birthweight group represents a pathological deviation from the norm for that population, as well as the quality of care given to the infant.

However, comparative studies at the lowest end of the weight and gestational age scale present particular methodological problems. Environmental improvements as well as developments of medical care may have the effect of shifting mortality from early to later in pregnancy, converting what might have been an early to a late fetal loss. Intrapartum care may convert what might have been a stillbirth to a live birth, albeit at high risk of an early neonatal death, often at gestational ages that up to recently had been regarded as pre-viable.

Similarly, medical advances have made it possible to delay the time of death of currently nonviable extremely immature infants from early in the neonatal period to later in the first year. National registration and certification practices have rarely kept pace with these developments and moreover have always differed from country to country, making comparisons difficult, particularly at the lower end of the maturity scale.

It is the purpose of this paper to describe the information relating to the survival of births of less than 1500 grams in the ICE data set, drawing particular attention to methodological problems, but also pointing out what seem to be real similarities and differences in survival between the countries involved. Data from England and Wales will be drawn upon for some of the more detailed analysis.

Background to information available

The information for this paper has been collected largely by the national statistical departments of the countries participating in this second ICE meeting, with the exception of subnational data sets provided by participants from Osaka in Japan and the Bundesrepublic of North Rhine-Westphalia and Baden in the Federal Republic of Germany.

The information requested was a breakdown by year and for singleton and multiple births, of live births, stillbirths and for the same birth cohort, infant deaths, by age and cause of death in 100 gram birthweight groups, and where available by gestational groups. For reasons of time singleton and multiple births are largely not considered separately, although they clearly present different problems.

Methodological problems

The major methodological problems that will be discussed include the effects on statistics concerning low birth weight of the definitions of viability, and therefore requirements for registration used in different places; the effects of having any data on gestational age, and less than complete data on birth weight and/or gestational age; the care with which distinctions are made between birth cohort and death data; and related to all these the importance of the choice of numerator and denominator.

Figure 1 compares, for the ICE countries for the periods 1982 to 1984, the incidence of births between 500 and 1499 grams for live births only, for all live and stillbirths, and for all live and stillbirths said to be of 28 weeks gestational age or over. The findings are as one might expect, with an increase from the ratio found in live births, to that found in total births after exclusion of those known to have had a gestational age of less than 28 weeks, to that found in total births without any exclusion. Taking the live birth ratio, or that in the restricted total births, the ratios in the countries lie in the order one has come to expect, with Osaka having the lowest proportion and U.S. blacks the highest. However, if one considers the ratio in the unconstricted total births, the rate in Osaka is second highest being eclipsed only by that in U.S. blacks.

It is in the countries that include for registration purposes births with gestational ages below 28, or indeed below 20 weeks (Japan, Norway, United States), that the difference between the live birth and total birth rates is the largest, even when, as here, the lowest birth weight considered is 500 grams. This is a theoretical issue of no practical importance, but it may be that the requirement to register extremely immature births actually influences the proportion of immature births considered to be live births.

This suggestion is supported by the data shown in figure 2, which compares the percent of all births reported to be of less than 500 grams in the different groups and countries. It is particularly in the United States, with a high proportion of low weight births, that substantial numbers of live births under 500 grams are reported. Indeed in this data set for the period 1982-84, live births of under 500 grams accounted for as many as 18 percent of infant deaths in U.S. black babies and 10 percent in U.S. white babies. In all other countries in the data set such births accounted for 2 percent or less of infant death.

Figure 3 illustrates the infant mortality rate in babies of less than 500 grams and between 500 and 1499 grams. Although the rates of the former group are very high, there is considerably more variation among these rates than in the latter group. In particular the relatively low mortality of those under 500 grams in Sweden, although the numbers are small, raises the question of the validity of this classification in all cases. It will be shown that in some countries the mortality of this lowest weight group is actually slightly less than that of the next 100 gram weight groups, suggesting that they included some misclassified cases. This cannot explain the numbers in the United States of this weight whose mortality levels are extremely high.

A group that may be numerically more important is that of births of unknown birth weight, particularly in countries where gestational age is not collected. Figure 4 shows that this group is particularly common in Sweden, England and Wales, and Israel. In North Rhine-Westphalia, as you have heard, it is true largely of infant deaths, not separately illustrated here. The size and characteristics of this group will be governed by the way in which birth weight is collected, whether it is an integral part of registration or collected separately, and how thorough are the attempts to obtain the information. The importance of the group is clearly illustrated by their extremely high mortality (figure 5). This is least in the countries where the groups are largest, and probably less biased by outcome, but even in England and Wales their infant mortality in the years under consideration was at a level otherwise seen in babies of about 1500 grams.

Almost certainly they include a substantial proportion of babies of low birth weight, who are therefore not counted in the appropriate groups. In England and Wales, as this group decreased in size those known to have been of low birth weight increased, and this may have a variable effect on birthweight-specific mortality rates. In North Rhine-Westphalia the group of unknown birth weight had a mortality rate of well over 1,000 per 1,000 live births. In this state the cohort was probably a death and not birth cohort so that true linkage between birth and death registrations was not achieved, and those of unknown birth weight were largely infant deaths.

Despite these problems, which particularly affect the lower tail of the birthweight distribution, it was clear that there are sensible comparisons among low weight births that could legitimately be made within the data set.

Comparative incidence and trends of births under 1500 grams

There are clear differences between the countries, which are unlikely to be explained by methodological problems. Figure 6 shows in more detail some of the differences in incidence that have been commented on. These diagrams, showing the cumulative incidence of the low weight births in 100 gram groups, again illustrate the high levels found in the United States at the lowest end of the scale, in white as well as black babies, when compared with Osaka and even England and Wales. I have indicated that this may be an effect secondary to registration practices, but the striking and well-known overall differences between the countries are almost certainly real.

Most intriguing are the suggestions of small increases over the years of the incidence of these high risk groups, particularly in England and Wales and in U.S. blacks, but evident in the other countries also. This may be a further example of the effect of heightening awareness of the very low birth weight, but whatever the reason the practical effects are considerable since many of these babies will require intensive care.

In England and Wales good data are now available from 1983 to 1987, when the proportion of unknown weight has been reduced to well under 1 percent and remains constant (figure 7). This shows that the increase of the numbers of these small babies has continued, partly because of an increase in the overall birth rate and partly because of the increased incidence of these births. Because of a simultaneous fall in mortality, the effect has been reflected in an increase of survivors, not of stillbirths or infant deaths. However, it must be remembered that particularly at the lowest weights we are still seeing a heavy load of chronic neurological morbidity in survivors. The apparent small increase in children with cerebral palsy in recent years is almost certainly the consequence of the rise in the number of survivors of very low birth weight. This has again raised the crucial question of how many of these survivors were born already damaged, and how many were potentially normal. To this question we still have no answer.

Birthweight-specific mortality rates

The birthweight-specific infant mortality rate for very low weight babies for a selected number of ICE countries is shown in figure 8. I have chosen to look at infant mortality rates only because of the likelihood that there may be postponement of deaths from one age to another and that this may vary from country to country. This issue will be discussed elsewhere.[1] In this figure I am presenting data for 1 year only, and 1984 was the latest year for which we have data for all countries. The picture is a little confusing, but overall the trend downwards with increasing weight is clear. However for the U.S. white births, England and Wales, and Scotland the mortality of births weighing less than 500 grams is lower than in the other weight groups, and as mentioned earlier this is an indication that these births may be biased in some way and probably include some in which weight is misclassified.

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[1]Macfarlane A. What is happening to post-neonatal mortality?

There are some clear and well-known differences between the populations illustrated. The figure shows the low birthweight-specific rates for U.S. black babies, particularly between 600 and 1200 grams. To clarify the picture a little I have chosen to compare certain pairs of countries, and it will be seen that allowing for the small numbers involved there is a close similarity between the rates in Denmark and Norway (figure 9) and even more so between the rates of U.S. white babies and those in England and Wales (figure 10). Given the conclusive evidence of the importance of medical care in the survival of these infants, it suggests that in these countries with similar populations the standards of care for these infants are likely to be fairly similar. However, I should point out that the British data include a minority of births to different ethnic groups. Nevertheless, the conclusion that may be drawn is that the higher mortality of the babies grouped as very low birth weight in the United States is attributable to their adverse birth weight distribution with an unusual excess at the lower tail, rather than high birthweight-specific rates.

Mortality by birth weight and gestational age

For many of the countries in the data set it is possible to look at joint effects of very low birth weight and gestational age, and the numbers are large enough to do this up to the gestational age group of 34 to 36 weeks. This is illustrated in figure 11, excluding Denmark, where there seemed to be some inconsistencies in the lowest weight groups. As discussed earlier in this symposium, adjustment for gestational age evens out many of the apparent differences between the populations and places the mortality rates of the U.S. black babies, known to be smaller for dates than other populations, into a better perspective. The rates in Sweden seem surprisingly low put in this context.

Trends in birthweight-specific infant mortality rates

Figure 12, for selected countries only, shows the trend toward a general fall in rates that has been seen over the years surveyed. I believe this to be a real phenomenon, and given that we are simultaneously seeing a trend in some countries of an increase in the very smallest babies, this is an impressive achievement. We should remember, however, that the morbidity rate in survivors of this birth weight is high, particularly cerebral, which is being found in 6 percent to 7 percent of such children. In recent years for the first time increases in the prevalence of neurological deficits are being reported and related to the falling mortality risks at these low birth weights. Nevertheless, even at the lowest weights 80 percent and more of the survivors are found to be normal healthy children, so that the balance between survival and death remains favorable.

Time of death

Very low birthweight infants contribute disproportionately to very early deaths. Figures 13 and 14 from data from England and Wales illustrate clearly the high proportion of first day deaths occurring in babies weighing less than 700 grams, particularly in multiple births. The apparent small peak in survival at 1000 grams raises questions about registration practices below this weight, and this is a phenomenon that needs to be looked at over time and in different countries.

Summary

In summary I believe this ambitious exercise in collecting international data has been very informative, particularly in this group of low birth weight infants. This group is one that acts as an indicator for methodological problems because it is so sensitive to questions of definition and registration practice. The exercise has raised important questions regarding the possible effects of such practices and the effect of incomplete information on international comparisons of survival. However it has also revealed the value of such a data set to act as a monitoring device of trends over time in different places.

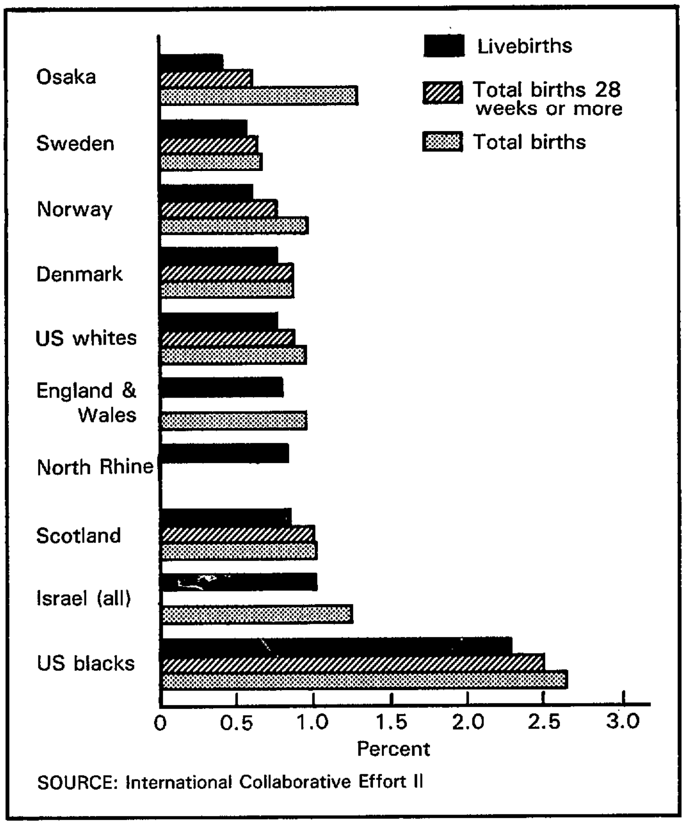

Figure 1. Percent of live births and total births with birth weight 500–1,499 grams: ICE countries, 1982–84

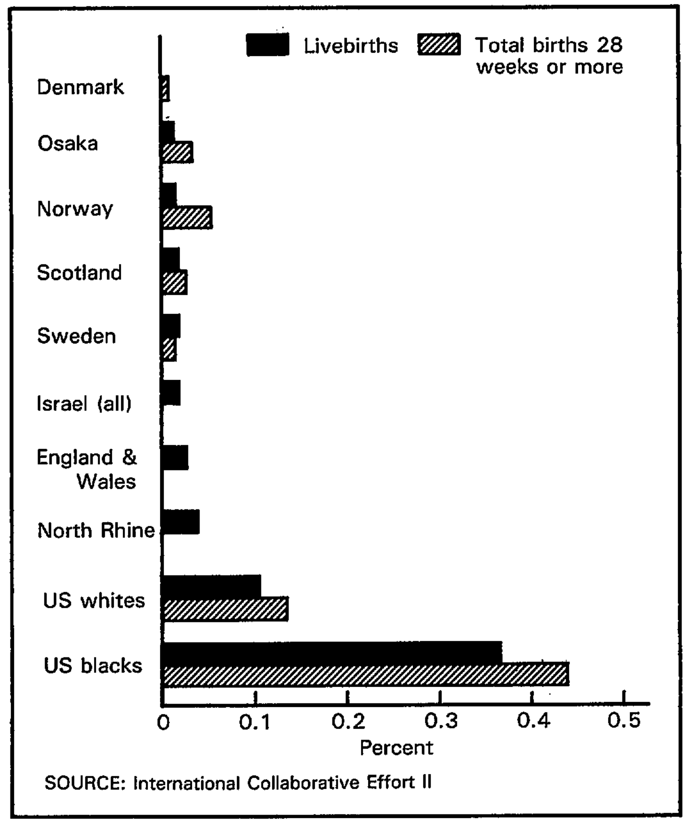

Figure 2. Percent of live births and total births with birth weight less than 500 grams: ICE countries, 1982–84

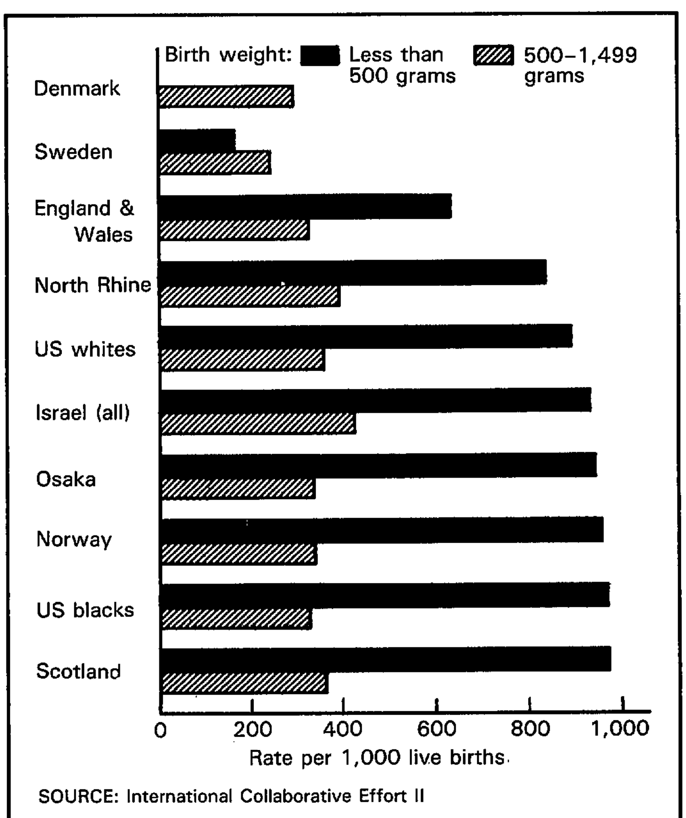

Figure 3. Infant mortality rate by birth weight for births with birth weight less than 1,500 grams: ICE countries, 1982–84

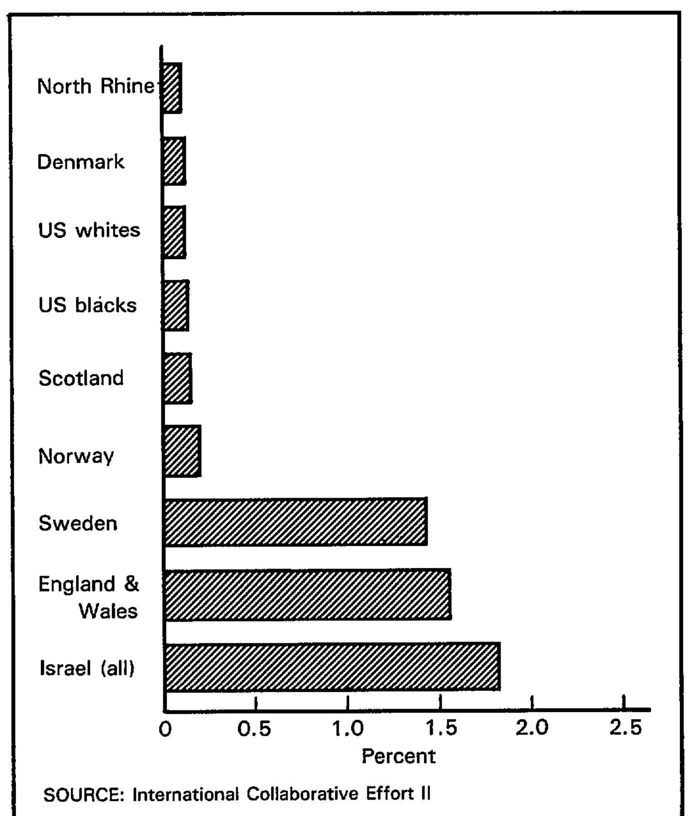

Figure 4. Percent of live births with unknown birth weight: ICE countries, 1982–84

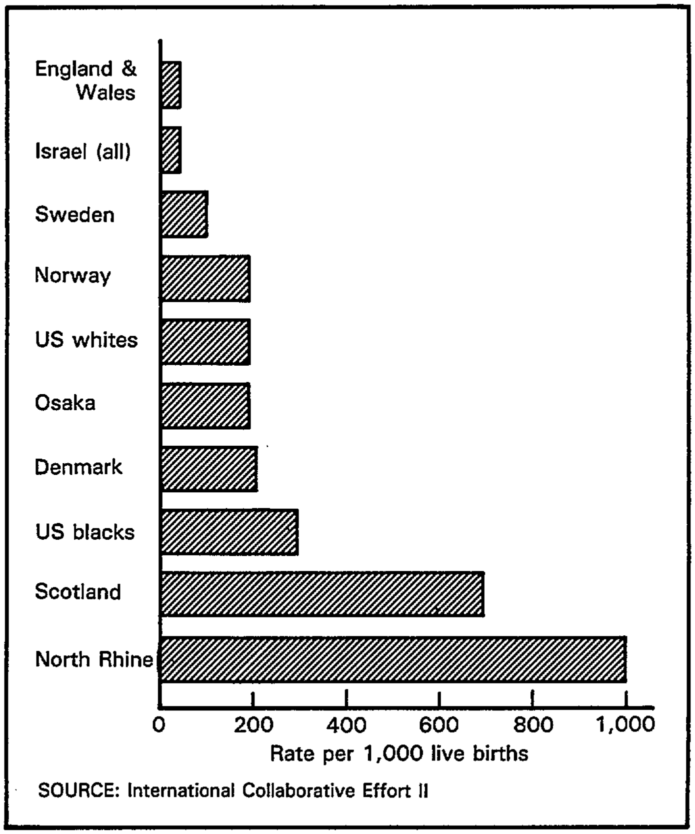

Figure 5. Infant mortality rate for live births with unknown birth weight: ICE countries, 1982–84

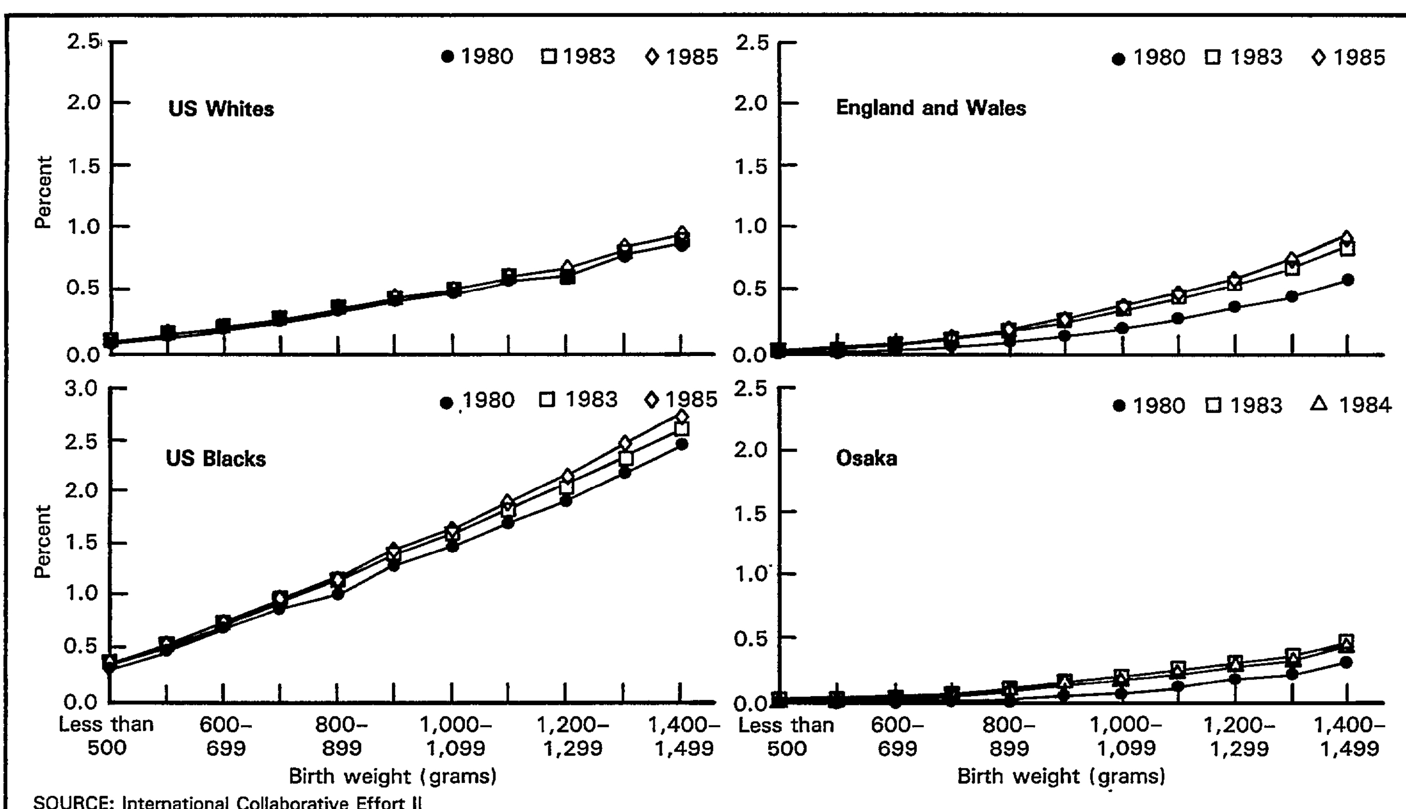

Figure 6. Cumulative birth weight distributions, live births with birth weight of less than 1,500 grams: selected countries, selected years

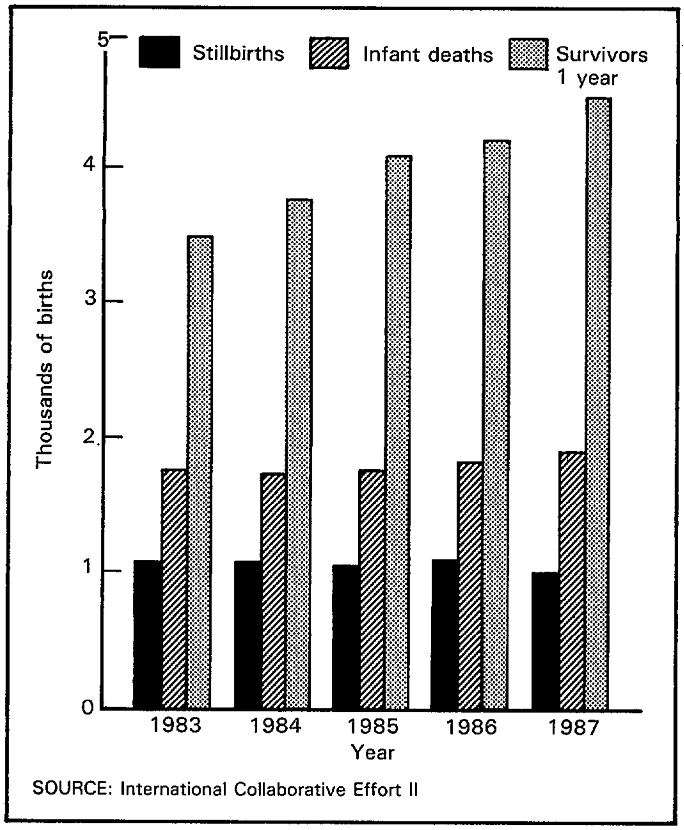

Figure 7. Outcome of births with birth weight less than 1,500 grams: England and Wales, 1983–87

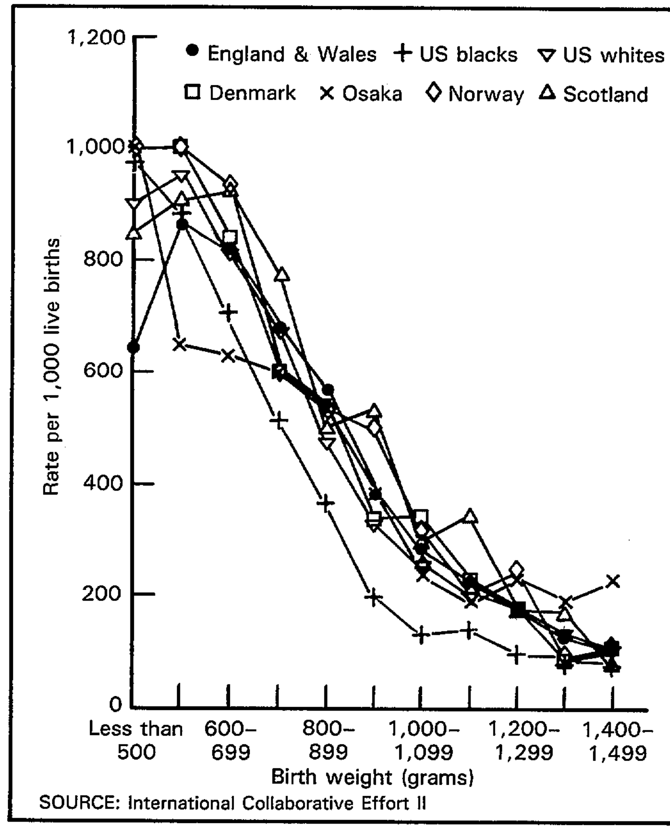

Figure 8. Infant mortality rate by birth weight, for births with birth weight less than 1,500 grams: Selected ICE countries, 1984

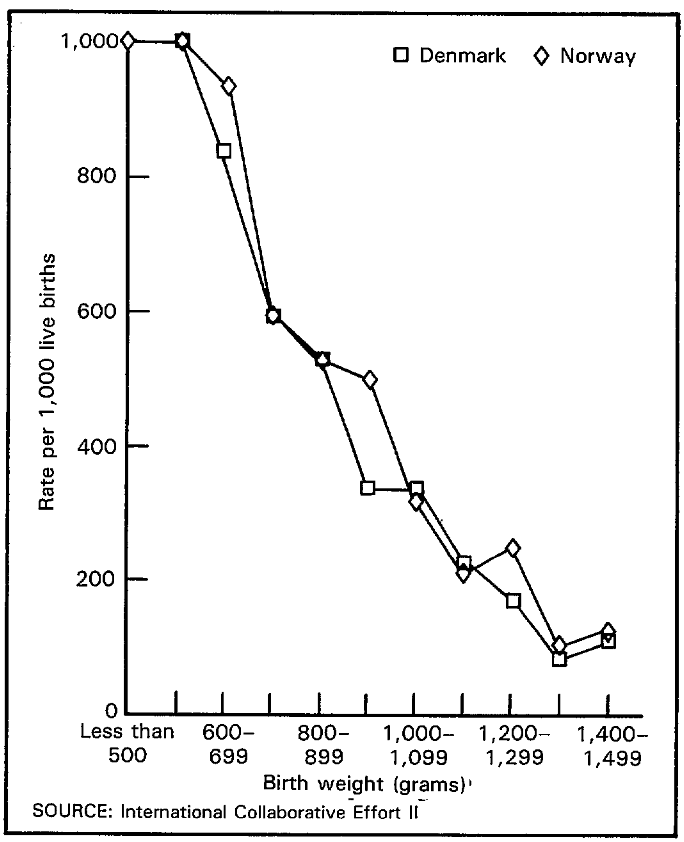

Figure 9. Infant mortality rate by birth weight, for births with birth weight less than 1,500 grams: Selected ICE countries, 1984

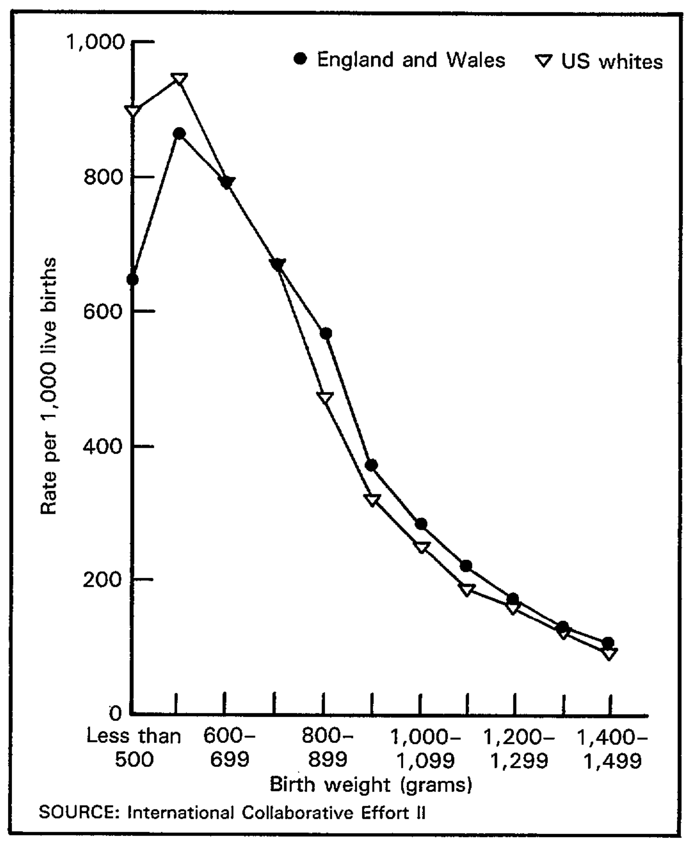

Figure 10. Infant mortality rate by birth weight, for births with birth weight less than 1,500 grams: Selected ICE countries, 1984

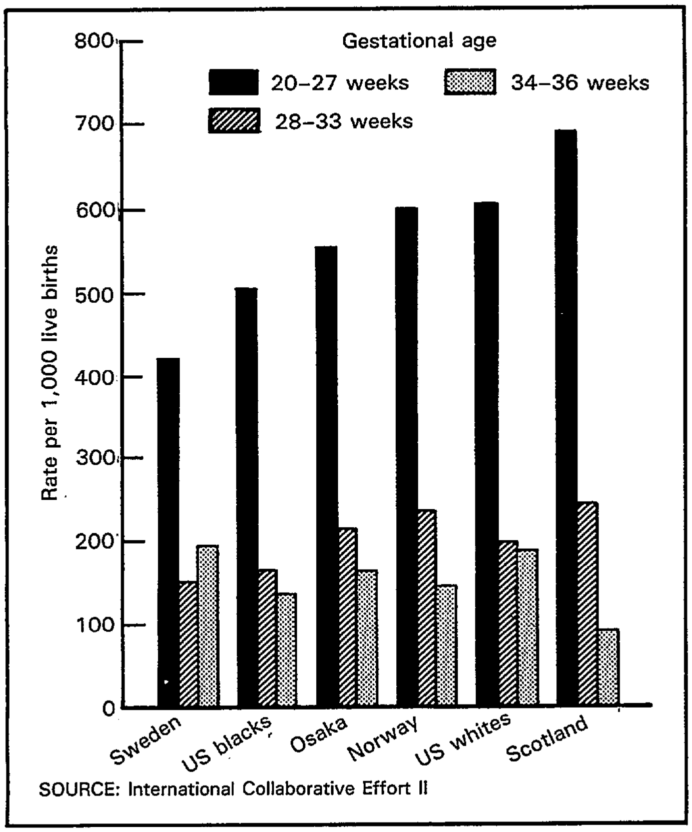

Figure 11. Infant mortality rate by gestational age: Selected ICE countries, 1982–84

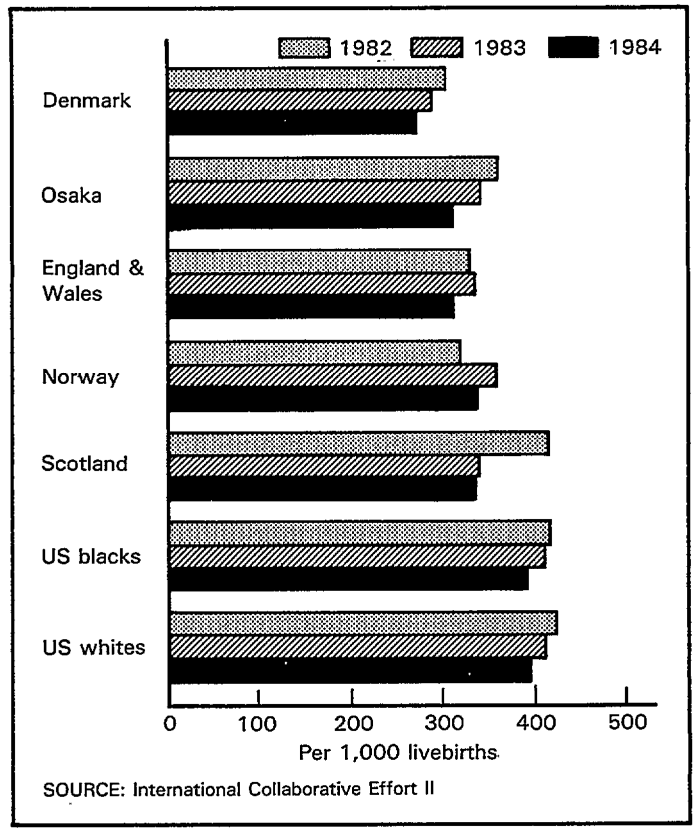

Figure 12. Infant mortality rate for all births with birth weight less than 1,500 grams: Selected ICE countries, 1982–84

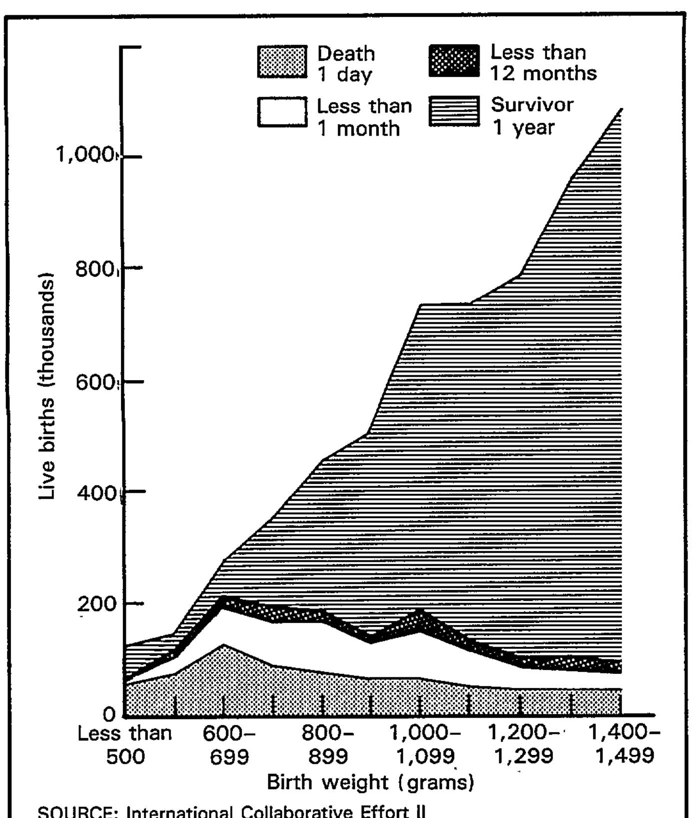

Figure 13. Survival outcomes by birth weight, singleton births with birth weight less than 1,500 grams: England and Wales, 1987

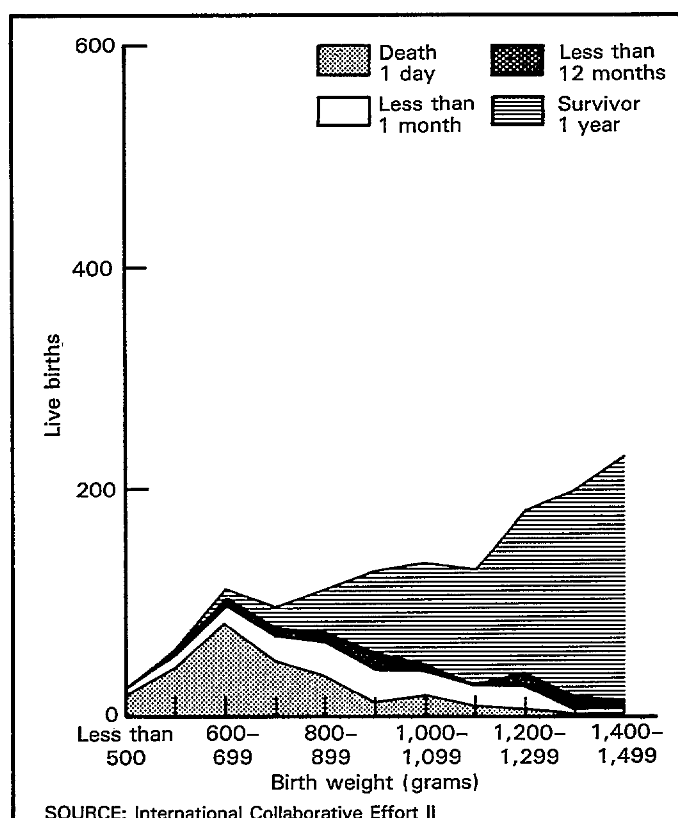

Figure 14. Survival outcomes by birth weight, multiple births with birth weight less than 1,500 grams: England and Wales, 1987

Characteristics of Multiple Births

by Enid Hennessy, M.Sc. and Stephen Evans, M.Sc.

Introduction

The ICE data are unique in many respects. The data available on multiple births are especially useful as the data set is probably the largest that has been assembled in the world. Thus it has been possible to make comparisons between and within countries and over time, of multiple birth rates, birthweight distributions, and perinatal mortality rates. It will be seen that there are some striking similarities between all countries that may reflect the biological effects, differences which are probably racial in origin, as well as smaller differences that may be as a result of differing medical practice and/or social conditions.

Information available

The information used has largely been taken from ICE 1 and supplemented by information from ICE 2.[1] Data from Japan, Sweden, and the six States for the United States have been used in all categories because they best describe similarities and differences that were encountered. The comments and conclusions were not contradicted by any of the data from the other participating countries.

Multiple birth rates

There are two types of twins:

(1) monozygotic--these are formed by the splitting of a single egg and are genetically identical and always of the same sex.

(2) dizygotic--these twins are thought to come from two eggs being formed and fertilized in the same menstrual cycle. They are as genetically alike and no more alike than any pair of singleton siblings.

The higher multiple births can be any combination of mono-, di-, tri-, or quadri-zygotic births and are considerably rarer than twin births. Although we have no information on zygosity, differing proportions will affect the birthweight distributions slightly and also perinatal mortality rates, since monozygotic twins are on average lighter and more likely to die than dizygotic ones.

Monozygotic twins occur at a fairly constant rate of 4 pairs per 1,000 maternities while dizygotic twins are very dependent on race, age, and parity. Dizygotic twins are least common in Mongoloid people and most common among black Africans. The twinning rate for dizygotic twins is dependent on demographic factors. The rate rises quite steeply with age of mother until about 37 years and it also rises with increasing parity (1).

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[1]For a description of the ICE 1 and ICE 2 data sets, see: Hartford RB. Definitions, standards, data quality, and comparability.

There have been reports of declining twinning rates from several countries throughout the 1950's and 1960's. Although much of this decline could probably be explained by demographic factors, a study of Italian births shows this decline occurring in specific age and parity cells as well (2).

Figures 1a and 1b show multiple birth rates over time for several countries. No country shows the MBR following the declining trend of the 1950's and 1960's, and with the exception of Norway all have obviously increased. Women on infertility programs have a greatly increased probability of having twins or other higher order births. Area studies in France and the United Kingdom have shown that the proportion of twins born as a result of infertility programs could be 11 percent or more of all twin births (3). This amount will obviously vary between countries but the increases and their timing is probably best explained by these medical advances. Even Norway's figures could be explained by superimposing a declining rate on an increasing one. There is some evidence that in the 1980's the MBR's leveled out, either because of greater sensitivity in the programs (avoiding the higher order births) or possibly because the supply is static. The racial differences are clearly not explained by differences in infertility treatment. The rates seemed to have stabilized in the early 1980's and comparisons are shown for the data nearest to 1983 in table 1.

From both figures 1a-b and table 1, it is abundantly clear that there are quite marked differences in the multiple birth rate. (Twinning rates will be approximately one-half the MBR.) U.S. blacks have the highest MBR at approximately 24 per 1,000, and Japanese the lowest at approximately 12 per 1,000. U.S. whites could be thought to have similar underlying rates with the actual differences being caused by random variation, demographic factors, and varying implementation of infertility programs. These differences between U.S. blacks, Japanese, and U.S. whites are almost certainly racial in origin and reflect current knowledge (1).

Birthweight distribution

Figure 2 compares the smoothed estimates of the birthweight distributions of multiple and singleton births for Sweden, U.S. blacks, U.S. whites, and Japan. These eight frequency distributions highlight the similarities and differences among all the countries for which we have data.

For all countries we have an underlying Gaussian distribution for both singletons and multiple births with an excess of low birth weight and preterm births. The negative skew is more pronounced in the multiple births. The multiple births tend to have a greater variance than the singletons, and their modal birth weight is about 1000 grams less than that of the singletons. What is not shown in these figures is the greater year to year variability in the shape of the distribution for multiple births. This is almost certainly a result of the smaller number of multiple births, which means that the standard errors of the median and percentiles are not negligible as they are for singletons.

Differences in singleton distributions between countries are mirrored in the multiple births; for example, Japan had a distribution with shorter tails than all other countries. This is not likely to be an artifact of data collection or registration practices, as babies of Japanese descent born in California also show a similar distribution (4). Excesses of low birth weight are more pronounced among U.S. blacks than whites for both multiples and singletons.

Table 2 shows countries in order of birth weight at the 75th centile. The 75th centile has been chosen as this is the best ad hoc measure we have of the birth weight that has the minimum perinatal mortality. Centiles were calculated from straight line interpolation between the points on the logit (cumulative percentage) birthweight curve using the ICE 1 data. Slightly different results will be obtained using other methods or using ICE 2 data, but the comparisons will be the same.

There is some slight uncertainty in this data as we know that those births of unknown birth weight are not representative of the population, they have a much higher than average perinatal mortality and presumably have a much lower than average birth weight. The average birth weight of the perinatal deaths is much lower than that of the live births. Table 2 shows that although there is a certain uniformity in the 75th and 50th centiles, the 10th centiles are much more variable. The 10th centile is particularly affected by different registration practices, by the differing proportions of unknown birth weight, and by differing proportions of low birthweight and preterm babies.

Figure 3 shows the trends in median birth weights over time. All countries with the exception of Norway seem to show small increases in the median birth weight over time, although this value is only statistically significant at the 5 percent level for Japan.

Perinatal mortality

At birth, monozygotic twins generally weigh slightly less than dizygotic twins and are more likely to die. There is no information on zygosity in the ICE data, although knowing that monozygotic twins occur fairly uniformly throughout the world it can be expected that the ratio of monozygotic to dizygotic twins will be inversely related to the MBR. Therefore we can expect, all other things being equal, to have slightly higher death rates for the Japanese multiple births and rather lower rates for the U.S. blacks as they should have, respectively, the lowest and highest proportions of dizygotic twins in our data.

Figure 4 shows the yearly perinatal mortality rates. It can be seen that the perinatal mortality rates have declined quite dramatically for all countries over the period studied.

There are also very big differences between the absolute values. U.S. blacks do particularly badly and the Swedes quite well. However the Swedish result would probably be worse if they were to register babies under 28 weeks duration.

Figure 5 shows both multiple and singleton birthweight-specific perinatal mortality for Japan, U.S. blacks and whites, and Sweden. The mortality rates were calculated from the aggregated births and deaths in each 500 gram weight band from 1979 to 1983 inclusive. This was done to minimize the standard errors of the points on the curve, particularly for the high birth weights where few deaths occur. The perinatal mortality is shown here on a log scale, although the general results will be exactly the same if we had shown log odds of death against birth weight.

These figures again show the marked similarities between countries, as well as the consistent sort of relationship multiples have with singletons. They are all U-shaped curves with mortality rising at low and very high birth weights.

All the multiples have a greater mortality rate at the minimum of the curve than their corresponding singletons. This is biologically plausible as we would expect a normal twin to be at greater risk than a normal singleton.

All the minimums on the curves are at birth weights above the 50th centile. This would be consistent with the healthiest babies being slightly heavier than the average.

All the multiple curves are shifted down the birth weight axis from their singletons. This again is to be expected as the death rates could be expected to rise the further away the baby is from the optimum birth weight. A 2000-gram twin is not very far from the median birth weight, but a 2000-gram singleton has either been born too soon or has been significantly deprived in utero; consequently we should not be surprised that the 2000-gram twin is more likely to survive than the 2000-gram singleton. This type of feature is seen in the relative mortality at low birth weight of U.S. blacks compared with U.S. whites in singletons.

If we rank countries in order of the 50th centile and also in order of birth weight at the minimum perinatal mortality, they are very similar; however, the difference in birth weight at the 50th centile does not approximate very well to the difference in birth weight at the minimum mortality rate.

The standard errors of the points on the curve are small for low birth weights where there are large numbers of deaths but are also rather larger for high birth weights. We have insufficient evidence to say that the two slopes of sides of the curve differ between countries.

Since the unknown birth weights have very high death rates, it could be assumed that the classification is related to the risk of dying at birth. If so, we would expect the true birthweight- specific mortality curve to be shifted vertically up the log (perinatal mortality scale) uniformly for each birth weight. If for each country the birthweight distribution were in the same relative position to the perinatal mortality curve, the ratio of overall perinatal mortality between two countries would correspond to the vertical difference between the perinatal mortality curves when they have been adjusted along the birth weight axis so that they were nested (i.e., their minimum perinatal mortality would be at the same position on the birthweight axis).

Doing this we would expect Sweden to have the lowest death rates and Japan to have the highest. Japan does much better than they should using this method and the U.S. blacks much worse. This is accounted for by the fact that the Japanese have a very narrow distribution of births with relatively few very low birthweight babies and the U.S. blacks have large numbers of very low birthweight babies. If these distributional differences can be partially accounted for by social, dietary, or other factors amenable to change, then there is still considerable scope for reducing the waste of life.

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Table 1. Multiple birth rates in the early 1980's

Country	Multiple births	MBR*	Standard deviation of MBR	Year
England and Wales	25,777	20.25	0.18	1983-4
North Rhine	6,520	19.09	0.34	1980-1
Japan	19,419	12.79	0.13	1983
Bavaria	1,784	20.22	0.69	1983
Norway	969	19.35	0.89	1983
Sweden	1,742	19.08	0.65	1983
U.S. black	2,908	24.62	0.65	1983
U.S. white	15,579	20.33	0.23	1983

*Multiple Birth Rate (MBR)=Total multiple births (alive + stillborn) per thousand total births (alive + stillborn, singleton or multiple).

Table 2. Centile birth weights (calculated for each year shown and averaged)

Country	Years	10th	25th	50th	75th	90th
Norway	79-83+	1752	2219	2624	2996	3288
Sweden	79-83	1795	2229	2607	2945	3229
U.S. whites	79-83	1505	2068	2525	2922	3238
North Rhine$	79-83	1605	2079	2471#	2805*	3096
England and Wales	83-84	1560	2053	2468#	2802*	3101
Bavaria	80-81	1763	2041	2453#	2786*	3070
Japan	79-85	1688	2111	2472#	2757	3032
U.S. blacks	79-83	1050	1786	2307	2731	3057

Key

$No deaths under 1000 grams registered.

+Except 1982.

#Countries with no statistically significant difference at the 5 percent level between birth weights at the 50th centile.

*Countries with no statistically significant difference at the 5 percent level between birth weights at the 75th centile.

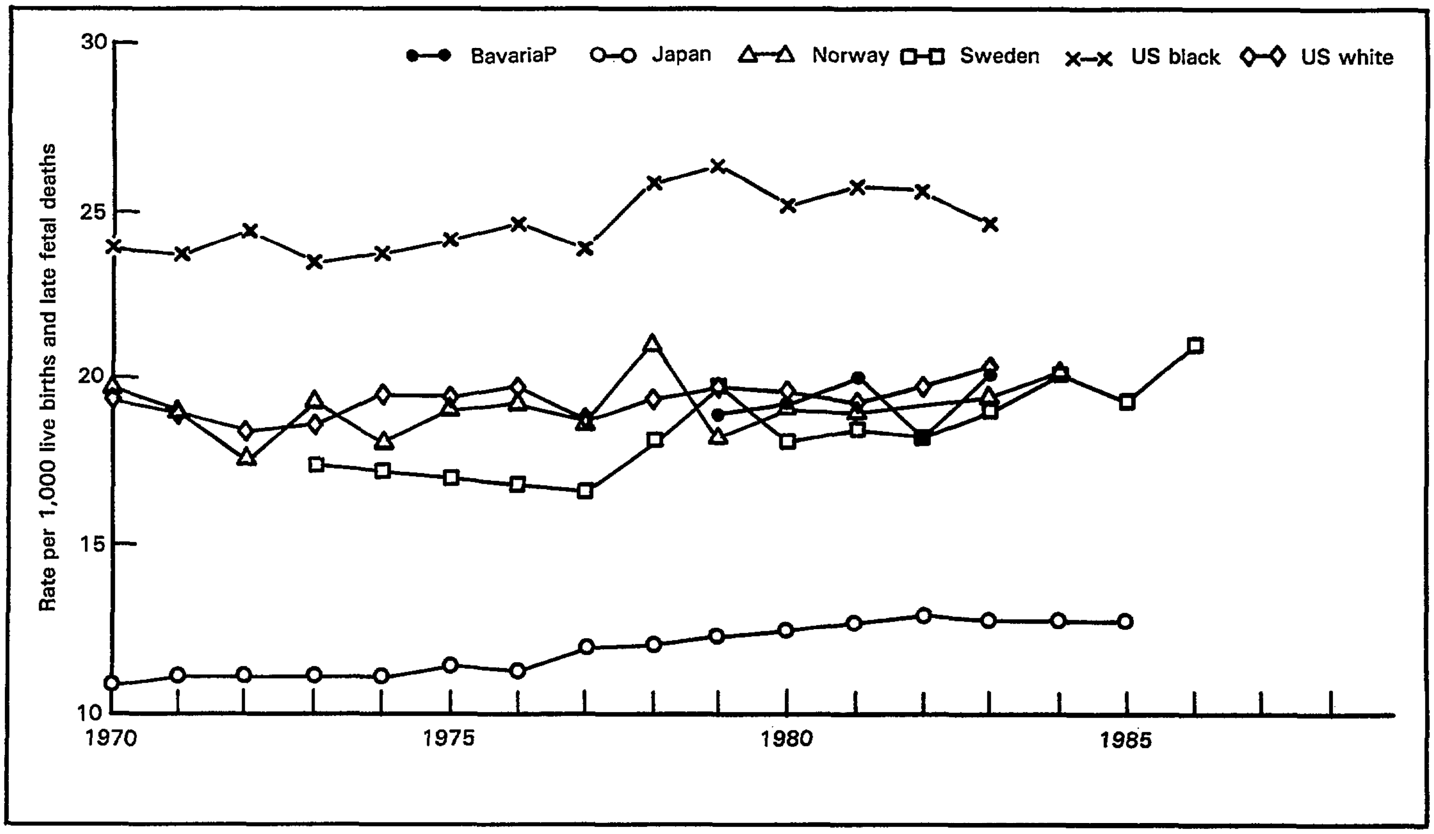

Figure 1a. Multiple birth rate: Selected ICE countries, 1970–85

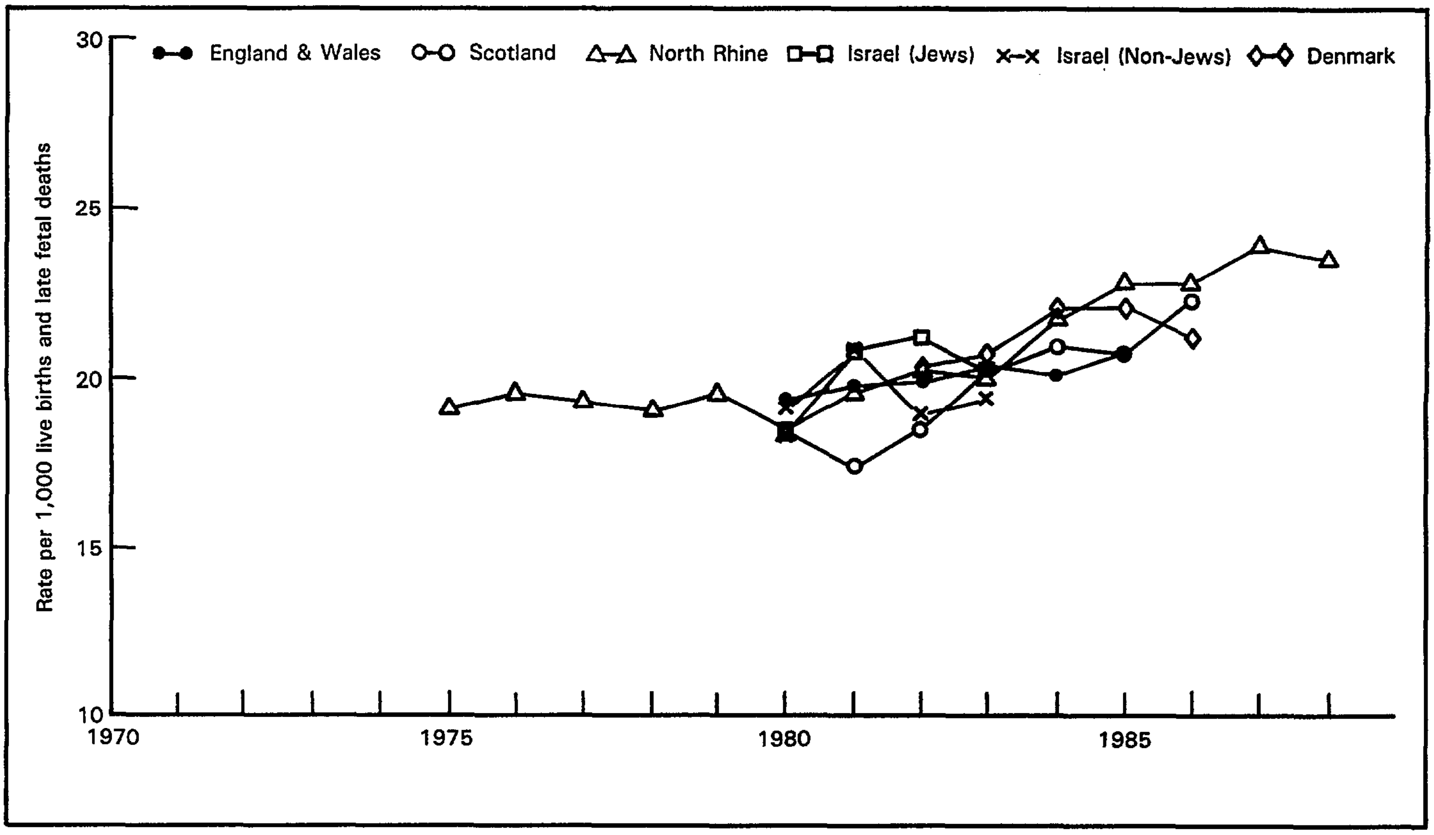

Figure 1b. Multiple birth rate: Selected ICE countries, 1975–88

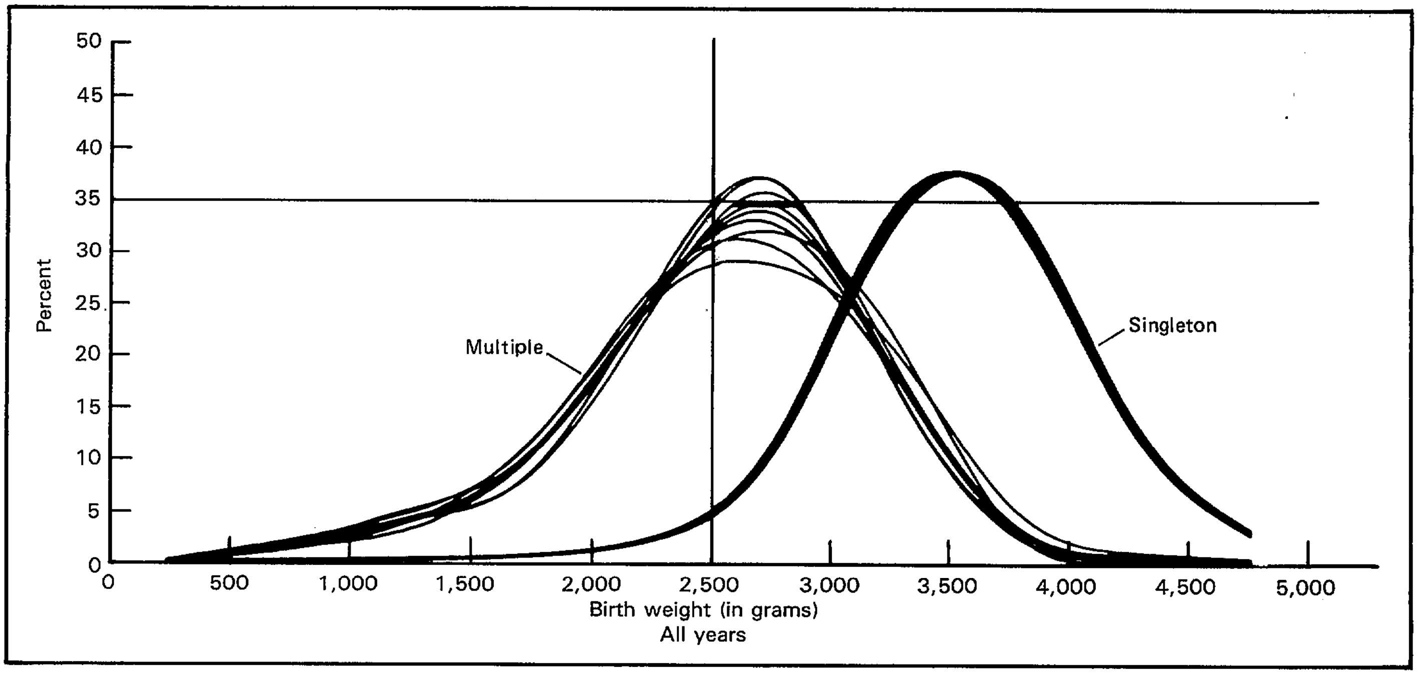

Figure 2a. Birth weight distribution by singleton and multiple births: Sweden, 1973–81

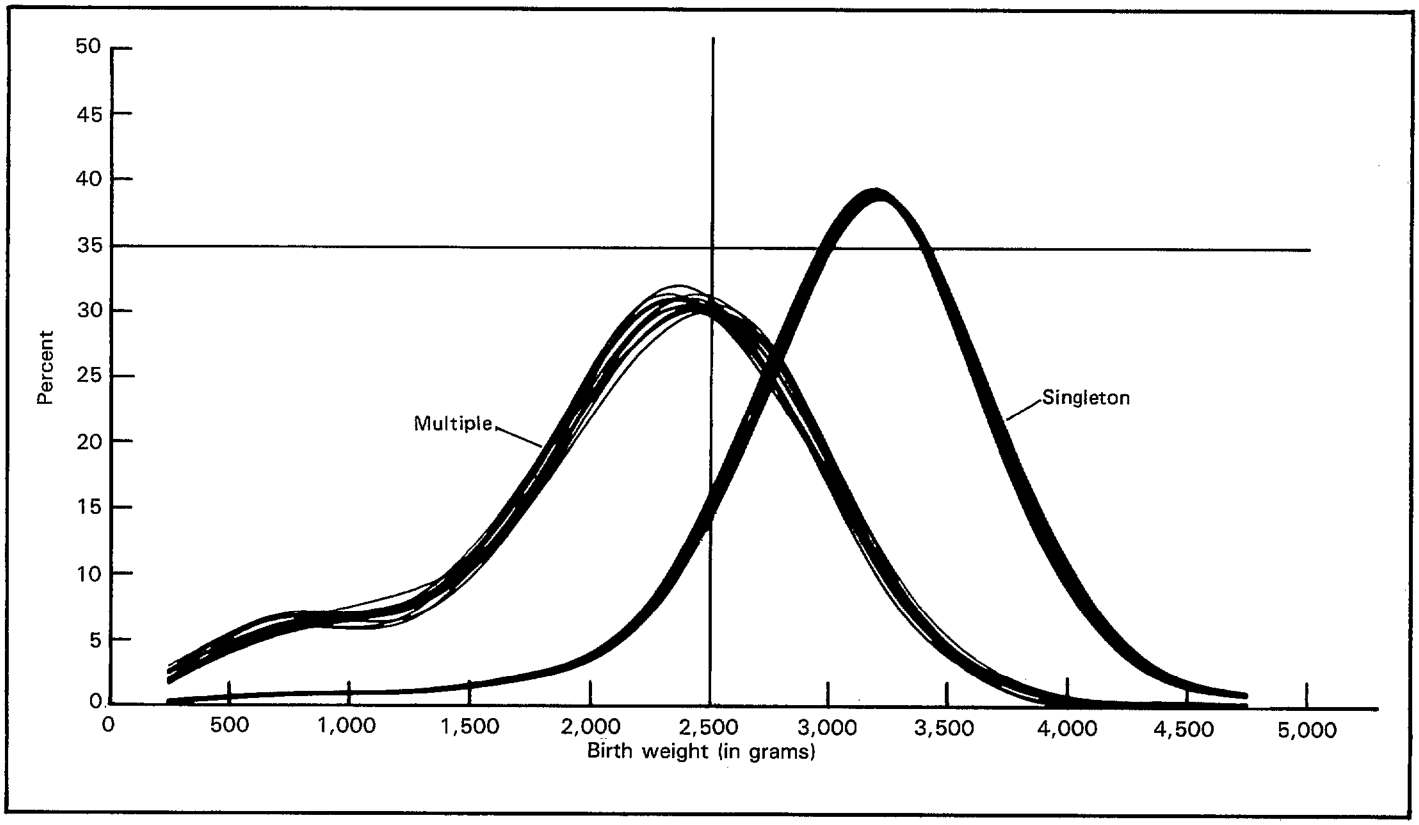

Figure 2b. Birth weight distribution by singleton and multiple births: United States blacks, 1970–83

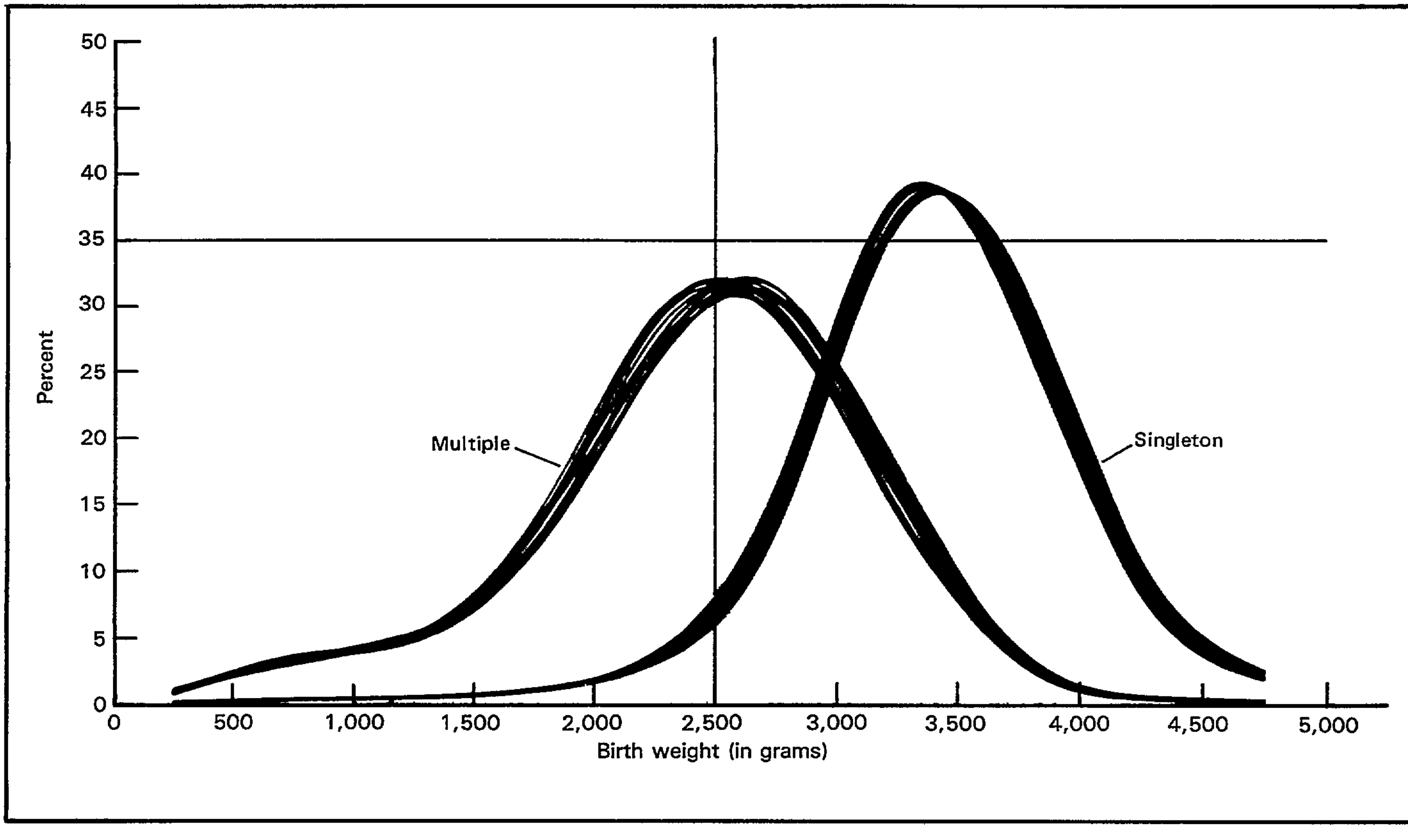

Figure 2c. Birth weight distribution by singleton and multiple births: United States whites, 1970–83

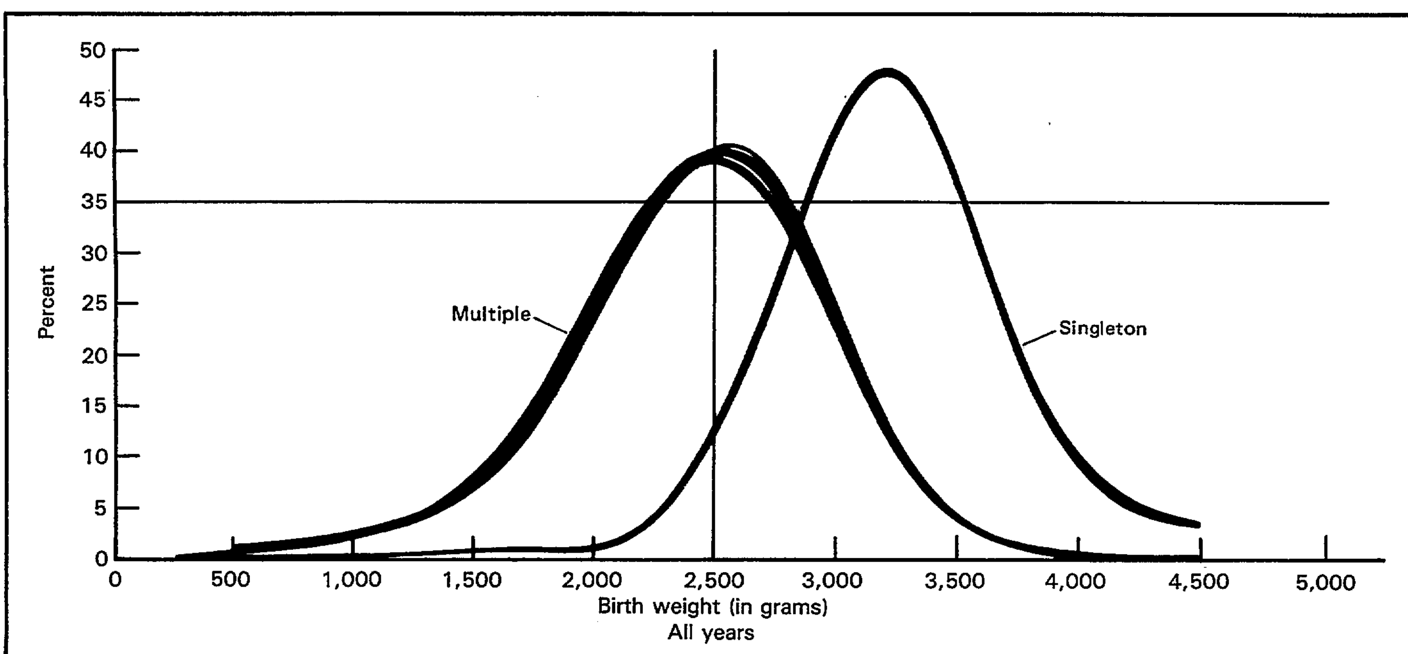

Figure 2d. Birth weight distribution by singleton and multiple births: Japan, 1970–83

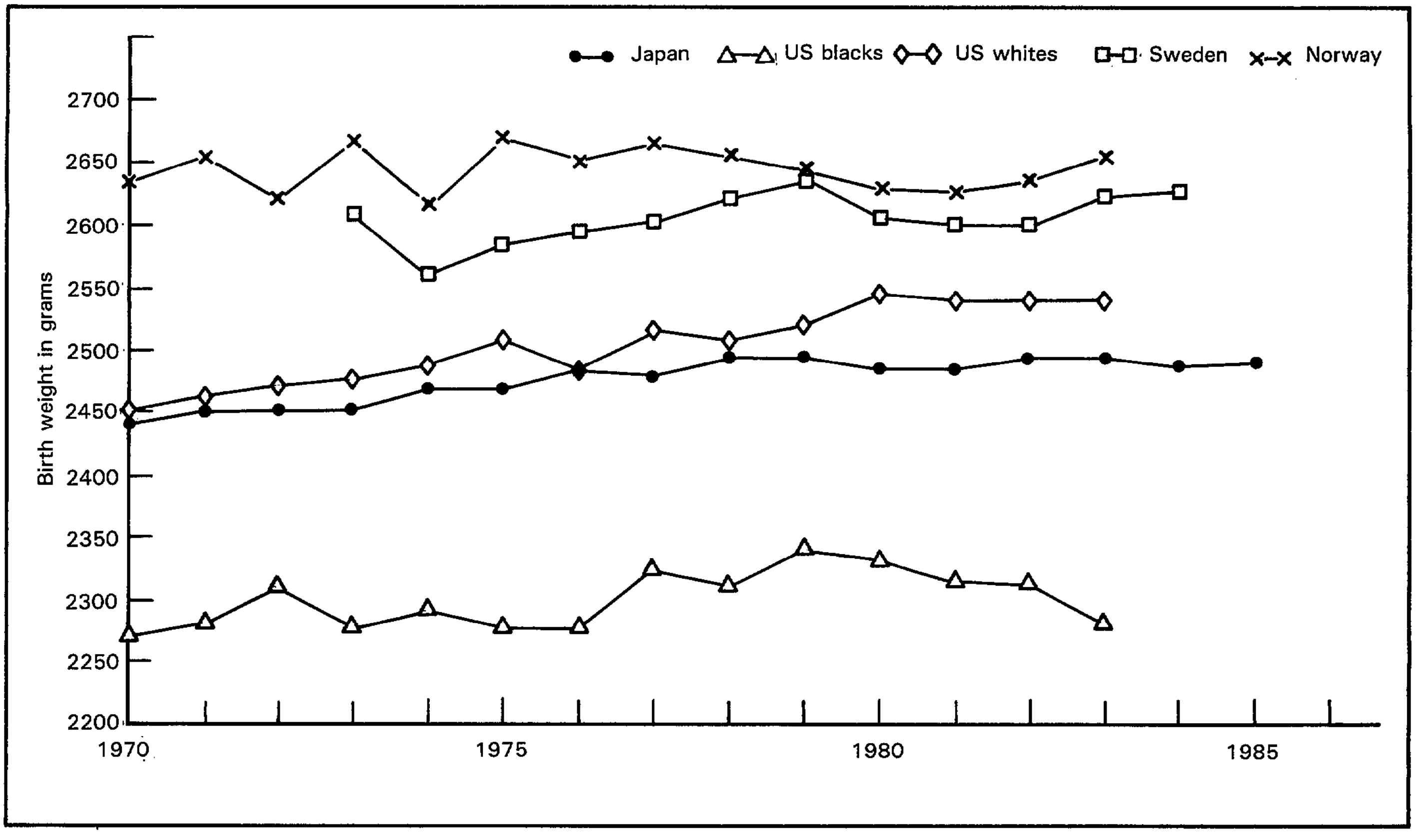

Figure 3. Trends in median birth weights, multiple births: Selected countries, 1970–85

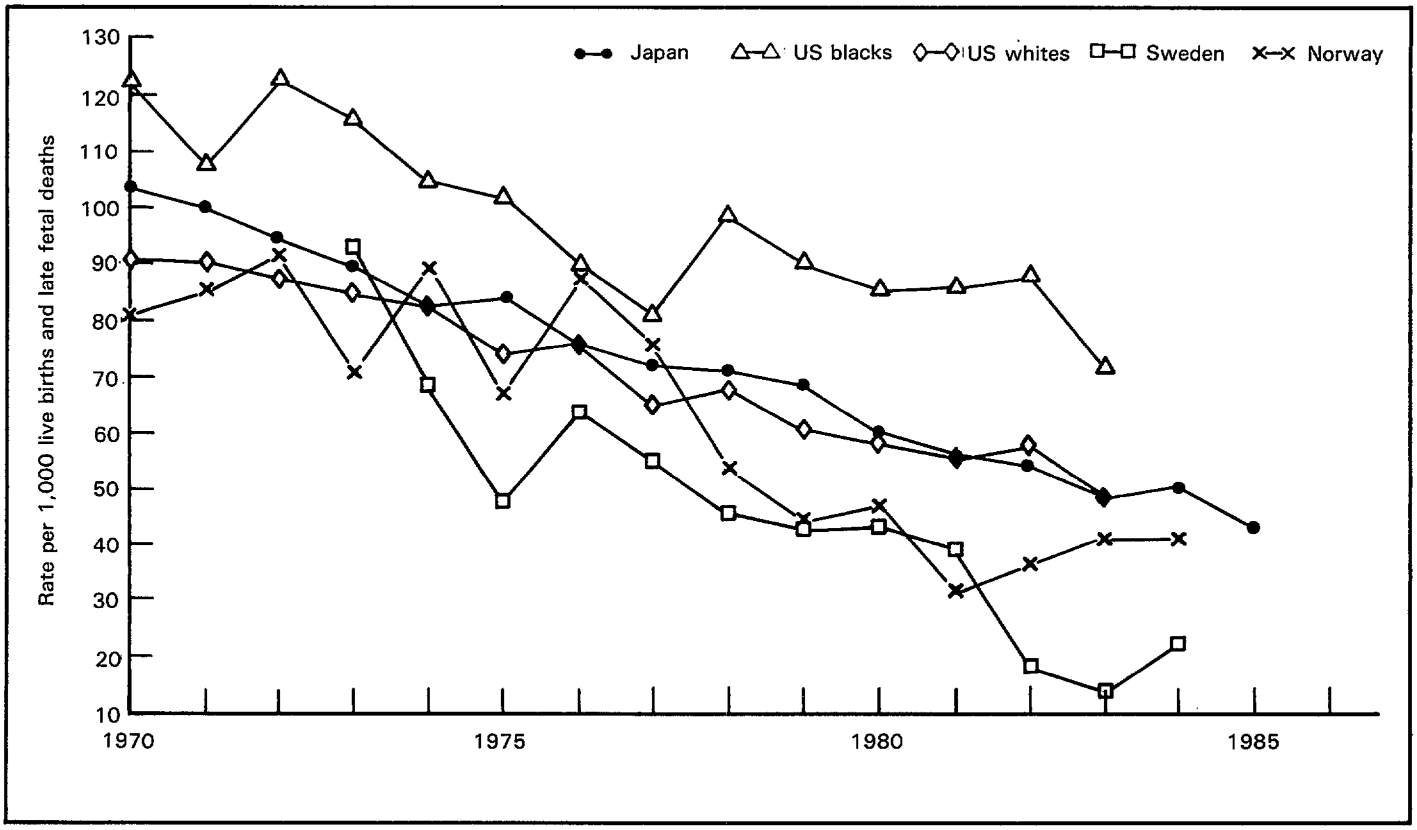

Figure 4. Perinatal mortality rates: Selected countries, 1970–85

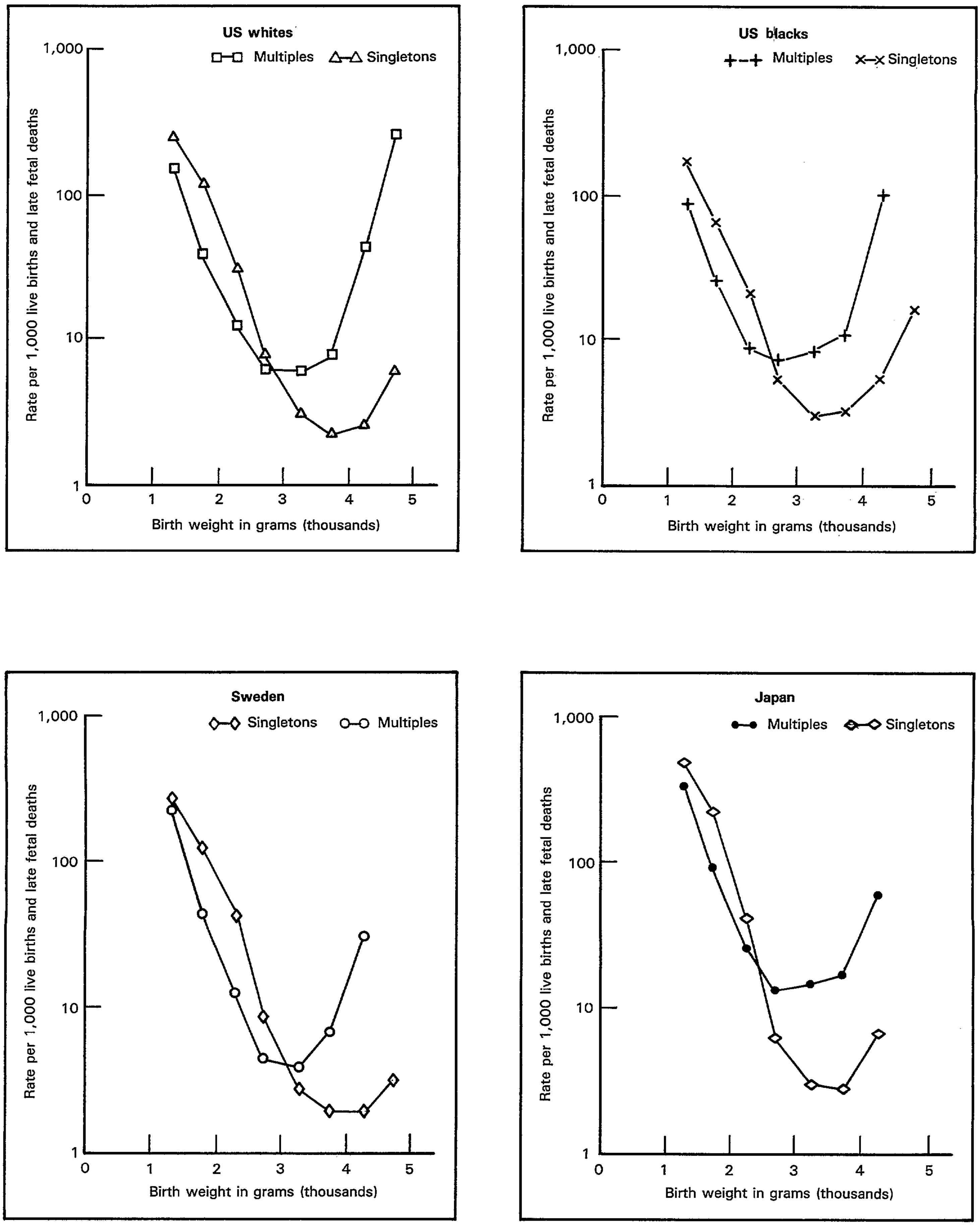

Figure 5. Birthweight-specific perinatal mortality rates, multiple and singleton births: US whites, US blacks, Sweden, and Japan, 1979–83 average

What Is Happening to Postneonatal Mortality?

by Alison Macfarlane, M.S., and Kate Prager, Ph.D.

This is a wide ranging question. In attempting to find some ways to answer it, we have looked at long-term trends in our own countries and then taken a cross-sectional approach to the much shorter series in the International Collaborative Effort (ICE) data. In doing this we have tried to draw together some of the points other speakers have already made about postneonatal mortality.

Long term trends

The dramatic fall in infant mortality since the early years of the century in the United States, and in England and Wales combined, is shown in figures 1a-b. Although series of infant mortality rates for England and Wales go back to the 1840's, 1905 was chosen as the starting point for figure 1b as it was the first year when infant mortality was subdivided into neonatal and postneonatal components (1). These terms were not used at the time, of course, but there were very specific pressures for making more detailed analyses of infant mortality.

In the early years of the century, there was considerable concern in Britain about the health of the population as a whole and about infant mortality in particular. This arose when the Government found that many potential recruits for the Boer War, which it was fighting in South Africa, were unfit. The atmosphere of rearmament in Europe made it clear that a larger military conflict was on the way, and it is not too cynical to suggest that the British Government was anxious to have healthier "cannon fodder" for the next occasion. It set up the Committee on Physical Deterioration to take evidence from "the great and the good" and to suggest what could be done.

The Committee's report (2) and other writings of the period pursue many themes that have a familiar ring today. Poor people in cities were criticized for eating white bread and jam rather than oatmeal. In discussions of infant mortality, women were described as ignorant and blamed for going out to work and for rejecting advice offered by self-appointed experts, such as clergymen, about how to look after their babies. On the other hand, the concern about the nation's health led to positive measures that were introduced in this era, including schemes for maternity care and school meals.

In the United States, national infant mortality rates were published for the first time in 1915, and the subdivision by age was made from the outset. This coincides with the year that the national birth registration area was first established, and the collection of live birth records and the publication of natality statistics started. In 1915 the original birth registration area consisted of 10 States and the District of Columbia and contained about one-third of the population of the whole country. These were the States where the registration of births had reached a sufficient degree of completeness to justify forming them into a registration area for births.

Although the U.S. Bureau of the Census had established a national death registration area in 1880, it was not until 1900 that the annual collection and publication of mortality statistics for this registration area began. Between 1900 and 1914, the collection and publication of vital statistics data was limited to death records because these were more complete and accurate and, for reasons of public health, were of greater interest than birth records. Starting in 1915 however, the numbers of infant deaths could be related to the numbers of live births and published as infant mortality rates.

Neonatal and postneonatal mortality rates for England and Wales since 1905 are plotted in figure 2. The neonatal mortality rate has fallen very steadily. The peak in 1918 resulted from the influenza pandemic that affected many countries in that year. After a larger drop in the early and mid 1940's, the decline slowed until a period of faster decline in the late 1970's and early 1980's, which has now been followed by a period of leveling off.

Postneonatal mortality shows a very different pattern. At the beginning of the century, it was much higher than neonatal mortality, with major peaks in years when there were epidemics of diarrhea and in 1918 during the influenza pandemic. Later the rate fell very rapidly. This is likely to be a reflection of the decline of infectious disease and the impact of social and public health measures on the health of babies. Somewhat surprisingly, the rate did not increase, on a national level at least, during the economic depression of the 1930's, although there were local increases in infant mortality in the most depressed areas (3).

By the mid 1950's, postneonatal mortality had begun to level off. After a major fall in 1976, the rate again flattened off and fluctuated about the same level, although the rate for 1989, which was released after this symposium took place, showed a noticeable fall.

Similar patterns can be seen in figure 3, which shows neonatal and postneonatal mortality rates for the United States since 1915. This shows a similar steady decline in neonatal mortality, with a tendency to level off in the late 1940's and 1950's. Between 1915 and 1945 there was a much more dramatic decline in postneonatal mortality, despite a halt in the mid 1930's. After this fall virtually ceased in the late 1940's, there was a further period of decline in the early 1970's, with a leveling off from the mid 1970's onward.

These patterns are summarized in figures 4a-b, in which postneonatal mortality rates for the United States and for England and Wales are plotted as a percentage of their respective infant mortality rates. In both cases, postneonatal mortality decreased steadily as a percentage of infant mortality in the first half of the century and subsequently started to rise again, but the timing was different. In England and Wales the minimum of 28 percent was reached in 1958, while in the United States, after a considerable period of flattening off, the minimum of 25 percent was reached some 12 years later, in 1970.

In 1987 postneonatal deaths accounted for 45 percent of infant deaths in England and Wales, but only 36 percent of those in the United States. The 1989 figure for England and Wales suggests departure from the trend described at the conference. It is too soon to say whether it signals the beginning of a long term change in trend, or a short term anomaly. It may, for example, be a consequence of the two exceptionally mild winters that occurred in the British Isles in 1988-89 and 1989-90.

The data prepared for ICE were used to plot a similar graph for all the countries involved, but the time period covered by the data set was too short to reveal any marked trends that could be distinguished from year to year variation (4). When we turn to other sources of data for developed countries with longer time series, patterns emerge that are similar to those in the United States and in England and Wales. Although there are exceptions, perinatal and neonatal mortality rates for most countries are continuing to fall, while postneonatal mortality rates have leveled off since the mid 1970's. This was shown clearly in a study of infant mortality in the European Community (5).

Similar patterns can be seen within England and Wales when rates for Wales and the 14 National Health Service regions within England are plotted separately in figures 5a-b, with the rate for England and Wales as a whole plotted using stars. Since 1970, perinatal mortality rates for these regions have decreased with a broadly constant ratio of the highest to the lowest, but the patterns for postneonatal mortality have been very different. The wide regional differences, which were apparent in the early 1970's, narrowed during a very short time period in the middle of the decade and all fluctuated around a similar level until 1989. This leads to the question of what lies behind this common pattern that can be observed both internationally and within countries.

Why are postneonatal mortality rates flattening off? Three hypotheses have been put forward as possible explanations of trends in postneonatal mortality (6-8). The classic explanation of trends in postneonatal mortality is that in general they reflect changes in socioeconomic conditions, while neonatal mortality rates are much more closely influenced by the quality of health care available. Although the rates could be refined in ways that have been discussed during this conference, it cannot be denied that socioeconomic conditions are a major influence on postneonatal mortality.

One hypothesis, therefore, is that the flattening off of postneonatal mortality in developed countries has occurred as a consequence of declining socioeconomic conditions in the late 1970's and 1980's. In particular, it may reflect the way that common economic crises have affected the most vulnerable and least advantaged people in our societies. For example, reports of homelessness in Washington, D.C. have a familiar ring to people who are aware of the situation in London and other cities in the United Kingdom.

It would be naive to accept this as an all embracing explanation, however, as there are other factors to be considered. Techniques for neonatal intensive care have been developing particularly fast since the mid 1970's. By the late 1970's, hospital-based studies began to show that some very small and ill babies in intensive care survived the first month of life, but died later. Probably the first of these was Maureen Hack's study in Cleveland, Ohio, that showed that of 427 babies weighing under 1500 grams admitted to an intensive care unit, 145 died within the first year. Twenty of these babies died in the postneonatal period and 17 of these 20 never left the neonatal unit (9).

Later, a study in Glasgow, Scotland, showed that 50 percent of postperinatal deaths could be attributed to factors that were apparent at birth (10). These, together with subsequent studies, suggest a second hypothesis that numbers of the deaths in the postneonatal period are swelled by the numbers of deaths that might well have occurred earlier in life if the babies had not been given intensive care.

The third hypothesis is that frail babies who may survive to be discharged alive from the hospital may then be particularly susceptible to further adverse conditions, such as infections, which may beset them later on in the first year of life. This may be confounded with the two previous hypotheses, in that people who may be experiencing the most adverse conditions can be at increased risk of giving birth to a very small and ill baby in the first place (7-11).

This means that the three hypotheses are not mutually exclusive, and it is difficult to see how they can be tested using routinely collected statistics alone (6-8). In particular, records in infant mortality linked files, which bring together data collected about the same baby at birth and death registration, may tell us that a baby was born with a very low birth weight and subsequently died in the hospital. What they do not tell us is whether the baby was discharged from the hospital between these two events.

This would only be possible if the files were linked to hospital discharge records. Although it is planned to do this in England, it will be years before the data are of adequate quality. Such linkages may be possible already in Scotland and some Scandinavian countries, but are unlikely to be feasible elsewhere. The alternative is to follow up cohorts of babies. This yields data of a much higher quality, with the potential to collect the information needed to answer specific questions, but is outside the scope of this presentation, with its focus on routinely collected statistics. In this spirit, it is appropriate to move on and look at the ICE data.

Postneonatal deaths in relation to infant deaths in the ICE countries

In the light of these hypotheses, we looked at the distribution of the ages at death in the ICE data to see what further clues they yielded. Needless to say, earlier presentations in this symposium have given us ideas for further analyses, but results shown in what follows are based on analyses done before the symposium and shown there.

Because of the much wider differences between countries in the reporting of fetal deaths, it was decided to restrict analyses to infant deaths. Further work could include fetal deaths as part of the continuum. The analyses presented here are based on data for the years 1982-84 combined in order to have data for the same time period for all the countries. Although some of the analyses looked at the racial groups within the United States and Israel separately, the subdivision does not appear in the figures that follow.

The age distributions of infant deaths in each of the ICE countries are shown in figure 6. Early and late neonatal deaths are shown separately, and the postneonatal period is subdivided, perhaps somewhat arbitrarily, into deaths of babies aged 1-2 months and 3-11 months. Figure 6 shows considerable variation between the ICE countries in the age distributions. Norway had the highest proportion of deaths in the postneonatal period. Only 57 percent of infant deaths occurred in the neonatal period and 72 percent before the age of 3 months. At the other extreme, in the United States, 67 percent of deaths were in the neonatal period and 81 percent had occurred before the age of 3 months. This may reflect the higher reporting rate at the very low end of the birthweight range, which other speakers have already described.

Age distribution by cause of death

Figure 7 shows the age distribution for each of the cause groups used in the ICE analyses (12) for data from one registration system, which is that for England and Wales. This is done to illustrate the differences between the cause groups before making comparisons between countries. It shows the marked contrasts between the age distributions for deaths attributed to asphyxia and immaturity, which are conditions originating in the neonatal period, and those attributed to the sudden infant death syndrome (SIDS), which are expected to occur in the postneonatal period. In the years shown, 96 percent of deaths attributed to asphyxia but only 6 percent of deaths attributed to SIDS occurred in the neonatal period. The distributions for deaths attributed to infections and also those attributed to congenital malformations, which will not be discussed further, occupy an intermediate position.

Age distributions of deaths attributed to asphyxia and immaturity are shown separately in figures 8a-b. Not surprisingly, they look similar and, as Per Bergsjø has already suggested[1], it is necessary to look for possible evidence of cross diagnosis. In looking at the percentage of deaths attributed to asphyxia occurring before the postneonatal period, two countries stand out as outliers. Only 84 percent of these deaths in North Rhine-Westphalia and 88 percent in Israel had occurred before the age of 1 month, compared with 97 percent in the United States. The question to be asked is whether these differences reflect recording artifacts.

There was no compensating difference in deaths attributed to immaturity. Once again, the percentage of deaths occurring before the age of 1 month was low, 89 percent in North Rhine-Westphalia and 90 percent in Israel, but these differed less markedly from the corresponding figure of 94 percent for the United States. Norway also had a low percentage of these deaths in the neonatal period, and 7 percent of them occurred at the age of 3 months or more.

The age distributions when deaths attributed to asphyxia and immaturity are combined, as Per Bergsjø suggested[1], are shown in figure 9. As would be expected, North Rhine-Westphalia and Israel and to a lesser extent Norway stand out as having higher percentages of deaths in the postneonatal period than the other countries.

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[1]Bergsjø P. Comparison of neonatal mortality by cause, length of gestation, and birth weight.

For deaths attributed to infections, shown in figure 10, the age distributions show rather more variation from country to country. Paradoxically, the widest differences are those between England and Wales and Scotland, with 29 percent of deaths occurring in the neonatal period in England and Wales and 53 percent in Scotland. As these countries are close to each other geographically, they might be expected to have a common pattern of infection as well as similarities in the way death is diagnosed and registered. As was shown in earlier presentations,[1-2] England and Wales have a relatively high rate of mortality attributed to infections, and these deaths would be expected to be concentrated in the postneonatal period. Israel and North Rhine-Westphalia have proportions of deaths at the age of 3 months or more that are as high as those in England and Wales, although they differ considerably in the percentages occurring in the neonatal period.

Deaths attributed to SIDS show a very different picture again (figure 11), with the majority of deaths in most countries occurring in the postneonatal period. The extent to which deaths occurred in the neonatal period has to be considered in the light of anomalies in the way causes are coded to this category. The data for Israel include the considerable numbers of deaths in the neonatal period for which no explanation was given on the certificate.[2] As a consequence, the percentage of deaths put into the SIDS category, but which occurred in the neonatal period, was 19 percent for the Jewish population and 25 percent for the remainder of the population. The data for Osaka should be regarded with extreme caution, as so few deaths there are attributed to SIDS.

For the remaining countries, the percentage of deaths occurring in the neonatal period ranged from 2 percent in Norway to 11 percent in North Rhine-Westphalia. The percentages occurring at the age of 3 months or more were fairly similar except that in Sweden and the United States they tended to be smaller.

Analysis by birth weight and gestational age

The next three figures compare the distributions of live births, neonatal deaths, and postneonatal deaths by gestational age for the countries for which this information is available. Figures 12a-b, giving gestational age and birthweight distributions for live births, is included only for comparative purposes, as these data have been explored very fully by previous speakers, particularly by Eva Alberman.[3] To improve comparability, babies with birth weights under 500 grams and births before 20 weeks of gestational age have been excluded.

In comparison with live births, figures 13a-b show that very small and very preterm babies account for a considerable proportion of neonatal deaths. Among the countries with data about gestational age, the United States stands out as having a high percentage of babies born at 20 to 27 weeks of gestation among its neonatal deaths. The difference is not so great when birth weight is used as a criterion. Although the United States has the highest percentage of babies with birth weights in the range from 500 to 999 grams, it does not stand out so prominently when all birth weights under 1500 grams are grouped together.

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[2]Barell V. Comparison of postneonatal mortality by cause, length of gestation, and birth weight.

[3]Alberman E. Survival in very low birthweight infants.

Although very small and immature babies form a much smaller percentage of postneonatal deaths, their contribution varies from country to country as figures 14a-b show. Their contribution appears to be very small in Sweden. This may be a consequence of the high percentage of missing values that may be coupled with selective under-reporting of very low birth weights and very short gestational ages. The high percentage of very low birthweight babies among postneonatal deaths in North Rhine-Westphalia is also likely to be an artifact caused by a high proportion of records having missing data. Among the remaining countries, those where babies with birth weights under 1000 grams accounted for the highest percentages of postneonatal deaths were the United States, Israel, and Osaka.

This leads to the question of the extent we should assume that different categories of death are delayed neonatal deaths. Should we, for example, take the percentage attributed to asphyxia, immaturity, or congenital malformations, or should the criteria be based on birth weight or gestational age? In the light of reporting problems, it is difficult to decide, but there is clear evidence that there are deaths in the postneonatal period that are related to conditions arising before, at, or around birth.

Multiple births

Long term trends in multiple births were mentioned in Stephen Evans' presentation.[4] Figures 15a-b shows that, as in many other developed countries, the multiple birth rate for England and Wales is rising again after many years of decline. Joel Kleinman's residual group included the increasing numbers of triplet and higher order births.[5] As these figures show, the rate doubled in England and Wales in the 1980's, and in some countries it has risen more than that. This has many consequences both for the parents and for the health and social services, including some for the provision of intensive care (13).

The distributions of age at death of singleton and multiple births in the United States are compared with those in England and Wales in figure 16. Although the differences between countries may be due to differences in reporting within countries, a higher percentage of singletons than multiples die in the postneonatal period. When analyzed by birth weight, as in figures 17a-b, a more complex picture appears, however. Interpretation of the data is not straightforward because of small numbers, but it appears that for babies with birth weights between 1000 and 3000 grams, neonatal deaths actually form a lower percentage of infant deaths of babies from multiple births than of singletons.

Discussion

Although the focus here has been on the leveling off of postneonatal mortality rates, the infant mortality rate has stopped falling in some countries, notably the Scandinavian countries and the Netherlands and Switzerland. The rate in the United States is still falling, but up to 1988 the rate in England and Wales appeared to be leveling off and even rose in 1986. On this occasion, the Prime Minister responded by saying that this figure might be a statistical error, but no such qualms were expressed when there was a larger than usual fall in 1989 (14)! It remains to be seen whether this decrease continues or is anomalous. It is tempting to suggest, more generally, that we may be approaching irreducible minimum values, but this is called into question by the social and cultural inequalities within every country for which data have been presented at this Symposium.

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[4] Evans S. Birth weight and survival in multiple births.

[5] Kleinman J. Implications of differences in birthweight distribution for comparisons of birthweight-specific mortality.

If the infant mortality rate is beginning to level off more generally, it is time to consider Eva Alberman's question of whether mortality is being delayed further, perhaps into the second year of life or later into childhood[3]. This leads to the related question of the extent to which mortality is the right measure to use and to John Kiely's challenge to the assumption that the reduction of mortality should be our only objective.[6]

The question of the reporting of late fetal deaths and the cutoff point for stillbirths has already been discussed. In England and Wales the gestational age limit for stillbirth registration is inextricably linked to the law on legal abortion, and this imposes constraints. Yet it is important to remember that an anencephalic pregnancy represents a loss to parents, irrespective of whether it appears in the statistics of legal abortion, stillbirth, or infant death.

Looking at the borderline between mortality and morbidity, there is an increasing body of research, some of it done by participants in this Symposium, that shows disturbing increases in cerebral palsy and other forms of morbidity. It is no longer believed that cerebral palsy is largely a consequence of poor obstetric care, so the increases in incidence raise other issues.

In describing trends and variations in postneonatal mortality, we have raised questions that it is impossible to answer using existing routine statistics alone. It is now time to develop new methods of monitoring trends and, at the same time, new measures of morbidity for use alongside our existing measures of mortality.

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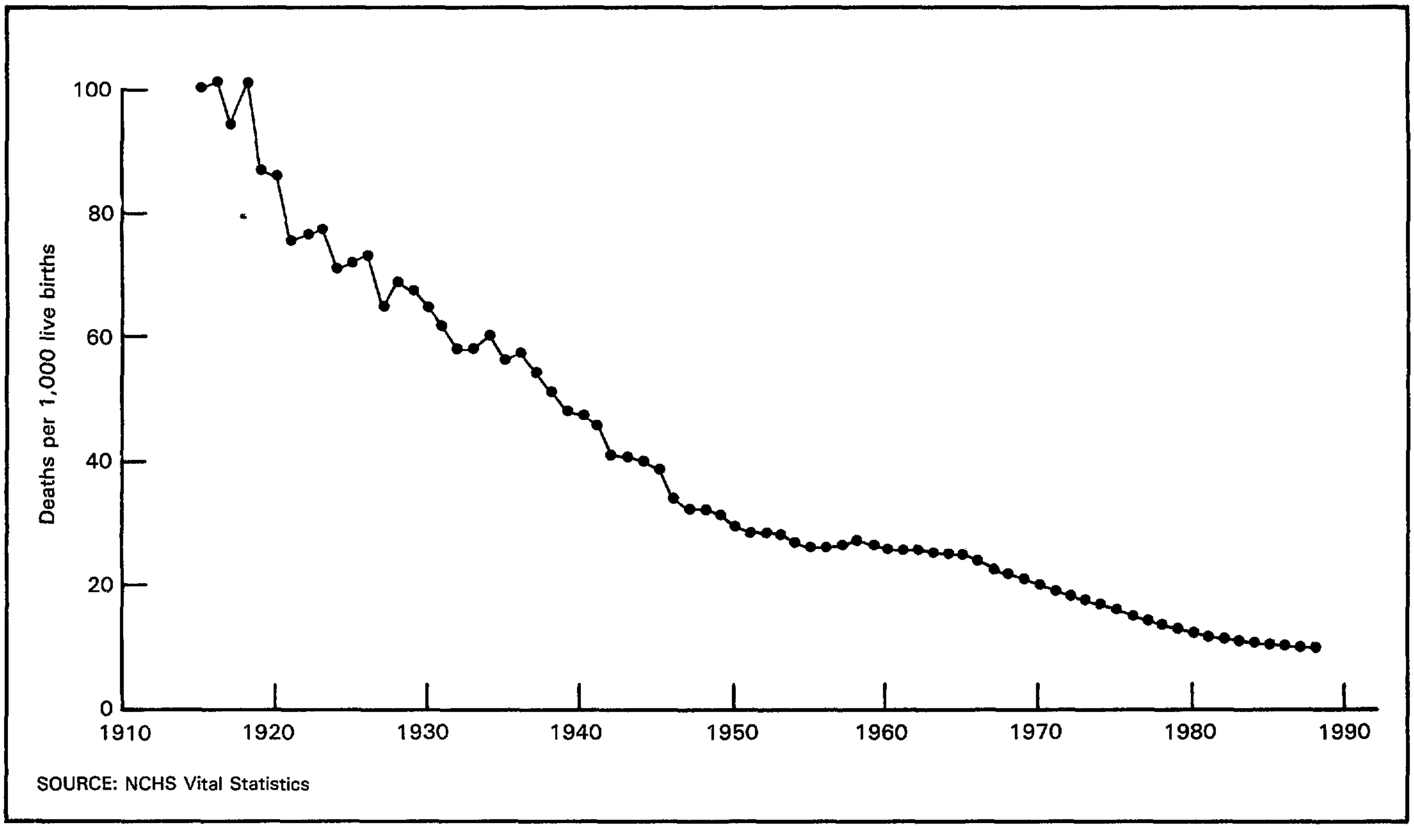


Figure 1a. Long term trends in infant mortality: United States, 1915–88

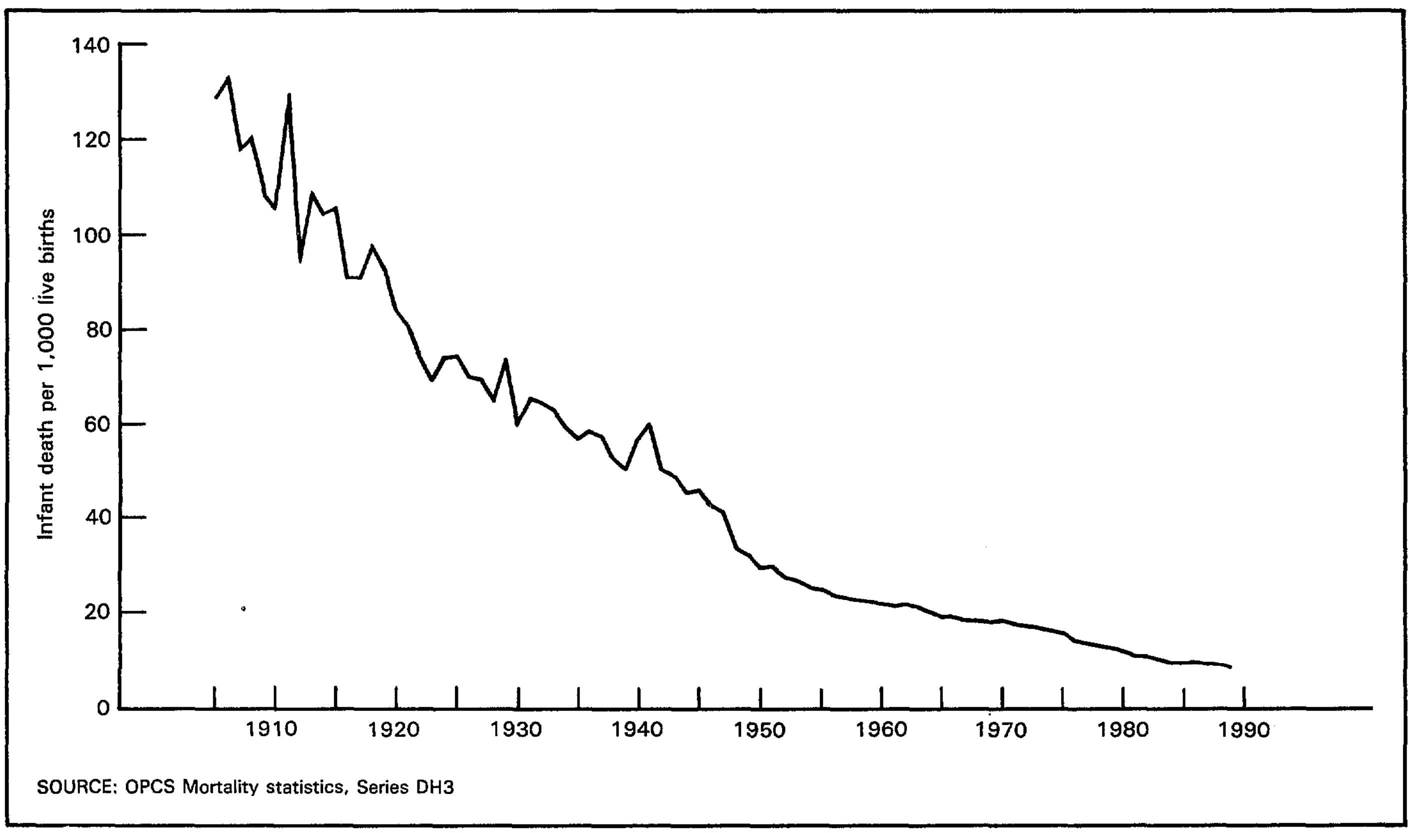


Figure 1b. Long term trends in infant mortality: England and Wales, 1905–89

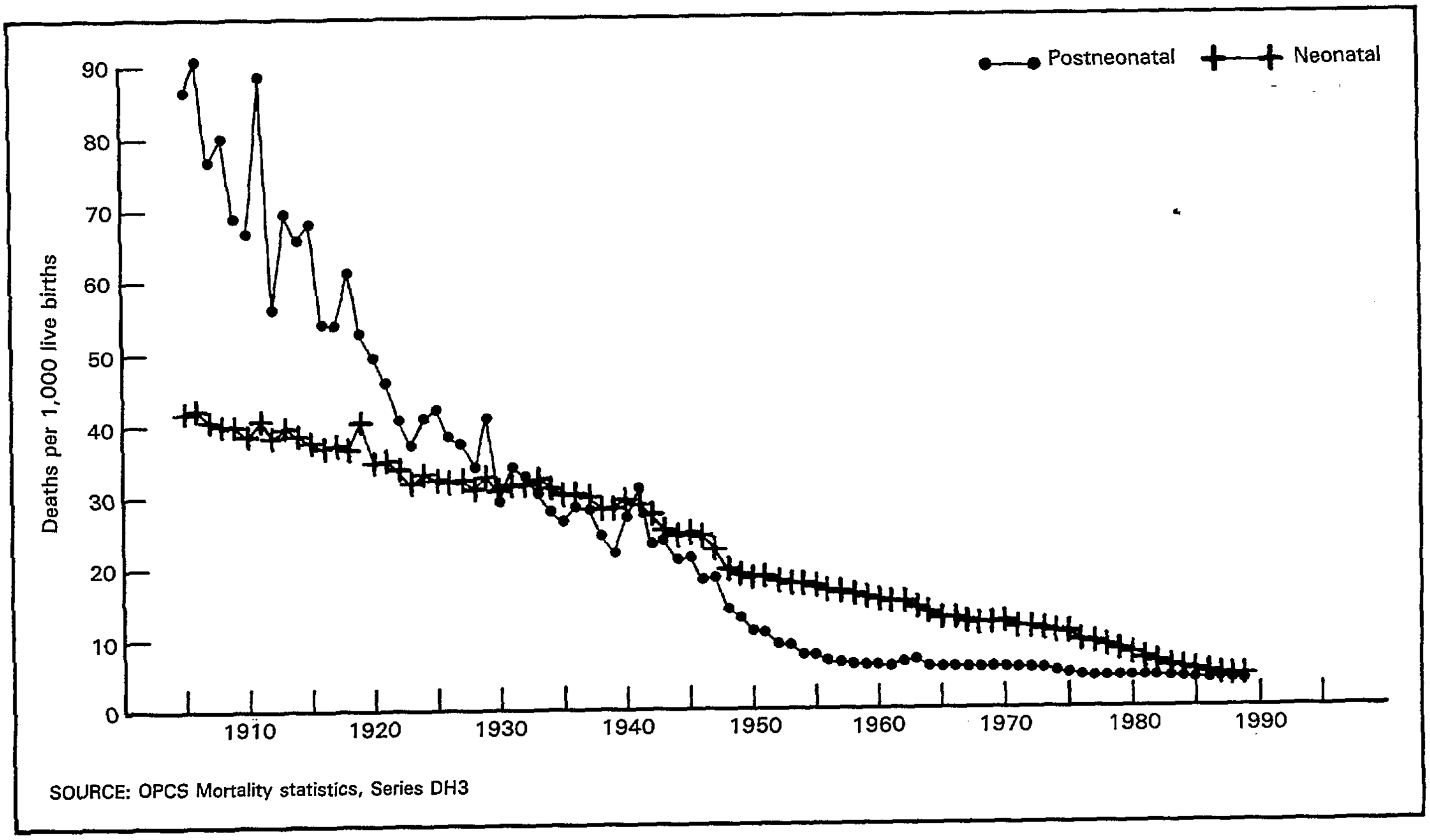


Figure 2. Trends in neonatal and postneonatal mortality: England and Wales, 1905–89

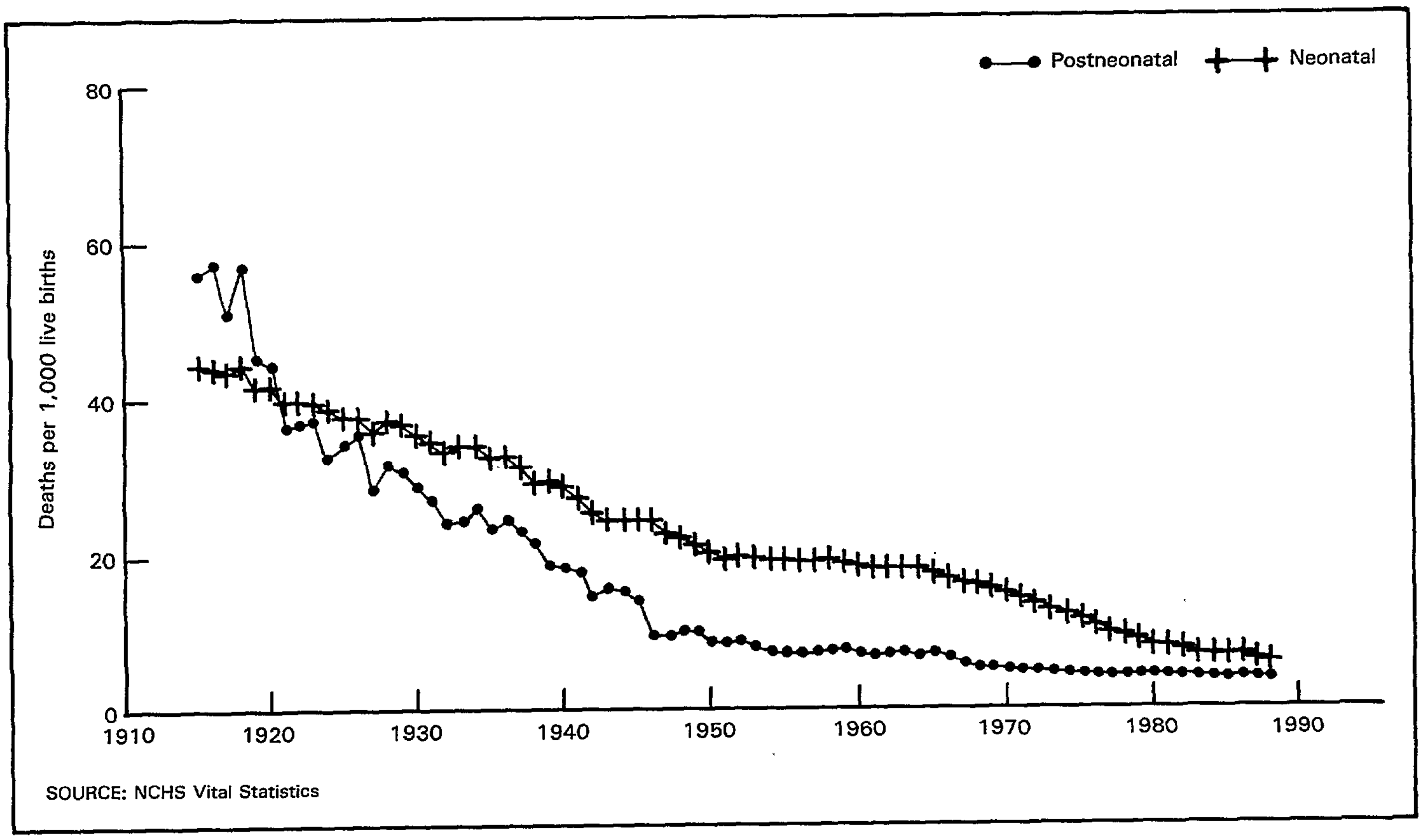


Figure 3. Trends in neonatal and postneonatal mortality: United States, 1915–88

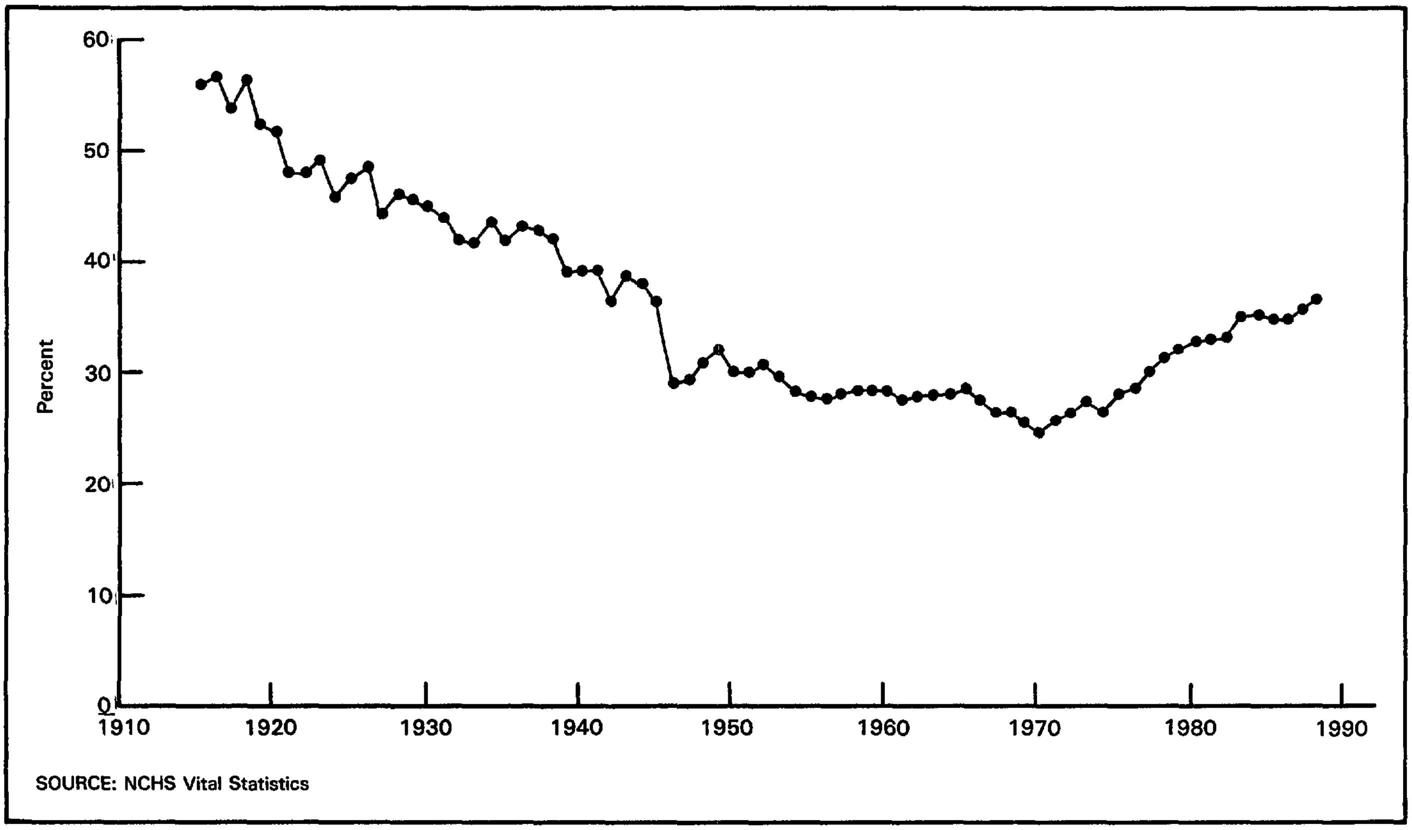


Figure 4a. Postneonatal mortality as a percentage of infant mortality: United States, 1915–88

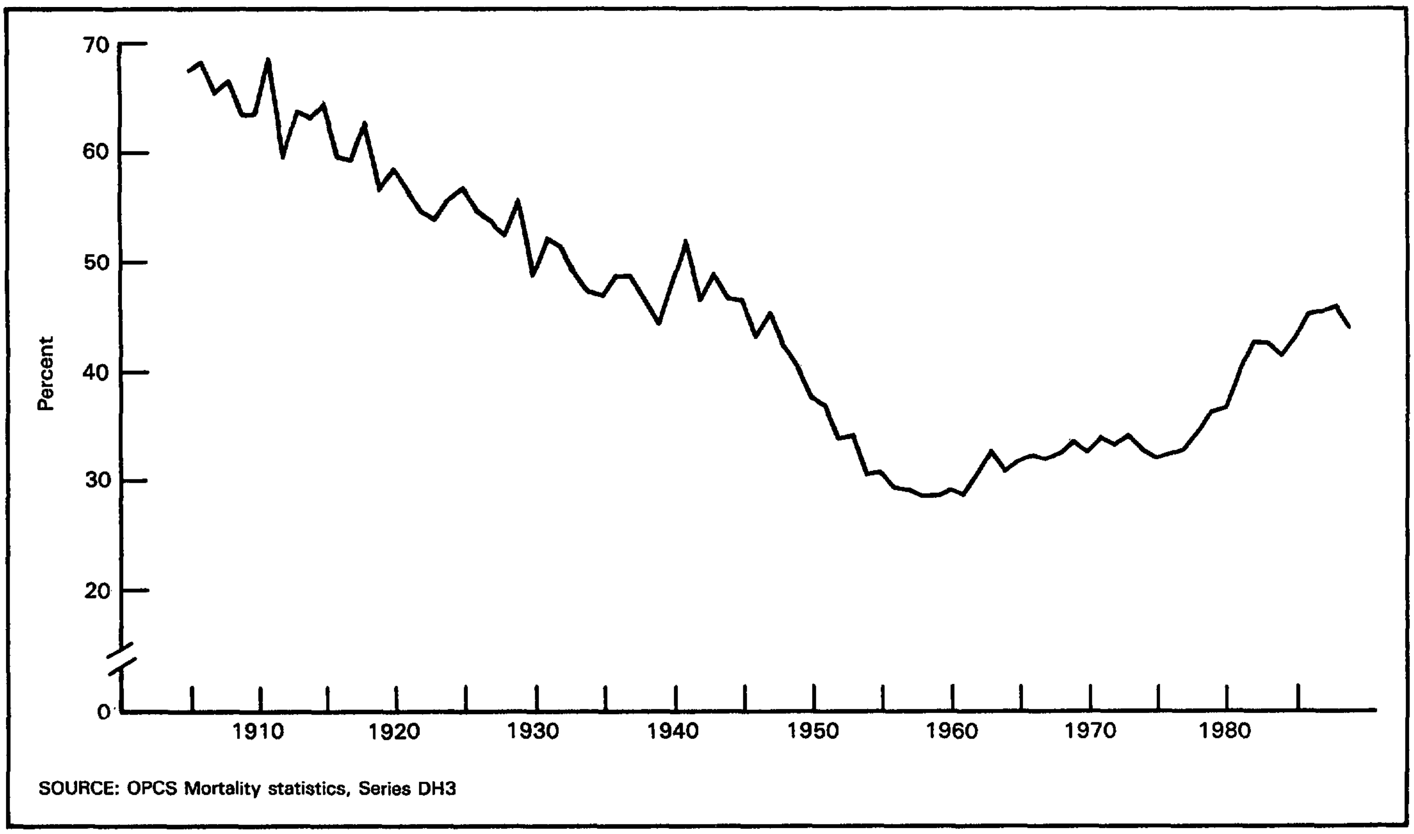


Figure 4b. Postneonatal mortality as a percentage of infant mortality: England and Wales, 1905–89

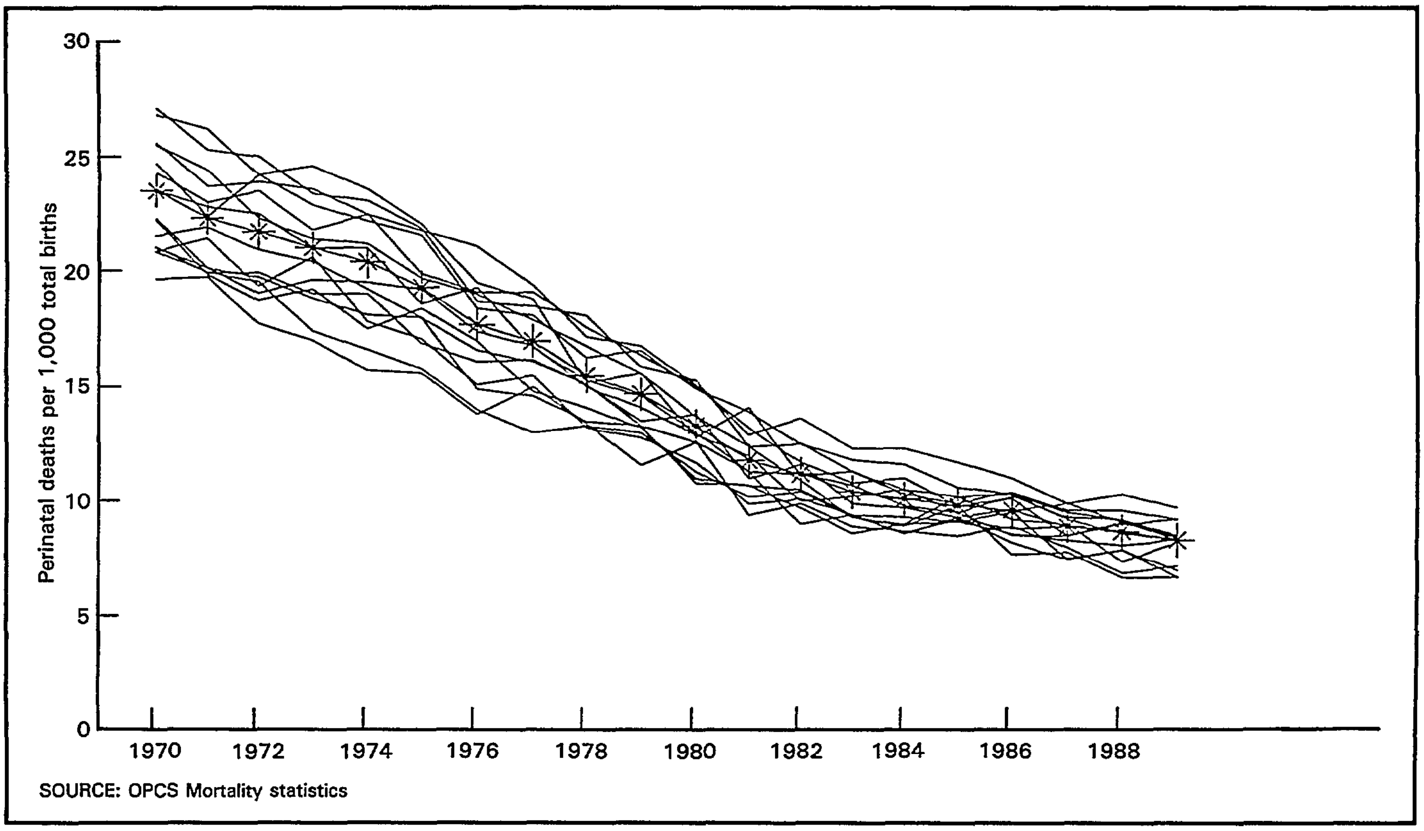


Figure 5a. Regional trends in perinatal mortality: England and Wales, 1970–89

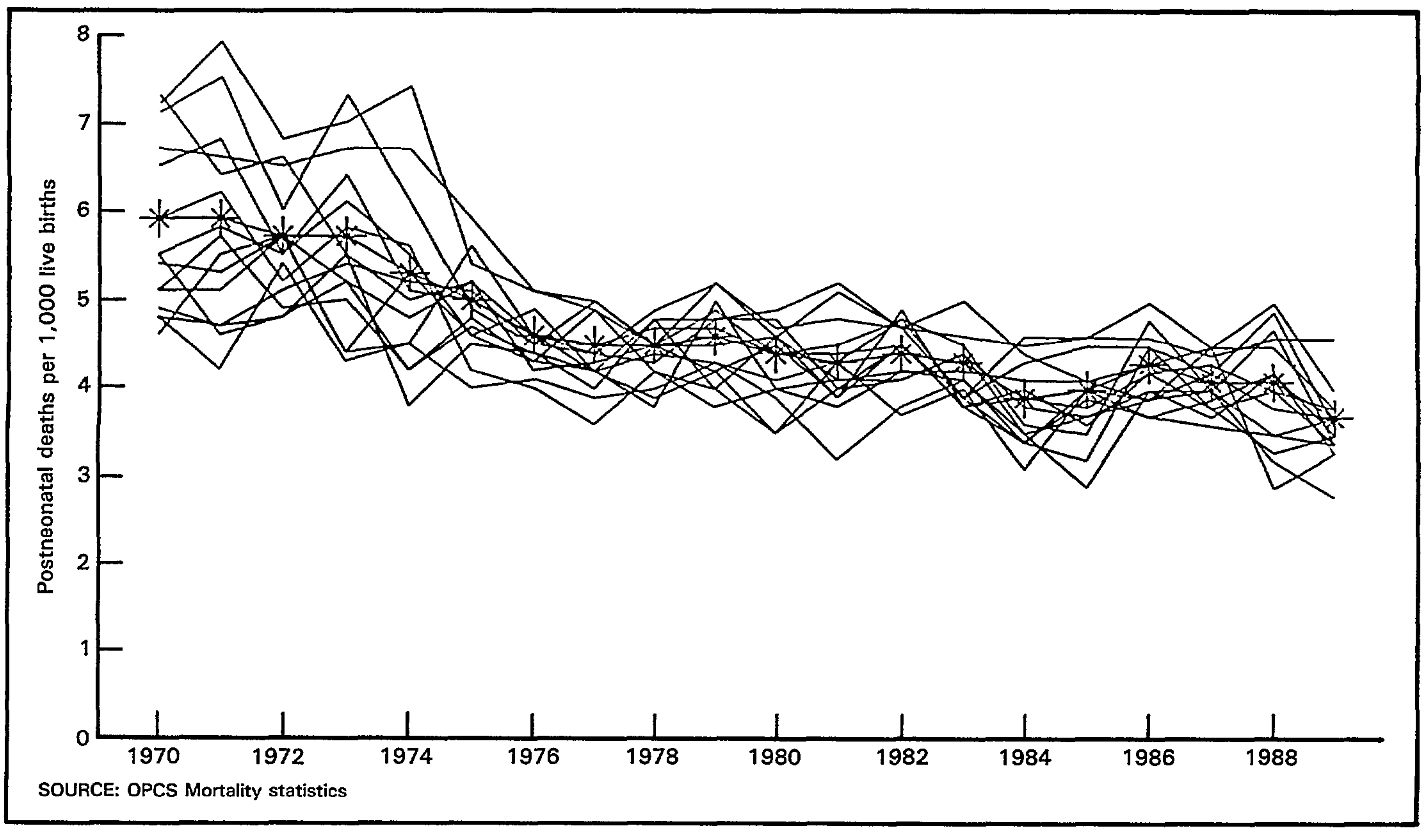


Figure 5b. Regional trends in postneonatal mortality: England and Wales, 1970–89

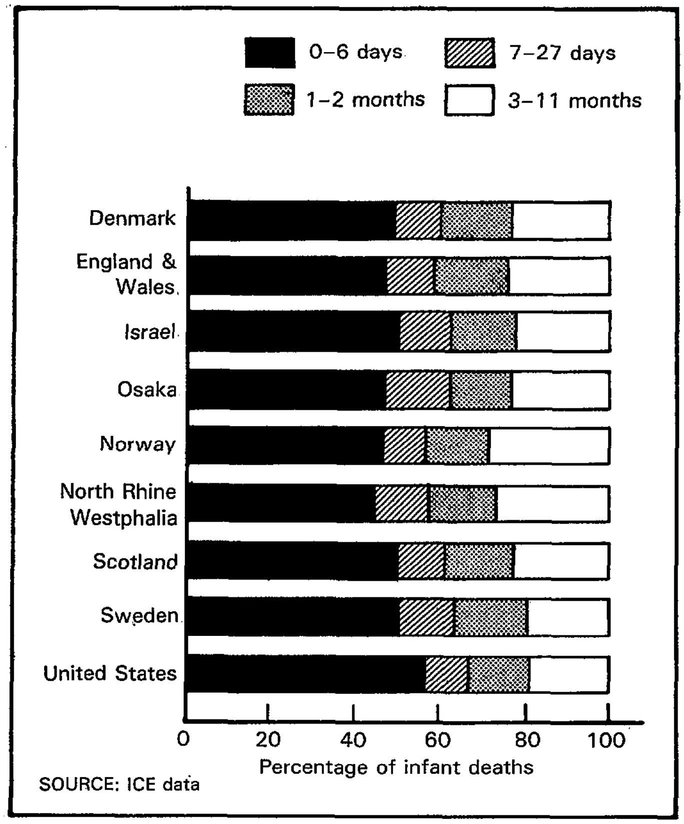


Figure 6. Age distribution of infant deaths: ICE countries, 1982–84

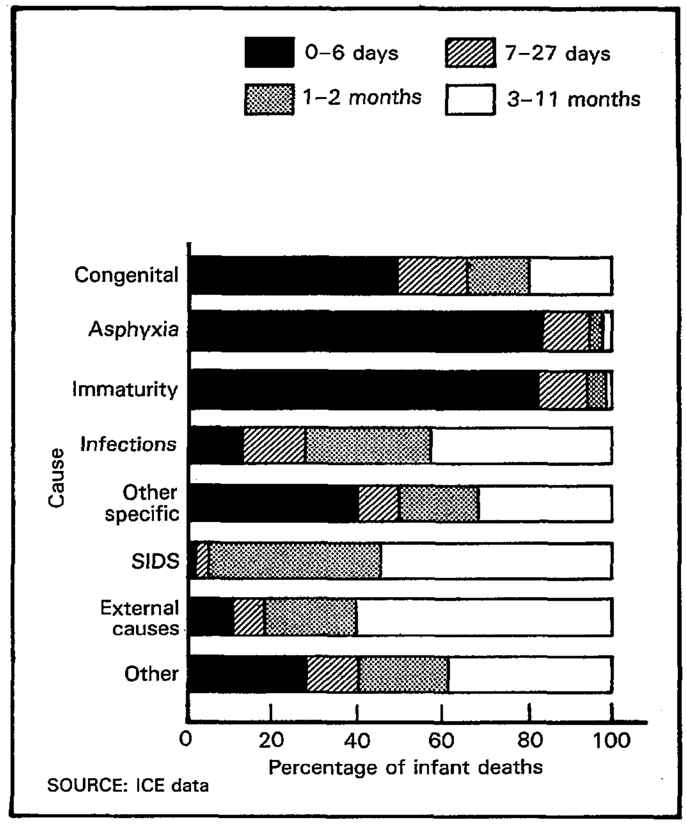


Figure 7. Age distribution of infant deaths by cause: England and Wales, 1982–84

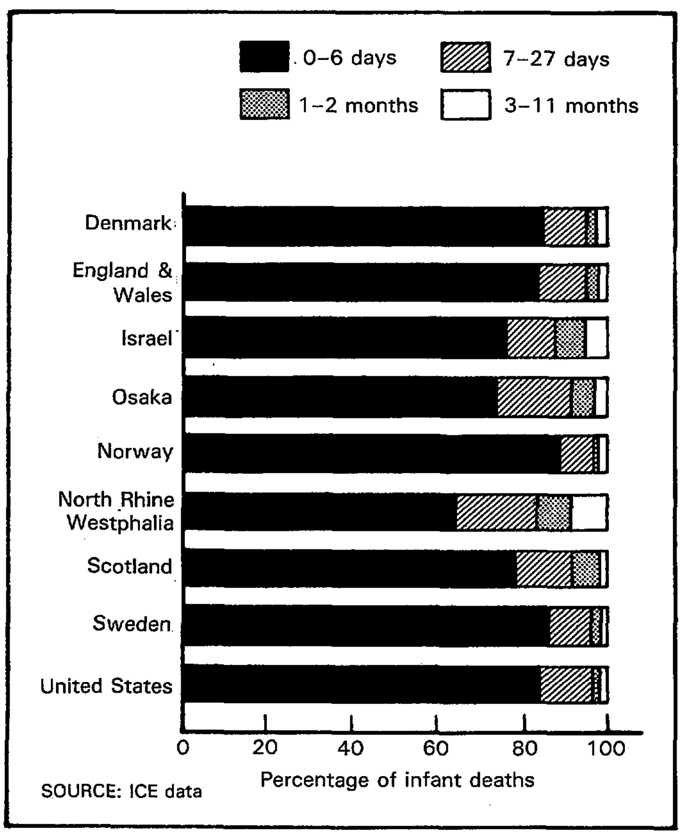


Figure 8a. Age distribution of infant deaths due to asphyxia: ICE countries, 1982–84

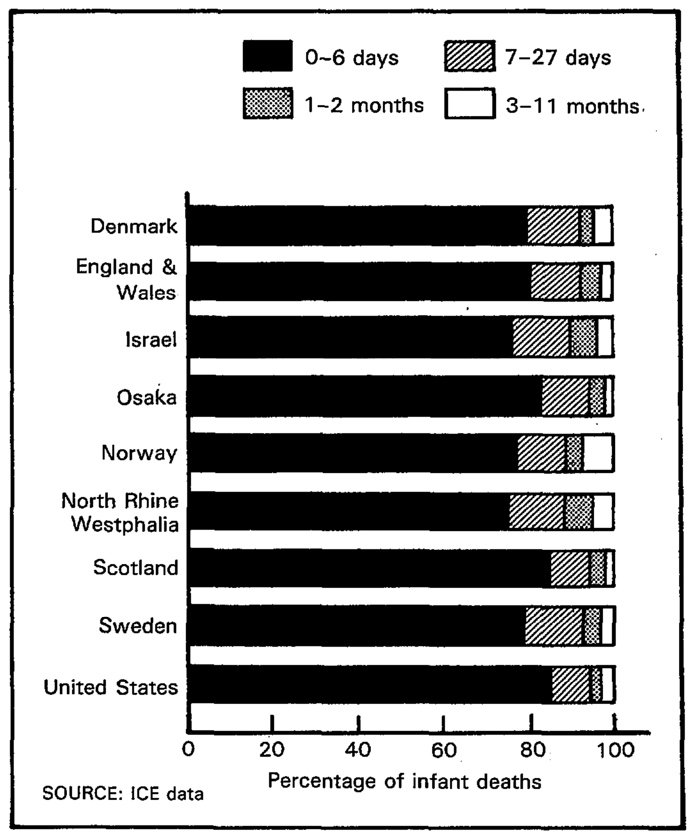


Figure 8b. Age distribution of infant deaths due to immaturity: ICE countries, 1982–84

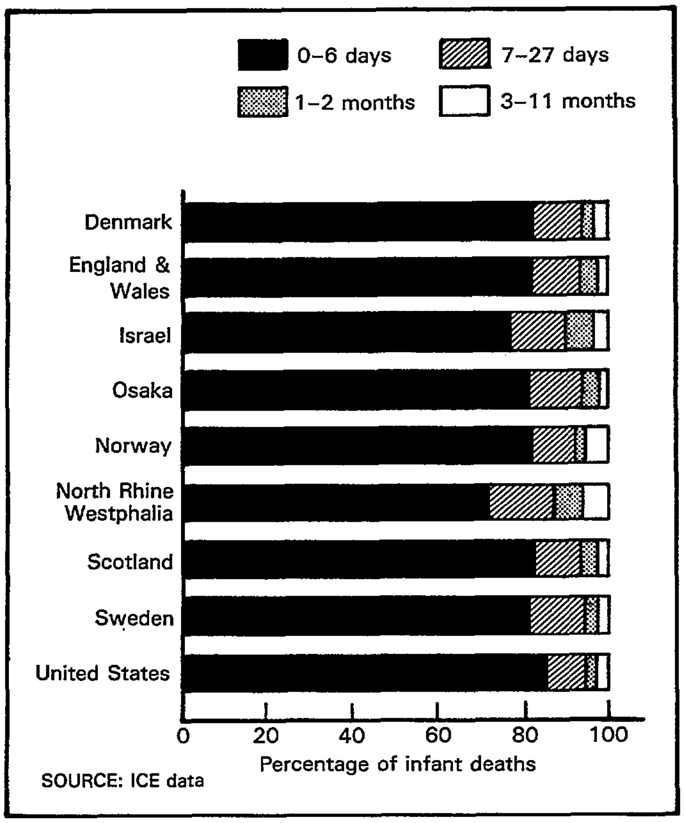


Figure 9. Age distribution of infant deaths due to asphyxia and immaturity combined: ICE countries, 1982–84

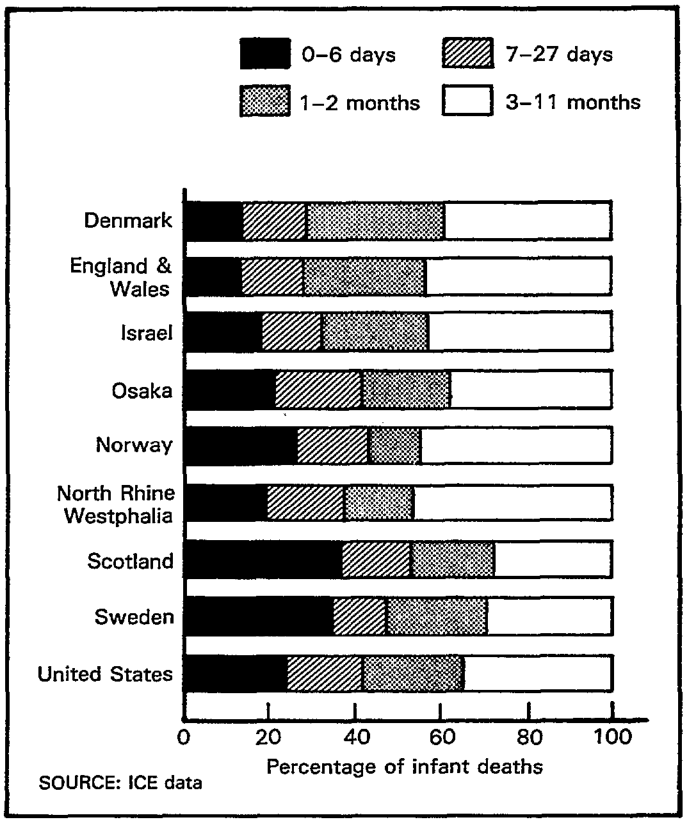


Figure 10. Age distribution of infant deaths due to infection: ICE countries, 1982–84

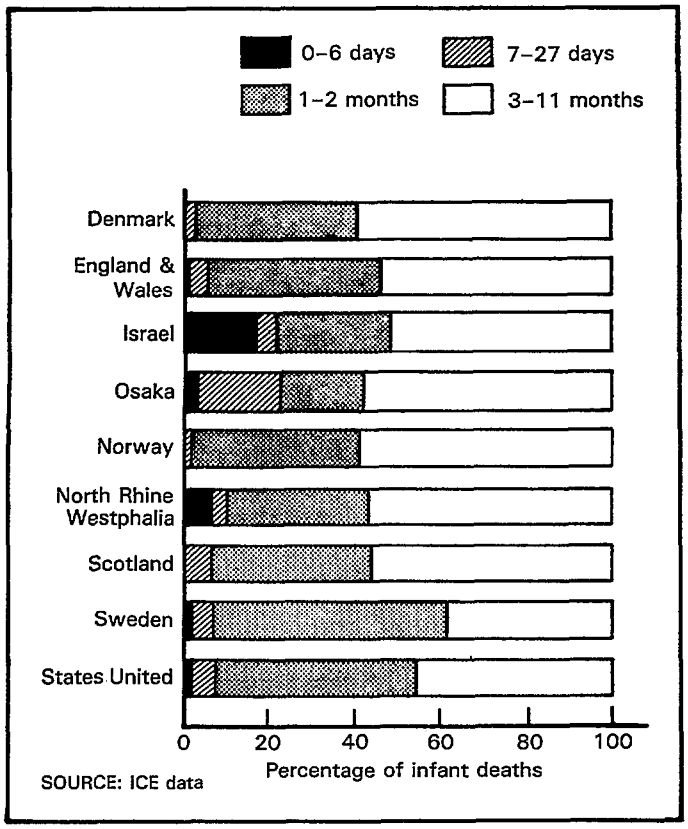


Figure 11. Age distribution of infant deaths due to SIDS: ICE countries, 1982–84

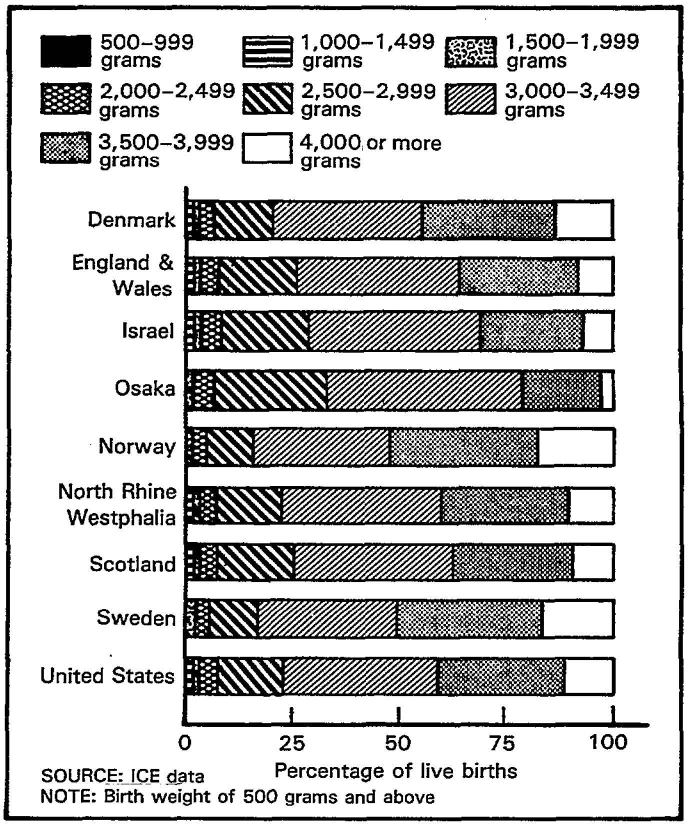


Figure 12a. Birth weight distributions of live births: ICE countries, 1982–84

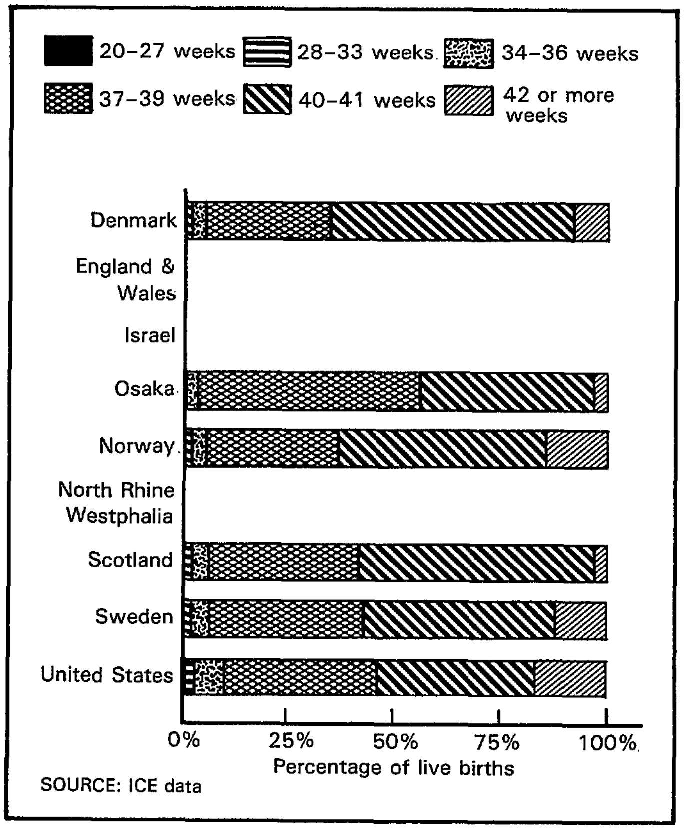


Figure 12b. Gestational age distributions of live births: ICE countries, 1982–84

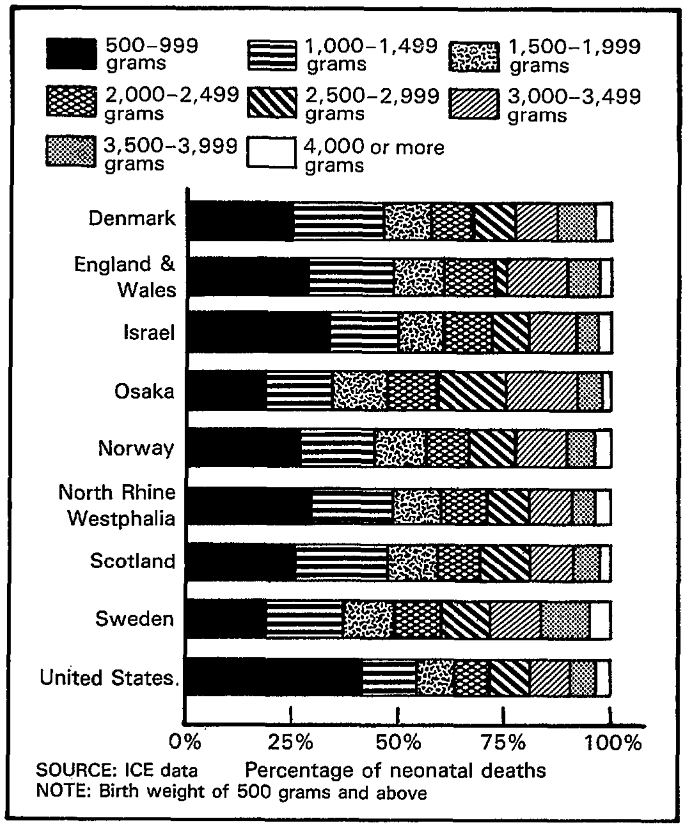


Figure 13a. Birth weight distributions of neonatal deaths: ICE countries, 1982–84

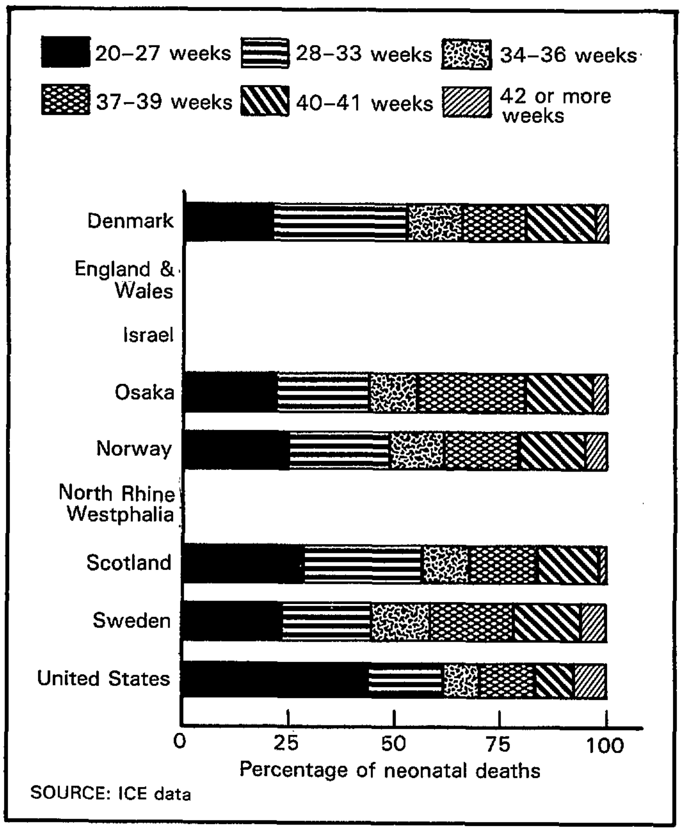


Figure 13b. Gestational age distributions of neonatal deaths: ICE countries, 1982–84

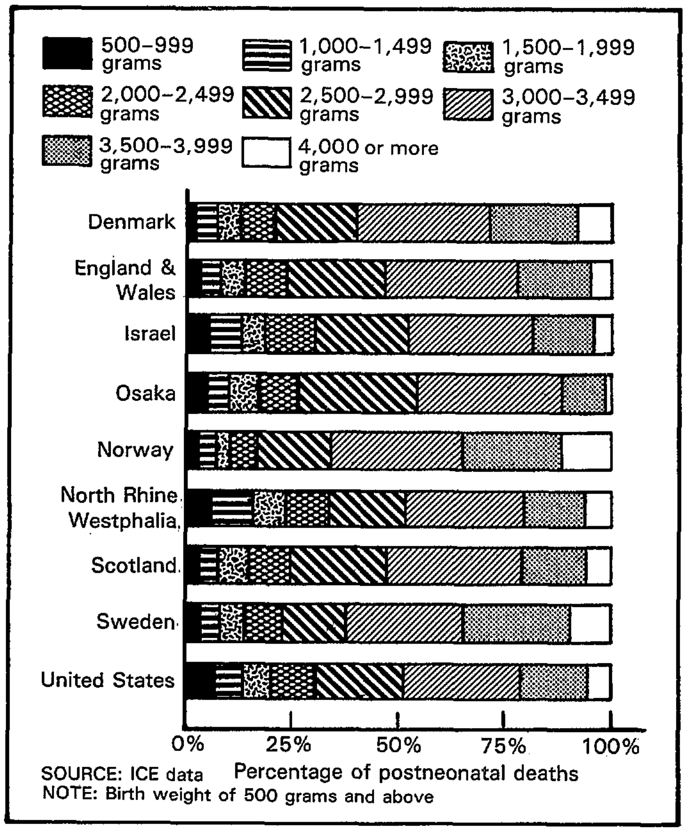
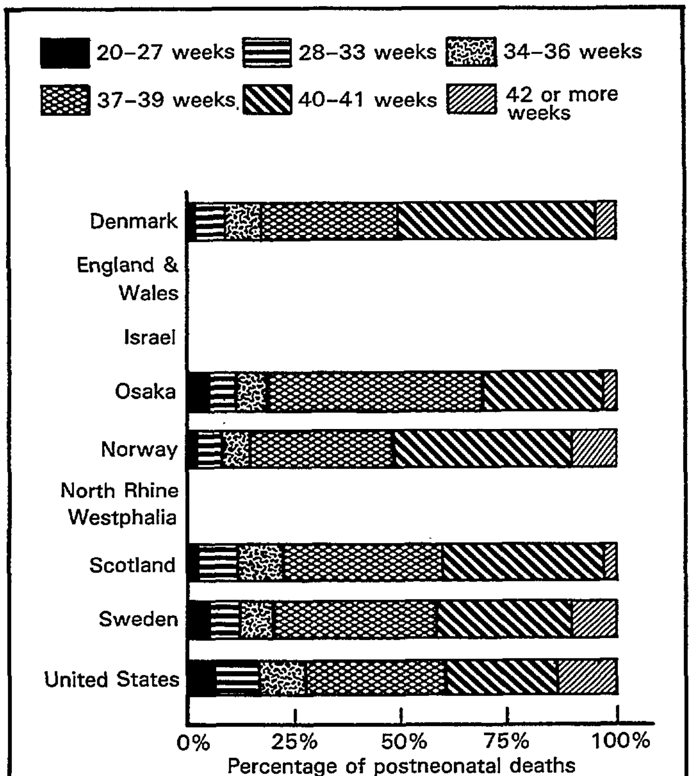
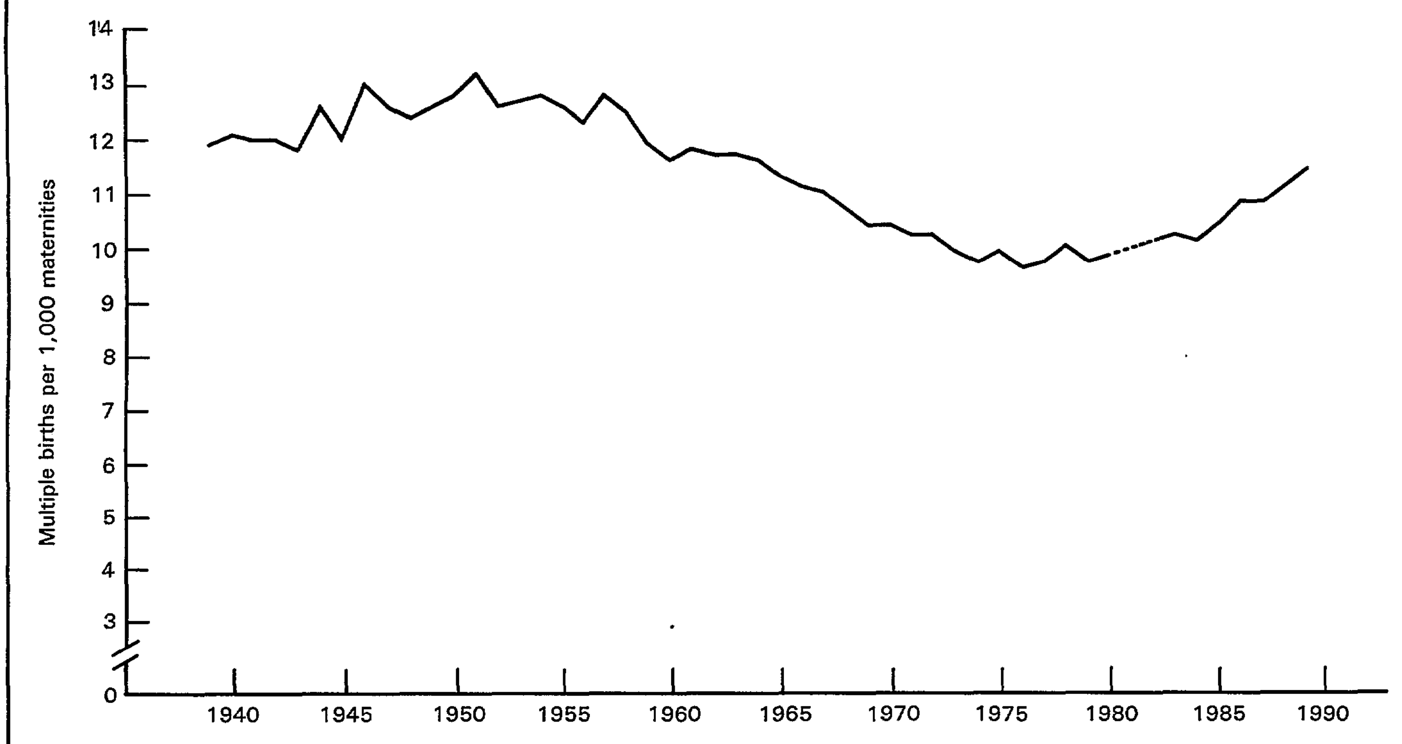


Figure 14a. Birth weight distributions of postneonatal deaths: ICE countries, 1982–84



SOURCE: ICE data

Figure 14b. Gestational age distributons of postneonatal deaths: ICE countries, 1982-84



SOURCE: OPCS Birth statistics, Series FM1

Figure 15a. Trends in multiple births: England and Wales, 1939-89

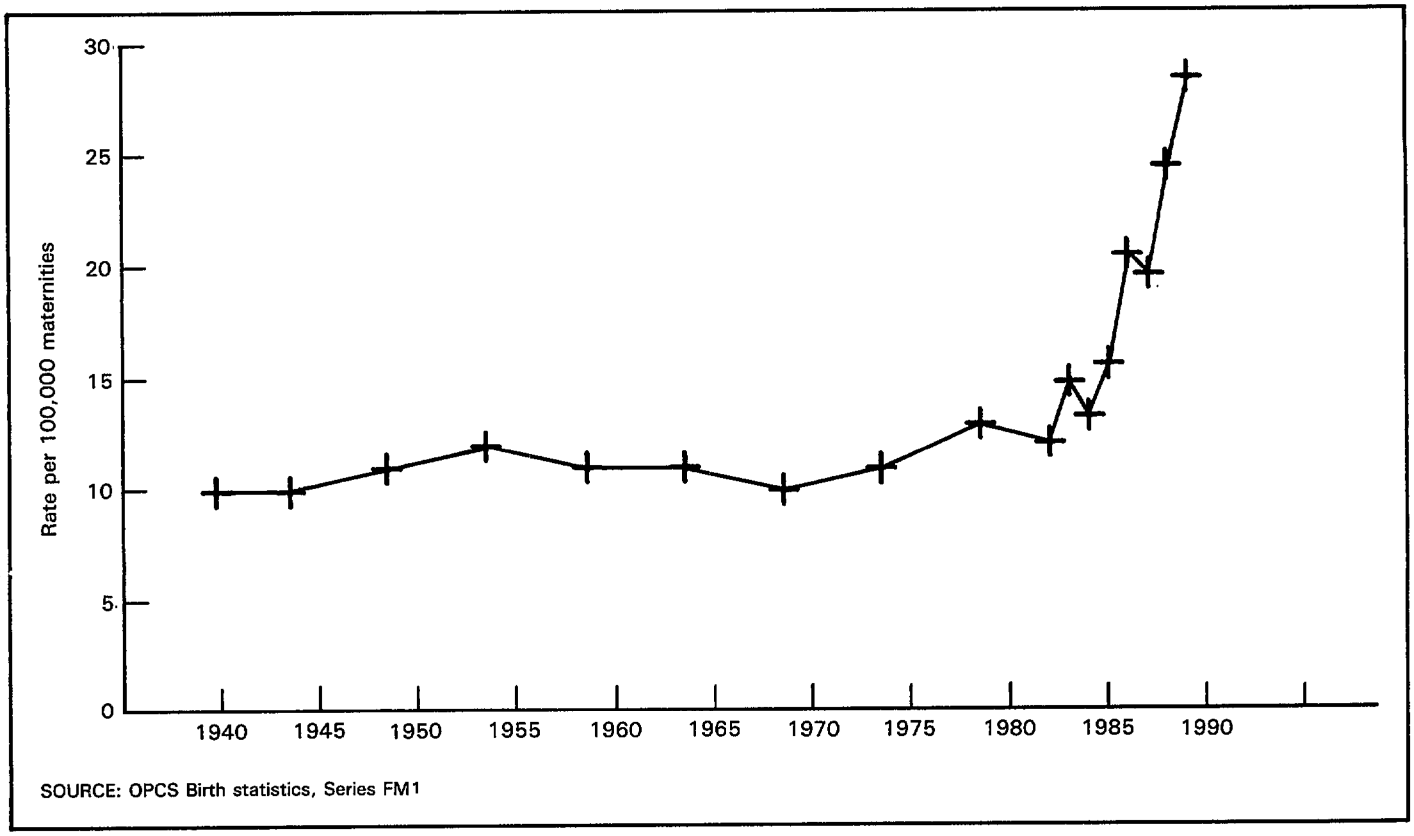


Figure 15b. Trends in triplets and higher order births: England and Wales, 1939–89

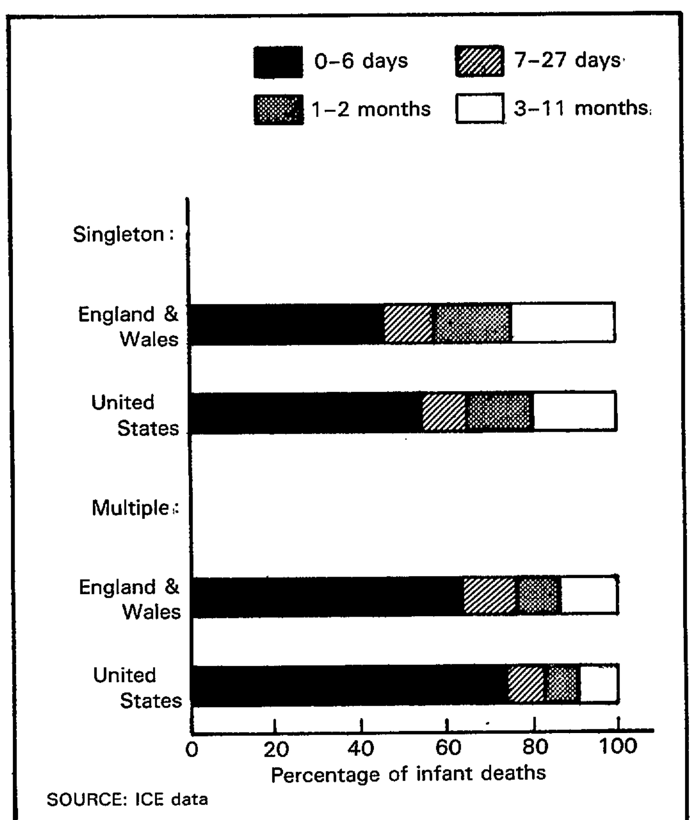


Figure 16. Age distribution of infant deaths among singleton and multiple births: United States and England and Wales

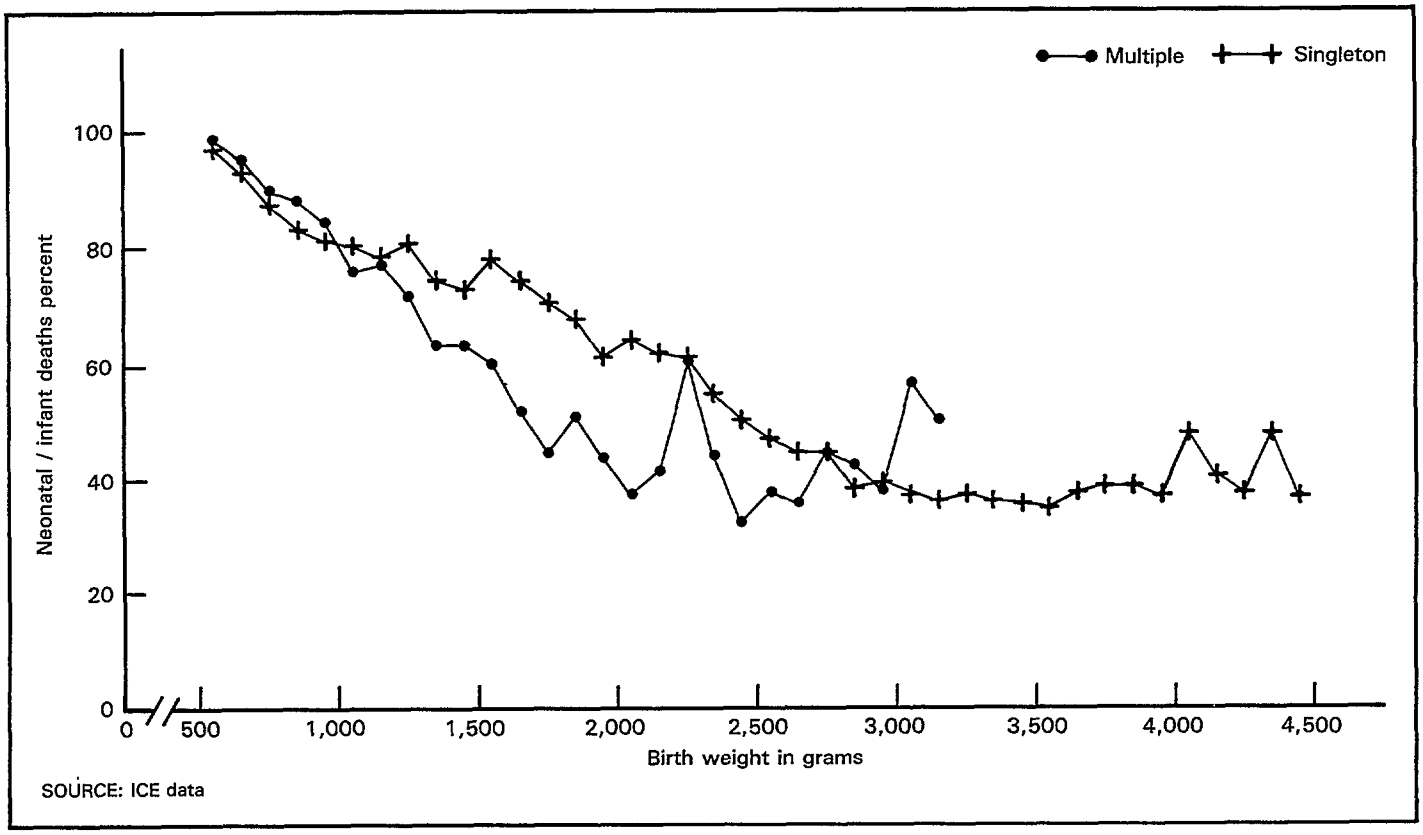


Figure 17a. Neonatal deaths as a percentage of infant deaths, singleton and multiple births by birth weight, United States

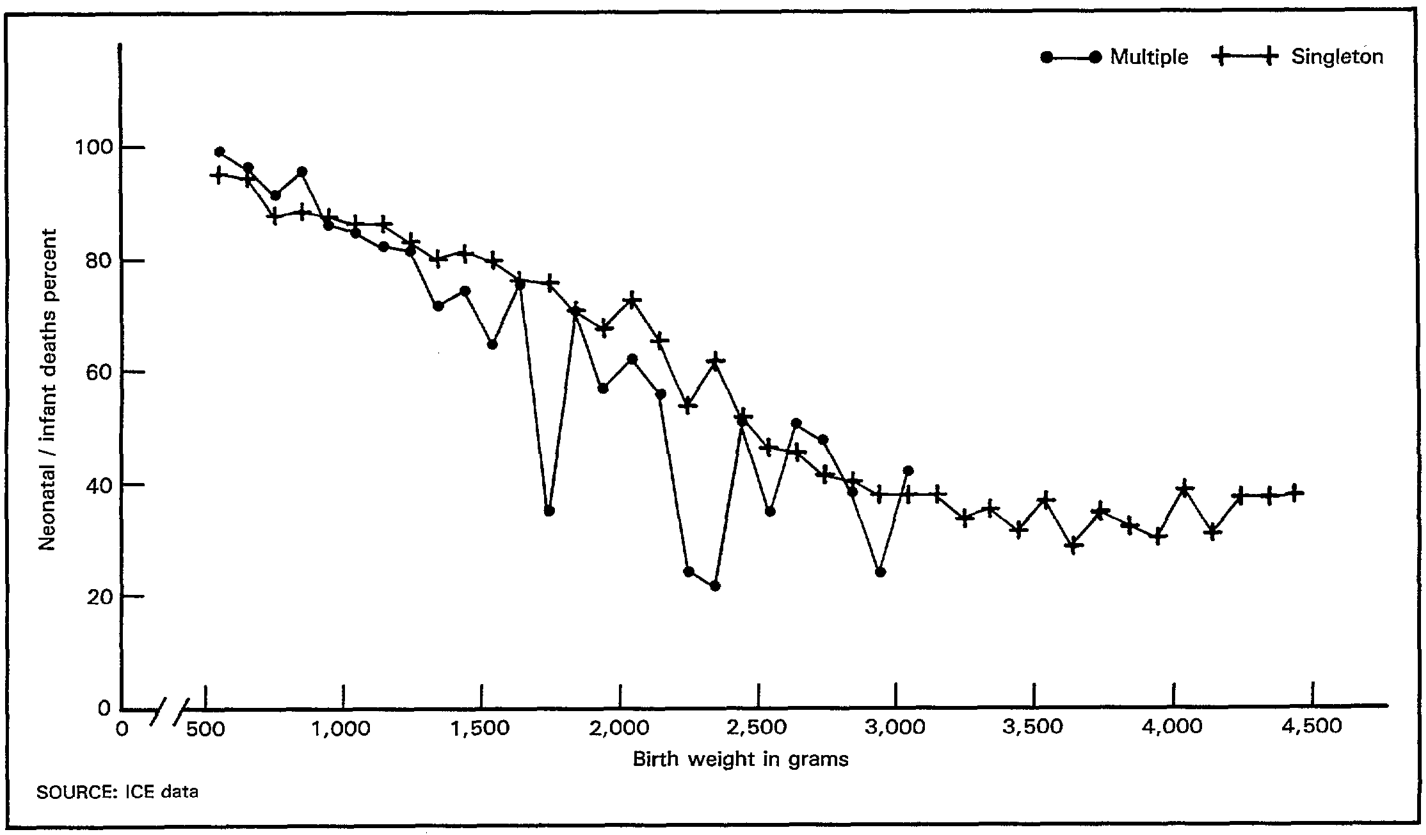


Figure 17b. Neonatal deaths as a percentage of infant deaths, singleton and multiple births by birth weight, England and Wales

Optimal Conditions for Survivorship--
What Can We Expect to Achieve?

by Sven Cnattingius, M.D., Leiv Bakketeig, M.D.,
Bengt Haglund, D.M.Sc., and Brian McCarthy, M.D.

During the 20th century, the declines in stillbirth and infant mortality rates have been dramatic in the Western World. In figure 1 these death rates are shown for Sweden from the Second World War onwards. Since 1945, stillbirth rates have decreased from over 20 per 1,000 to about 4 per 1,000. A similar dramatic decrease has also been observed for neonatal deaths. During this period of time, the improvements in postneonatal death rates have been far less. Similar trends in mortality rates have also been observed in several other countries.

Although dramatic improvements in survivorship have occurred, today there are considerable differences in mortality rates between and within countries. Given these findings, what are the most important risk factors for adverse pregnancy outcome today, and what level of mortality rates can we expect to achieve in an extremely low-risk population?

The level of care (antenatal, obstetrical, and pediatric care), socioeconomic status, and smoking habits represent three important factors that are associated with pregnancy outcome. In the long run, socioeconomic status probably is the most important factor, and socioeconomic conditions correlate with smoking as well as with the level of care during pregnancy. However, cigarette smoking and probably health care also have a direct influence on pregnancy outcome.

How important is antenatal care? If we try to evaluate antenatal care by register studies, we are faced with great methodological difficulties. During the recent two decades, antenatal care has increasingly focused on fetal well-being, and many systems aiming at the detection and supervision of risk pregnancies have been developed. During the same time period, birthweight-specific late fetal mortality rates have dropped in parallel in almost all birth weight groups. However, the decline in late fetal mortality started before modern technology focusing on fetal well-being was introduced in antenatal care. Thus, several other factors are also likely to have influenced this development.

During the last two decades, neonatal intensive care procedures have been developed with the objective of improving the prognosis for the extremely low birthweight infant. Figure 2 shows the rate of survival of infants with birth weights under 1000 grams in Sweden from 1973 to 1988, a total of 2,174 infants. As the figure shows, survival has increased dramatically during these years. The improved survival started in the latter half of the 1970's and continued until the early 1980's. From 1983-84, the survival curve has flattened out and even seems to have dropped somewhat.

Such observations as the ones presented here have to be interpreted with caution. Some of the components of care have been evaluated applying more strict scientific methods. However, although the overall impact of antenatal, perinatal, and neonatal care is likely to be substantial, the impact still remains to be quantified properly.

If we then turn to cigarette smoking, two large register studies (1,2) have found that maternal cigarette smoking increases the risk of late fetal death by 20 to 60 percent (table 1). Today a causal relationship between fetal growth and maternal smoking must be considered well established (3). In perinatal audit studies, fetal growth retardation has been assessed as one of the most important factors for late fetal death (4). Thus, it seems logical that smoking may also influence fetal death.

The influence of smoking on neonatal and postneonatal mortality has also been evaluated. In the Missouri data (5), there was increased risk for neonatal, and in particular postneonatal, mortality if the mother stated that she was a daily smoker during pregnancy. In the Swedish data, the risk estimates were less-- practically no risk increase for neonatal mortality and a nonsignificant risk increase in postneonatal mortality.

However, this difference of smoking as a risk factor for infant death may be attributed to differences in causes of death between the countries. Figure 3 illustrates infant mortality rates for different countries from 1980 to 1985. Each bar is divided into mortality caused by congenital malformation and other causes of death. There are great differences in infant mortality rates. However, the rates of infant mortality caused by congenital malformation are rather stable across the countries. Thus, in Sweden, the overall infant mortality rate was 6.9 per 1,000 live births. Thirty-eight percent of these infants were malformed. Among U.S. whites, the infant mortality rate was 9.1 per 1,000, of which 28 percent were malformed. At the extreme, U.S. blacks had an infant mortality rate of 19 per 1,000, of which 15 percent were malformed.

The great differences between ICE countries in late fetal death and infant mortality are probably to a major extent the result of the direct or indirect influence of socioeconomic differences. However, socioeconomic differences in pregnancy outcome are also present in the most favored nations, such as the Scandinavian countries. From a hypothetical point of view, it may be interesting to look at mortality rates of infants among the most privileged women in a low risk country.

We used the Swedish Medical Birth Register from 1985 to 1986 and census data from 1985 to answer this question. We looked at 20- to 29-year-old nonsmoking women, nonmanual employees of intermediate level, delivering single births. About 15,400 such women were found (8 percent of the birth population). The overall mortality rate among single births was reduced by 60 percent. The stillbirth rate was 2.1 per 1,000, the neonatal death rate was 1.8 per 1,000, and the postneonatal death rate was 1.5 per 1,000. Thus, if a homogeneous low risk population is offered adequate antenatal, obstetrical, and neonatal care, the overall late fetal and infant mortality rate among single births may be as low as 5.4 per 1,000.

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2. Kleinman J, Pierre MB, Madans JH, Land GH, Schramm WF. The effects of maternal smoking on fetal and infant mortality. Am J Epidemiol 127:274-82. 1988.

3. Sexton M, Hebel RH. A clinical trial of change in maternal smoking and its effects on birth weight. JAMA 251:911-5. 1984.

4. Mersey Region Working Party on Perinatal Mortality. Confidential inquiry into perinatal deaths in the Mersey region. Lancet 1:491-4. 1982.

5. Madans MH, Kleinman JC, Land GH, Schramm WF. The association of maternal smoking with age and cause of infant death. Am J Epidemiol 128:46-55. 1988.

Table 1. Adjusted relative risks (95 percent confidence interval) for smoking

	Late fetal death	Neonatal mortality	Postneonatal mortality
Sweden 1985-86	1.6 (1.3-1.9)	1.1 (0.9-1.3)	1.3 (1.0-1.6)
Missouri 1979-83	1.2-1.6*	1.2 (1.1-1.3)	1.6 (1.4-1.9)

*Data were analyzed in four classes with respect to differences in parity and amount smoked per day.

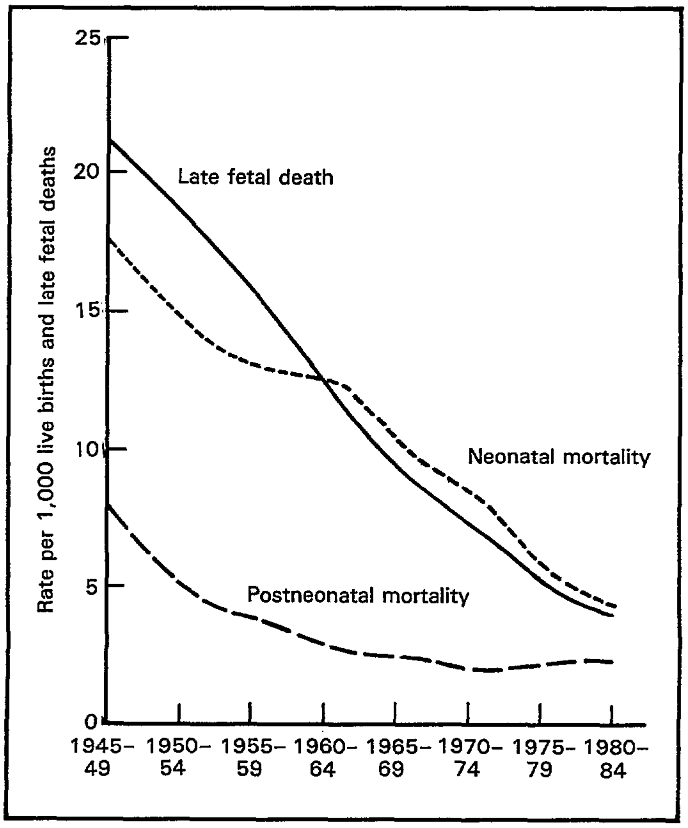


Figure 1. Late fetal death and infant mortality rates per 1,000: Sweden, 1945–84

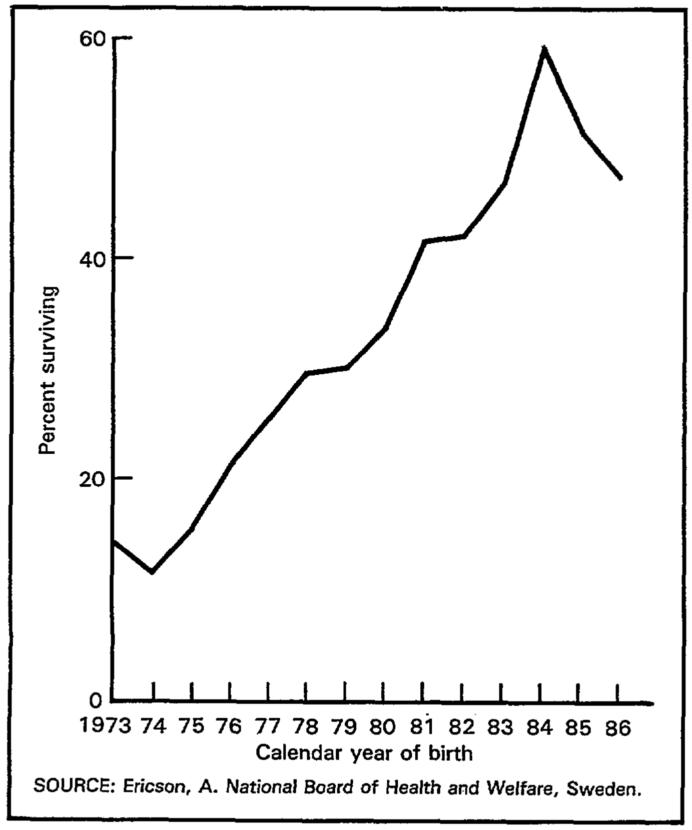


Figure 2. Time trends in survival in live births weighing less than 1,000 grams: Sweden, 1973–86

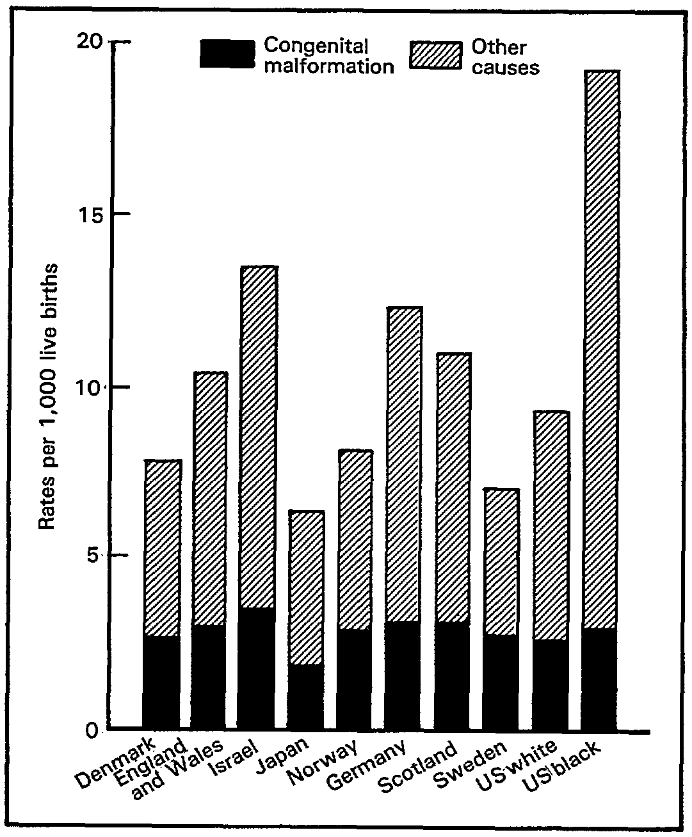


Figure 3. Infant mortality per 1,000 live born in nine countries, caused by congenital malformation or other causes of death: ICE *countries, 1980–85*

Discussion

DR. GOLDING: Could I aim a question at Stephen Evans concerning the twins data? I was involved in the WHO Collaborative Study, which analyzed 1973 vital statistics from a group of countries that bear a striking similarity to the ICE countries. It included Japan, Sweden, the United States, and England and Wales, and in analyzing the twin data, there were obvious gaps in the vital registration data. For example, if one of a pair of twins had died, then the surviving child was counted as a singleton in several countries; there were other countries where the multiplicity of the pregnancy was not recorded in a strikingly large proportion of cases. I wonder whether there are still gaps in the registration systems?

MR. EVANS: My own view is that you are quite right about that as a general problem. I think that in more recent years the data quality has improved. We have seen those problems occurring in Israel, and I think they have occurred on occasion in Norway. When we had our strike in 1981 (in England and Wales), I think we also had problems.

I think the most interesting problem in a sense is the one of the vanishing fetus. A recent paper, published by some Israelis, reports that we are now able to detect through ultrasound the fact that there are multiple pregnancies that become singletons by the time they are delivered. Undoubtedly in the past those have not been detected; there are now instances where the second twin is detected, but where we draw the line will depend very much on the diagnostic capabilities of the individual unit in an individual pregnancy. It will probably require a clinician, someone like Per Bergsjø or some of the other clinicians who are here, to be able to make a full comment on that, but it is a major problem. I have always held the view that quite a lot of our low birthweight singletons may well be surviving twins.

MS. MACFARLANE: Could I just add to that? In England and Wales the law is that, in the event of a multiple pregnancy, you can only register the live birth(s) and not any fetal deaths occurring before 28 weeks. In addition, in the triplet study that Stephen Evans mentioned, more selective ultrasound scans were done for women who had received infertility treatment of some sort. This is not surprising because scanning is part of the process of evaluating the success rate of the infertility treatment. Thus, there will probably be selectively higher detection rates of fetal loss where mothers have had infertility treatments that resulted in multiple births.

MR. EVANS: Sorry, could I come back to that again? Certainly in the England and Wales data, and I suspect elsewhere among the multiples, there is an excess of fetal deaths at the minimum gestational age for registration.

What is happening--certainly in England and Wales--is that if you cannot register a fetal death of less than 28 weeks, and one of the twins dies and the other is born alive, you cannot say to the parents, "This is a live born twin and this is a nothing" for the late fetal death. What happens in practice is that the dead twin is registered as a late fetal death, apparently having a gestational age of 28 weeks. In reality it will have a lower gestational age, but because of our laws in regard to not being able to have funerals and things of that kind, we find that the deceased twin sometimes does get registered.

MS. MACFARLANE: The Stillbirth and Neonatal Death Society has records of where one twin has been registered and one has not, and this has caused great distress to the parents.

DR. BAKKETEIG: I would like to return to the issue of postneonatal mortality. The ICE data stops at 1985, and I wonder if any of the panelists are going to comment on what is happening now. For example, in Sweden there has been a tendency for postneonatal mortality to increase over the last few years and the same has been true in my own country, Norway. Perhaps Sven Cnattingius could offer some explanation for this development.

DR. CNATTINGIUS: We have only looked at postneonatal mortality in Sweden through 1985, so I cannot comment on changes since then.

MS. MACFARLANE: In addition, you need to address this question from a birth cohort perspective, which in most countries means doing a reanalysis.

DR. KLEINMAN: I think the most recent data in the United States suggest that we have had a slowdown in the postneonatal mortality decline, as have, I think, most other countries. I am not really convinced that it is all that necessary to look at birth cohorts to measure trends in postneonatal mortality. Using vital statistics files, the decline in postneonatal mortality has slowed down in virtually every country that I have looked at. Notable exceptions are Canada and France, which have had considerable declines in recent years and have shown no signs of slowing.

MS. MACFARLANE: I think that the need to use birth cohorts to assess trends in postneonatal mortality depends on what is happening to your birth rate. When I had a look at it in the late 1970's, we had a turnaround in our birth rate. It went down, then it went up again, and then it leveled off. Now the number of births is going up, not only because of the increased registration of births under 1000 grams, but it is going up generally. Thus, the more changes you are having in your birth rate the more it is necessary to base your analysis on birth cohorts.

DR. ALBERMAN: May I just make a point that I think has not been sufficiently well made? We have all taken for granted that we are dealing with birth cohorts, but it is something that we are not actually used to, and certainly people outside this data set are not used to. It was something that I kept coming back to when I compared the ICE data with the national published statistics for England and Wales. I kept having to remind myself that there are differences, and in fact, our postneonatal mortality in those (published) data was lower. So, I think it is something we ought to remember. We are breaking new ground here, and it is terribly important.

MR. HOFFMAN: I wanted to ask Sven Cnattingius if he could comment on the historical trend data that he showed. I could not tell from the slide, but it looked like in the late 1950's there was a crossover between the late fetal death rate and the early neonatal death rate. Can you comment on the reasons for that, perhaps historically?

DR. CNATTINGIUS: No, I am not able to provide any comments on that.

DR. BOBADILLA: The difference between neonatal and postneonatal mortality can be traced to a paper in the beginning of the century by Bourgois-Pichat. At least that is where there is an explanation of why these two events should be separated. He suggested that deaths in the first months of life are due to endogenous causes and the others are exogenous. Of course, he was trying to say that the first ones were biological and the other ones were social.

The reason I am bringing this up is because it appears to me that infant mortality as a concept is no longer very useful. Perinatal mortality suggests to me that the conditions that caused the deaths were arising from the pregnancy or during the time of labor. Now it looks like most of the countries that we have been analyzing have about 80 percent of all the infant deaths due to causes arising during pregnancy or labor. So maybe now when we say perinatal mortality we should think of mostly up to the first year of life and maybe later. This brings into question the whole concept of perinatal mortality and, of course, changes our understanding of postneonatal mortality.

DR. HARTFORD: I have a few comments. First, Eva Alberman seemed concerned about those under 500-gram outcomes. ICE tabulations for the United States and Denmark show that about 9 percent of all U.S.

white infant deaths are produced by under 500-gram births. Eight percent of white singleton deaths and 20 percent of the multiple deaths are under 500 grams; for U.S. blacks the respective percentages are 16 and 25.

Now, the U.S. white rate is undoubtedly understated because as you recall, there is a dropoff in the mortality rate for births under 500 grams. If we consider that the mortality rate should be more elevated, then the percentage would be more like 10 percent, I think. Denmark, on the other hand, had 2,500 infant deaths in the 6-year period for which they provided data, but only about 7 infant deaths out of that total weighed under 500 grams. As a matter of fact, there were only 10 live births under 500 grams. So, we have obviously got quite dissimilar things going on here.

My second comment has to do with what might be happening in the postneonatal period. The ICE data set does not have birth cohort data past 1985 or 1986, in most cases, but I have seen period data for most of the countries. Japan continues to have a good, healthy decrease in postneonatal mortality based on period rates. In Sweden, after many years of having a fluctuating but generally gradually increasing postneonatal rate--from 1985 or 1986 on--the postneonatal rate has started dropping consistently, again as reflected in period rates.

MS. BARELL: I also wanted to comment on the 18 percent of infant deaths under 500 grams (for U.S. blacks). Have you recalculated the infant mortality rates for 500 grams and above to see what the differentials between U.S. whites and blacks would then be in relation to some of the other ICE countries?

DR. ALBERMAN: The short answer to that is no, but I am sure Bob Hartford has done it.

DR. HARTFORD: Except I do not have it right here in my hands.

MS. OVERPECK: Howard Hoffman and I have just completed a paper on this topic. Using the United States 1983 linked data set, we found a total U.S. infant mortality rate of 10.9 per 1,000 live births. If we had not included births under 500 grams, the rate would have been 9.8. The white rate would have gone from 9.3 to 8.5, and the black rate would have dropped from 18.9 to 16.3. So the black rate would drop by 2 points if the under 500 gram babies were excluded. Looking at 750 grams, which we are considering as essentially 24 weeks gestation, if we had taken out all of those under 750 grams the total rate would have gone from 10.9 to 8.3, the white rate from 9.3 to 7.3, and the black rate would have dropped from 18.9 to 12.8.

DR. EBARA: I would like to comment about the high mortality rate for high birthweight babies in Japan. The bigger baby in our birthweight distribution is quite a rare occurrence. The doctors just do not know how to deal with them, and also most of them suffer from birth trauma. Most of them have some paralysis of the hand, foot, or spinal cord. Because our hospitals average 500 to 2,000 deliveries annually, these are rare events--both the high birthweight babies and multiple births. As rare events they are relatively high risk births, as obstetricians have limited experience in managing these deliveries.

MR. EVANS: I think that people ought to be aware that in published national statistics, the postneonatal mortality rates usually use live births as a denominator. What one ought to do is as Rudiger von Kries suggested--but I do not think he actually did in his presentation earlier--you must use the survivors as the denominator. What is happening is that as neonatal mortality rates have improved, the underestimate of the postneonatal mortality rate (that results from using live births as the denominator) becomes progressively less, and so that contributes to an apparent slowdown in the reduction of postneonatal mortality rates. It is not terribly important, but a number of these rates are very small and all these factors contribute, and so, people ought to use the survivors of the neonatal period in calculating their postneonatal mortality rates.

DR. BERGSJØ: A question to Stephen Evans and possibly Alison Macfarlane. Do we know to what extent the in vitro fertilization and embryo transfer programs have contributed to the twinning rates in the various countries?

MR. EVANS: From my memory, there is a case-control study in Nottinghamshire that demonstrated that essentially 8 percent or so of multiple births were attributable to IVF, and the proportion goes up dramatically if you look specifically at triplets and higher order births. Overall, I suspect that only 8 to 10 percent of the multiple births are attributable to IVF, as far as we can tell at the moment.

MS. MACFARLANE: I think it is a very rapidly changing picture. Our triplet study, in which we had twin and singleton controls and full infertility treatment questions, covered births from 1980 to 1985. Of course, in 1980 IVF had only just started, whereas by 1985, we saw the IVF births come in. It is a very rapidly changing situation, and certainly even what we had for 1985 was obviously an underestimate of what was happening in 1988. Also, another thing to think about is that the use of infertility drugs was also quite a strong contributory factor in the early 1980's. The other thing is this huge difference from country to country in the use of IVF. For example, there is much greater use of IVF in Australia, where they have an IVF register and much more marked increase in the triplet rate. Again, having focused on the triplets, I am not sure about the twins.

MS. BOTTING: One of my transparencies is on our newly established IVF register (for England and Wales). We have not yet got data sufficient to be able to answer the question, but looking at summary data that is being collected from our clinics that are licensed to do IVF, it would appear that something in the region of 50 percent of triplets are a result of IVF. The main problem we have is that many people come from overseas for the IVF treatment, may well be expecting triplets but then will go home to deliver. So, it is very difficult to compare the number of established triplet pregnancies with the actual deliveries that take place in England and Wales. Alison Macfarlane showed a slide earlier that showed this dramatic increase in the number of triplets and higher order births, and it does seem to be very strongly associated with the IVF data.

MS. MACFARLANE: The analysis that Bev Botting and I did in 1976 showed an increase in dizygotic twinning rates in England and Wales for all age groups, except for those under age 20. You would suspect that this was a reflection of the use of probably infertility drugs at that time, and now more recently IVF.

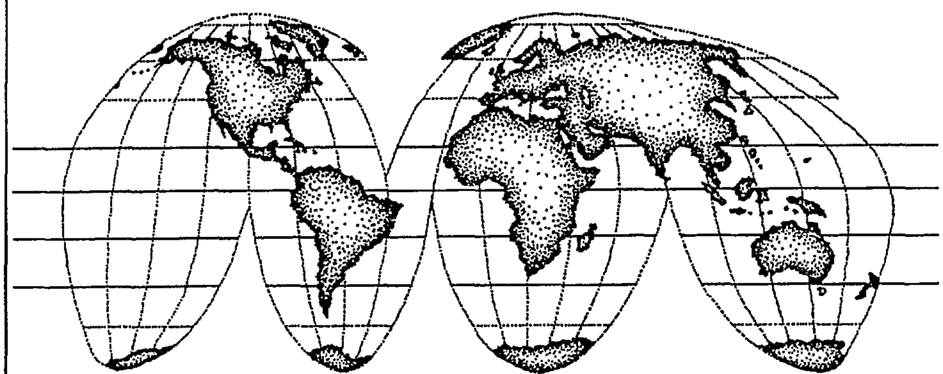
DR. ALEXANDER: In terms of actual numbers, the contribution of IVF should be smaller than the contribution of infertility drugs. Have there been any studies that have tried to attribute the increase in twinning that you see to the use of infertility drugs, or to see whether this is a totally natural phenomenon or partly natural phenomenon? Monozygotic rates, for example, might give you an indication.

MS. MACFARLANE: With IVF, as you probably know, you also get embryo splitting. Thus you get an increase in monozygotic rates with the use of infertility drugs and IVF. So, it is quite complicated. In the early 1980's, clearly infertility drugs alone played a much larger role than IVF.

What we are hoping to do is a comparison of the 1989 survey and the earlier surveys. We expect to see a very different picture in 1989, compared with the early 1980's.

MR. EVANS: Merrill Dow says that Clomethine has a contribution in the recommended dosage of about 157 multiple births per 1,000 births, but it obviously has a dramatic effect on the triplet rates and higher order births.

The data that they have tend to be rather higher than Japanese data. I think there is someone called Imitzumi from Japan who has published data suggesting that the drug treatments actually lead to a slightly lower rate than that, but again, the Japanese particularly have been using ultrasound in combination with drug treatment to try to minimize the multiple pregnancies.



Panel Discussion: Summary, Conclusions, and Recommendations for the Future

Summary of the Major Findings of the ICE on Perinatal and Infant Mortality; Recommendations for Future Activities

by Per Bergsjø, M.D.

First, I would like to join in the chorus of those who have praised the truly unique international effort that has been a feature of this ICE program. I think that the international and multidisciplinary group has done a fine job in analyzing data, but I do not think that the job is quite finished yet.

We heard on the first day from Manning Feinleib that U.S. expenditure on health care is not reflected in rates of infant mortality. On the second day, William Roper, Director of CDC, said that infant mortality is a national embarrassment in the United States. Analysis of the data we have gathered has indicated that it may not be so bad after all, but the figures are still there to be seen. Robert Hartford has done a fine job in collecting all the data and in organizing the group activities.

I should like to remind you of the work that has been done. There have been two data sets: the first contained annual information on births and perinatal and infant deaths, grouped by birth weight, plurality, and (for the United States) ethnicity, over a period of up to 15 years; the second data set, which in addition contained the causes of death and gestational age at birth, is quite unique.

The group did a fine job in assembling the causes of death into functional groups so that they might be handled more easily than by the ICD classification numbers, which are too numerous to be used for this comparative purpose.

As to what has been achieved, I think the proceedings these 3 days in a way speak for themselves. We have been reminded that there are social gradients in infant mortality, which were not really so distinct before. We have recognized, of course, that the United States, which splits its statistics into blacks and whites, has marked social differences. In the Nordic and other countries we have not really paid sufficient attention to social differences, as we did not think they were so marked. We have heard from Norway, Sweden, Denmark, Great Britain, and Israel that there are social gradients, which are reflected in stillbirths and in postneonatal mortality rates, but not so much in neonatal mortality rates. In Sweden there was sort of a reversed phenomenon, which has not been fully explained but should be looked into.

There have been attempts these days to standardize comparisons. We know that different birthweight distributions complicate matters when we try to compare the mortality rates by weight categories. There have been attempts to overcome this by various sorts of standardizations, for example, by the Wilcox-Russell transformation.[1] Stephen Evans has previously tried to do it by comparing rates according to centile transformation (1). I do not think this problem can be totally overcome, but surely more can be done to try to standardize comparisons better than we have been able to do at this Symposium. Part of the reason for discrepancies in presentations at the Symposium is that the data collection itself and assurance of comparability of data took so long that we had too little time to really sit down and try to standardize our presentations. Now, different ways of presenting results may be an advantage in itself, but it also creates a certain confusion that should be overcome at a later stage if we attempt to make our data comparable by standardization.

Before this meeting we also collected information on the different health care delivery systems in all the countries, and we received a sufficient number of answers to permit analysis of the data. The results made

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[1]Kleinman J. Implications of differences in birthweight distribution for comparisons of birthweight-specific mortality.

us realize that the systems differ from country to country, which I think should be looked into seriously, although we do not know how these differences in reality affect outcome.

Speaking of outcome, we have been concerned with mortality, but there is another side of the coin--namely maternal satisfaction--to which we should pay more attention. We know that 99 percent of the mothers have live babies and experience happiness around the time of birth, but what about their satisfaction with the interventions and all the care that they are given? Does this care meet their demands or could it be done differently? Antenatal care systems have been the center of attention recently. We do not know what 14, 16, 9, or 7 antenatal visits really mean, or if the number of visits is reflected in the outcomes.

So, I think we need more research into the antenatal care delivery systems to try to arrive at a better system than the one we have today, or to ensure that what we have today is good, if you want to put it that way.

I was asked to comment on where we go from here, and in the hope that this effort is not ended with this meeting, I have made some suggestions for future activities of the ICE group or of the subgroups of the ICE group. I think that future activities should concentrate on further data analysis, aiming at better comparability and stringency of presentation.

We have not really had time to complete the analysis of these data, with particular regard to standardizing the different birth weight distributions and the different residual left tails of these distributions. I mentioned Joel Kleinman's and Stephen Evans' attempts, and I think these should be further elaborated (1).[1]

We must also try to overcome the problem of different definitions of stillbirth versus live birth. In the Symposium workshop, Finn Kristensen showed us a possible way to do this by life table analysis.[2] We should realize that preterm births and stillbirths are all part of a continuum of reproductive events that start at the time of conception. Therefore, the earlier we can start registering events, the better we will be able to understand the biological significance of these events and possibly discover causes that can be addressed through some sort of intervention.

We should also strive to get better standards for international comparisons. In particular I am thinking of the possibility of improving the WHO recommendations for standardizing international reporting. The problem of stillbirth must be analyzed further.

The group could also try to come up with indicators for quality control based on the data. The mortality figures we use may not be the best indicators for quality control in a system to assess the quality of services, and in this respect, we must try to disseminate our results more widely than we have done so far. The volumes of proceedings are fine, but they do not have the distribution of articles in widely distributed international journals. I think we should try to put more effort into writing articles and really disseminate the truly unique results.

I also have some general recommendations that are not aimed specifically at the ICE group but which can be taken home to the various governments or official bodies for consideration. First, it cannot be emphasized strongly enough that the last menstrual period should be retained as the starting point for measurement of gestational age. Reporting of the last menstrual period should be mandatory in all birth report forms. Whatever people want to do with ultrasound measurements is up to them. These may, of course, also be recorded, but I strongly feel that the last menstrual period is the primary yardstick, and if that is discarded, we are left with nothing by which to measure the size of the child by gestational age. We lose perspective of small for gestational age and appropriate for gestational age children. So I think it is absolutely necessary to retain this information.

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[2]Kristensen FB. Life table analysis of feto-infant mortality.

Furthermore, national registration or reporting of births should start at 20 weeks or if possible at an even earlier gestational age, and this should also include reporting of stillbirths and those "late induced abortions" that occur after the reporting limit.

International comparisons, on the other hand, should start at a later gestational age than the national registration starting point, in order to avoid the confusion or the errors introduced by the defined limit. So, if we want to start our comparisons at 28 weeks or 24 weeks, the national registration should start earlier.

Registration forms should include simple indicators of social differences, such as the number of years of schooling. These indicators are now recognized to be important for sorting out the risk groups. Efforts also should be taken to reassess the value of antenatal care by scientific means, if feasible by some sort of randomized controlled trials.

Finally, I have been told that the ICE effort has already sparked initiatives in certain governments. For example, in Israel the government has taken steps to reexamine the legislation concerning pregnancy and childbirth, which is quite satisfactory for members of this group to hear.

I also know that due to Robert Hartford's persistent calling to confirm and reconfirm the data reliability, people have discovered the flaws and errors in their own reporting systems and in their own reports, which have now been rectified.

Thank you.

Reference

1. Evans S, Alberman E, Pashley J, Hampton B. International Collaborative Effort (ICE) on Birth Weight, Plurality, and Perinatal and Infant Mortality, vol II: Comparisons between birth weight distributions of births in member countries from 1970 to 1984. Acta Obstet Gynecol Scand 68:11-7. 1989.

Implications for Definitions, Standards, Data Management, and Quality Control

by Mary Anne Freedman, M.P.H.

The International Collaborative Effort (ICE) represents a successful use of existing national data systems to make international comparisons of infant and perinatal mortality. This paper presents some recommendations for potential technical improvements to the ICE data systems.

The ICE project brought together an impressive group of researchers knowledgeable about the vital statistics systems in their own countries and how these systems differ from those in other countries. This collective knowledge is necessary to the intelligent interpretation of the ICE data. Therefore, it is important to fully document and make available specific information about the registration and statistics systems of each of the ICE countries, with special emphasis on the differences among them (1).

> *Recommendation 1.* Formal documentation of the ICE data systems should be developed. In addition to technical specifications, it should address the definitional differences among countries, as well as differences in legal registration systems, the practice of clinical medicine, cultural issues, and any other factors that may affect the interpretation of the data. Country-specific information should include the geographic area covered, whether the data represent a birth or death cohort, whether the system is based on residence or occurrence data, and the data system's comparability to that of other ICE countries. This documentation should be widely disseminated, including distribution with all ICE public use data tapes.

ICE countries and (U.S.) States differ in their fetal death reporting requirements, ranging from those that mandate the reporting of all products of conception (Georgia and New York), to those that limit reporting to fetal deaths of 28 weeks or more (England, Israel, Scotland, Sweden). Thus, international comparisons of fetal death rates based on reported deaths without reference to gestational age are inappropriate.

> *Recommendation 2.* Differences in fetal death reporting requirements should be considered when performing international comparisons of fetal or perinatal mortality. When possible, a threshold of 20 weeks of gestation should be used.[1] However, some analyses may need to be limited to comparisons of fetal deaths of 28 or more weeks gestation until all ICE countries implement mandatory reporting of fetal deaths at an earlier threshold.

Unfortunately, ensuring that statistical analyses are consistent with reporting requirements does not completely resolve the issue of international comparability. The reporting of fetal deaths at or close to a mandatory reporting threshold (be it 12, 20, or 28 weeks) is typically poor. Therefore, in order to improve the registration of late fetal deaths, countries should consider reducing the mandatory reporting threshold for fetal deaths to 16 weeks or less. We recognize that there may be political or cultural barriers to implementing this recommendation in some countries. However, the beneficial effect on data quality may make it worth pursuing.

> *Recommendation 3.* ICE countries should strive to achieve mandatory reporting of all fetal deaths of 16 or more weeks gestation.

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[1]The rationale for 20 weeks is related to the increasing prevalence of viable births between 20 and 28 weeks.

Although all ICE countries officially use the World Health Organization definitions of live birth and fetal death, there are indications that, in practice, some variations exist. Since it may be difficult or impossible to attain consistency among countries in the application of the definitions, the use of the feto-infant mortality rate[2] is recommended for international comparisons[3].

> *Recommendation 4.* International comparisons of infant mortality should make use of the feto-infant mortality rate.

Vital statisticians have traditionally calculated gestational age by subtracting the date of last normal menses from the birth date. Clinicians prefer gestational estimates based on ultrasound or other clinical measures. The appropriateness of each of these estimates to the ICE research has been raised several times during this symposium. One suggestion might be to collect both a clinical estimate and an estimate based on dates, to compare them, and to use the one that is most consistent with other data on the record. This would permit data quality checks and might also reduce the percentage of births for which no gestational estimate is available.

> *Recommendation 5.* Analyses of gestational age should utilize the estimate based on the date of last normal menses. In addition, the collection and evaluation of independent estimates of gestation is recommended.

Recommendations 2-5 address definitional concerns. It is interesting to note that the lack of definitional uniformity is not limited to the international arena. In the United States there are concerns about standardization among the States. The United States vital registration system is decentralized. Responsibility for data collection is vested in 52 registration areas (the 50 States, the District of Columbia, and New York City). Each has its own statutes, procedures, and practices. As a nation, we try to promote uniformity through the development of "model" laws, definitions, and standard certificate forms. However, the States are not legally obligated to adopt these--and indeed, there are differences in the legal reporting requirements for fetal deaths among States similar to those observed among the ICE countries.

In 1989, States in the United States introduced new birth and death certificates, which were based on revised standard models. Each State took the "models" and adapted them to its own needs. The resulting documents are very similar from State to State, but not identical. In addition, these forms were put into the field without definitions for many of the medical items. The analytic and comparability implications of this situation are becoming evident as statisticians begin to look at the resultant data. Therefore, the Association for Vital Records and Health Statistics, an organization representing the managers of State vital and health statistics programs, has worked with physicians, data providers, and staff of the National Center for Health Statistics to develop a set of uniform definitions for the medical data items. States are being encouraged to adopt these definitions in order to improve the consistency and quality of the national vital statistics system.

As definitions can influence consistency and uniformity, differences in registration practices can produce artificial international differences in vital statistics rates. For example, the country that vigorously attempts to identify and register all events may have a higher published infant mortality rate than the country that does not pursue complete registration, even though the "true" rate may be the same in both countries. (It has been

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[2]The feto-infant mortality rate includes late fetal deaths and infant deaths in the numerator and late fetal deaths and live births in the denominator. See also footnote number 3.

[3]Kleinman, J. Implications of differences in birthweight distribution for comparisons of birthweight-specific mortality.

alleged that this situation exists among certain adjacent States in the United States.) Comparable data requires that all vital statistics programs find and register all events.

Another data quality issue is the existence of large numbers of "unknown" values in important variables. The lack of complete data can lead to erroneous analytic conclusions since the distribution of "unknowns" is often not random.

The ICE project should critically examine these data quality issues and make recommendations for improvements.

> *Recommendation 6.* The ICE project staff should develop a report for each ICE country documenting the definitional, procedural, and registration issues (problems and probable causes) that may contribute to international inconsistencies. When appropriate, the report should also suggest solutions. These reports should be submitted to each country's registration officials and data providers by its ICE member.
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> *Recommendation 6a.* Uniform definitions for the variables common to the ICE countries' vital statistics systems should be developed.
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> *Recommendation 6b.* Minimum standards for achieving registration completeness should be developed and implemented in each ICE country. These standards may incorporate both administrative and statistical techniques to identify and correct problems. Examples include follow-up on low birthweight and/or premature infants to identify unregistered deaths and statistical trend analysis by geographic region to identify areas of potential under-reporting.
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> *Recommendation 6c.* Each ICE country should institute measures to maximize the completeness of reporting for all data items in its vital statistics system. These measures may include aggressive query programs and training for data providers.

Cross tabulations and consistency checks can be useful in the identification of data quality issues. These, combined with an appropriate program to correct errors found, can be extremely helpful in developing better data. Examples of the types of problems that can be identified include "heaping" on category boundaries in a continuous variable and the presence of highly unlikely combinations (for example, 4000-gram, 20-week babies).

> *Recommendation 7.* The ICE program should establish criteria for consistency checks to be used in each ICE country. For some measures, it may be appropriate to develop country-specific parameters.

In summary, the best way to build a quality data system is to use it. The more applications a system is used for, the more likely it is that the system's weaknesses will be identified and corrected. The ICE program has not only yielded a better understanding of differences in infant mortality among nations, but has also provided considerable insight into the quality and comparability of the data each country brings to the project. We hope that the recommendations in this paper will further enhance the ICE efforts.

Reference

1. Alberman E et al: International Collaborative Effort (ICE) on Birth Weight, Plurality, and Perinatal and Infant Mortality, vol I. A method of data collection and analysis. Acta Obstet Gynecol Scand 68:5-10. 1989.

Discussion

DR. KIELY: I wanted to add a recommendation on something that has hardly come up in the presentations. That is, many people from different countries have been surprised to hear about the way births and deaths are registered in other countries, and we do not know that much about it.

For example, there has been a lot of surprise over the fact that, in most U.S. States, the responsibility for registration of births and deaths really lies with hospitals and doctors, whereas in much of Europe, it resides with the parents. We just do not know enough about the process of actually filling out certificates and registering births and deaths in each of the countries. It would be nice if somebody would actually write that up. I hope I am not getting myself in trouble by saying that.

DR. BOBADILLA: I have a comment. The interest in using vital statistics to study quality of care really depends on the precision of the data. Among the differences that have not been mentioned is trying to differentiate between intrapartum fetal deaths and antepartum fetal deaths. Because when you relate them to resources and practices they really mean something different, even antenatal care. So, another possible recommendation is to try to include information that makes it possible to differentiate between these two clinical entities.

Implications for Future Avenues of Epidemiological Research

by Heinz Berendes, M.D.

Thank you very much. For those of you who were here this morning, I speak on behalf of the tall and slim in the audience.

First of all, let me express my admiration and congratulations to Dr. Hartford, Dr. Feinleib, the ICE members, and other people who have worked so hard in making this immense progress from the last ICE meeting to this meeting. Although I have not been an active participant, I have been somewhat involved over the years, and I am very supportive of your effort.

Having made a career out of involvement in complex collaborative projects, several of which I was involved in either as a coordinator or director, I know how difficult it is to work constructively as you have with various groups, and I am particularly aware of the difficulty of working across national boundaries with very, very limited resources. I hope that you will continue this work. I certainly look forward to a continuing effort of this group.

Let me make some random comments. I cannot give you a comprehensive research agenda for the future, but I can make some comments about topics you might want to consider. I think it is appropriate to be preoccupied by a concern about the comparability of data across countries and by problems in reporting. This area will have to receive even more emphasis in the future, and it is not an issue as you know that is limited to comparisons across national boundaries. We heard this morning, for example, in the presentation by Eva Alberman, about a remarkable increase in the proportion of very low birthweight live births. This recent trend in a number of the ICE countries may very likely be the result of better reporting. On the other hand, in the United States, recently there has also been observed an increase in very low birthweight births, particularly among blacks and to a more limited extent among whites. Many people dismiss this observation as a result of better reporting.

Part of it might be, but there are clearly other possible explanations for this observation. For one thing, conceivably better obstetrical practice and management might prevent a fetal death and result in a very low birthweight live birth. Then there might be new circumstances in our environment, in our cities, such as drug abuse, which might increase the risk of very low birthweight live births.

Clearly the subtitle of your effort, "Using international comparisons to understand national problems," is a tall order. It is very complex to understand or begin to understand the reasons for the differences between our countries, that is the differences in infant mortality. We have been involved for some time in an effort to understand, as an example, the known ethnic differences in the rate of low birth weight, as well as preterm delivery between blacks and whites in this country. To our surprise and chagrin, we could not explain much of the difference between blacks and whites in low birth weight by the known risk factors for low birth weight, nor could we explain much of the difference in preterm delivery between blacks and whites by the much less completely understood risk factors for preterm delivery. I suspect it may be a little easier to understand differences in neonatal mortality across countries than differences in the rate of low birth weight.

I propose to this group that in addition to comparing the now and present, you might also want to try to address how specific countries got to the present from where they were some years ago, particularly countries like Japan and Sweden. It might provide some additional insights that you may not obtain from a comparison of current data.

I have been puzzled, and Dr. Feinleib's initial remarks served as a reminder about the lack of change in the rate of low birth weight in a number of countries over a considerable period of time, except for Denmark and the United States. I do not quite understand that.

In an earlier study in which Dr. Kessel was involved, we looked at the change in rate of low birth weight in the United States for the decade from 1970 to 1980, and we found a modest reduction of around 12 percent. Most of the reduction was in term low birthweight births, which we equate with intrauterine growth retardation and very little of the reduction was in preterm low birthweight births. This made sense to us in view of the fact that in the United States since about 1968, obstetricians have gotten away from the prior dictum that a woman should gain no more than about 20 pounds during pregnancy to a recommendation of more liberal weight gain. In addition, especially among middle class women, there has been a decrease in smoking during pregnancy. All of these clearly would tend to affect intrauterine growth rather than preterm delivery. Again coming back to my earlier comment, I am not sure why we are not seeing more of a decline in the rate of low birth weight in other countries as well.

Are we to assume that these countries have reached a point beyond which further reduction is difficult or impossible? I wonder whether any of you, particularly Petter Karlberg and others who must have thought about it, might have some explanation to offer.

I was very pleased to see gestational age used as a variable. I understand why we tend to avoid gestational age as a variable, and I am sorry to say I have no recommendations or suggestions for improving gestational age reporting except to cheer on my younger colleagues in pursuit of this effort.

Gestational age is an important and currently mostly missing link in comparing birthweight-specific mortality. There may be a different mix of intrauterine growth retardation and preterm births among different countries and ethnic groups that are represented in the data. Gestational age has an important effect on survivability. Also, the etiologies of intrauterine growth retardation and preterm delivery are clearly very different. Epidemiologists have neglected research on the epidemiology of preterm delivery.

I would like to comment about the issue of care and especially the issue of prenatal care. Clearly the countries represented in this effort have very different health care systems, and there may be differences in the content of care offered to pregnant women in these various countries. Recently in the United States an expert panel on prenatal care, sponsored by various components of the Public Health Service, addressed the content of prenatal care as it is currently practiced in this country. To no one's surprise a good deal of what is currently being done in prenatal care--and I am sure if we were to look at regular health care in other fields than maternal health you would find the same thing--many elements in prenatal care as currently practiced are not based on sound scientific information. Most have evolved out of clinical practice over many years.

We need to find out from each other as we share our data, what works and what important differences, to paraphrase Brian McCarthy, may make a difference. I am concerned that we may tend to adopt practices from each other on the assumption that these are the ones that actually account for the better outcome in a particular country. I understand that there is an interest in the United States in adopting the maternal passport that has been used in Japan and which I believe actually came from Germany in the 1930's. I have no idea what the Japanese think about it and whether indeed, they feel that the use of the passport has contributed to the marked decline of the infant mortality rate in Japan.

There may be some other important differences in practice. I could not listen or stay for Sam Notzon's presentation on cesarean section. Therefore I am not sure he covered this, but in the United States recently an increasing proportion of very low birthweight births are delivered by cesarean section on the assumption that this will save lives. There have been several observational studies in the United States that challenge this particular practice. I do not know to what extent this is practiced also in other countries.

We spent a whole morning discussing social class differences. I remember several years ago at least one publication from Sweden, which suggested that Sweden did not have any differences in infant mortality related to social class. Our Swedish colleague corrected that notion and demonstrated to our satisfaction that indeed, the Swedes have a differential in infant mortality by father's occupation. There was at least a twofold difference in infant mortality between blue-collar and white-collar workers. Yet in contrast to the United States, where we know that social class differences measured by income or education translate into problems of access to care, problems of financial ability to pay, this does not seem to be a problem in Sweden. While Sweden may have overcome the problem of access and the problem of financing care, there is still a social class differential in infant mortality. The question is, Why? What is really behind the social class differential?

I have been impressed in working in developing countries about the importance of technology transfer or knowledge transfer. Let us say in a country like ours or other developed countries, a good deal of medical knowledge and what represents good medical practice is transferred to certain segments of our population. It is internalized and used by them. Certainly middle class women have acquired the knowledge and act upon this knowledge, and they have developed behaviors that they draw upon when they become, or even before they become pregnant, in an effort to improve birth outcome. This is an issue that we might want to address in the future. There may be other countries where the issue of access is not any longer a problem, and yet there are still social class differences in infant mortality. I know that Japan has differences in infant mortality among different population groups, and I am however not sure about the issue of access to health care in Japan for these different groups.

A very brief comment about sudden infant death syndrome, which I look upon as an enigma of our times. We really do not know what it is. In common with congenital malformations, it has become an issue of increasing importance as we reduce other causes of infant mortality. Japan has the distinction of having a very low rate of SIDS. Maybe this is due to differences in reporting. I do not know the answer. If it is not, I think we ought to look at that.

A final comment on something that we are not able to address in the context of ICE. It is an important issue for our constituents, namely pregnant women, and it is the issue of work during pregnancy. The question as to whether work and heavy work or various types of work, including standing, adversely affect birth outcome is not resolved. There are some very conflicting data on this question. It is a question that needs to be addressed and answered in the near future because it is of utmost importance to an increasing number of pregnant women who are part of the labor force in our countries.

Discussion

DR. MCCARTHY: I have not quite formulated the question yet, Heinz. So, I am going to have to try to do this. Yesterday we discussed the tail of low birthweight births and in view of--this may even be a little bit more provocative than I had wanted it to be--unpublished data that would enable us to reduce that tail by subtracting out subpopulations with medical risk and socioeconomic risk as well, I would predict that using some of the data available to us that I could get a low-risk black population to look like the Japanese. So, my question to you is: does that make any difference regarding the gestational age distribution for the normal low-risk black population, and given that there are differences in birthweight-specific mortality rates between those two populations, are we not looking at--except for the pathology that might exist--increased incidence within the black population for various reasons? I mean that is a big aside that I put there, that a lot of our thought of whether or not we have chosen the right thing to do in shifting the mountain as opposed to building it up, that we really need to seriously rethink that, and that a lot of the disparity still exists because of an inability for that population to have things done right.

DR. BERENDES: I prefer not to answer that question.
(Laughter.)

Implications for State and Local Maternal and Child Health Programs

by Peter C. van Dyck, M.D., M.P.H.

Good afternoon. Is your end as tired as mine? You know, "There once was a man from Bagheath, who sat on a pair of false teeth, said he with a start, 'Oh, my, bless my heart, I have bitten myself underneath.'" That might feel good right now. Did you see the Washington Post yesterday? Many of you did. "France wants me to have this baby, the story of a pregnant American in Paris" (1). I cannot help but read just a paragraph to you because it points out so uniquely the difference in what we are dealing with here in the United States.

"The French Government found out I was pregnant before my mother got the news. My gynecologist looked over the laboratory results, congratulated me and then took out a sheaf of official papers. She signed and stamped the forms. I added my signature at the bottom, and thus, I was registered in France's system of pregnancy surveillance."

The timing of this article is just perfect for this meeting. "The health of my baby-to-be was now a matter for the state. Contrast my experience here with the United States system, which leaves expectant mothers to look after themselves according to their income, education, motivation, and ability to obtain care. It is a system health experts say that is riddled with contradictions. While American medicine is regarded as the most technologically sophisticated in the world, capable of saving lives of desperately ill 1-1/2 pound premies, it cannot guarantee adequate care for pregnant women or their infants."

I am paraphrasing here a bit. "After each exam the doctor was to sign and stamp the appropriate coupon in the handbook and send it to the Social Security Office; as an incentive to keep these appointments, the French Government would pay me 830 francs, which is $160 each month, from the fourth month of pregnancy through the third month after birth."

"That payment would be made regardless of my income. It, also, detailed my rights under French law. If working, I was entitled to 6 weeks of paid maternity leave before the birth and 10 weeks afterward, in addition to 2 more weeks if the doctor certified it was necessary."

This article continues for four pages, and I think it points out some of the tremendous difference between countries outside the United States and the system here. In fact, most people in the United States do not even know that this kind of care exists outside the United States.

It has really been a privilege for me to be part of the presentations. It is fascinating but hard work.

We, in maternal and child health, in this country are expected to plan, carry out, measure, and monitor all the programs designed to reduce the infant death rate and to improve the outcomes of pregnancy. There has been a tremendous increase in this interest in the last few years.

Medicaid, our national program for the poor, has increased the amount of money available to serve women at increasing levels of poverty. Maternal and child health has new legislation this year that requires States to do a needs assessment, a needs assessment related to some of the information we have seen in the last 3 days related to States and counties.

The Institute of Medicine released a report a year or two ago that really emphasized the entrance into early prenatal care (2). The National Commission to Prevent Infant Mortality released a report, and is still releasing reports that I feel focus on decreasing the incidence of low birth weight (3).

This past year the Public Health Service released a report on improving the content of prenatal care (4). We heard Dr. Roper say that the CDC has a very great interest in the infant death rate and is probably going to initiate some kind of activity in that area.

We, in the State programs, receive all this information and then have to put it together in some way, and basically we are encouraged to implement programs to reduce infant death rates in our State. We do that by decreasing the low birthweight rate, and that, by increasing entrance into early prenatal care.

At the first ICE meeting I was very excited because I could see the great potential in analyzing the countries with the best statistics and using the information learned in a way that would be applicable to those countries or States that had worse statistics.

I am going to relate just four things. First, what do we do in the U.S. States to lower the infant death rate? Do we improve pregnancy care access geographically? Do we improve newborn intensive care unit care? Do we increase the percentage of women getting into early prenatal care? Do we improve the content of care? Do we work on SIDS? Do we increase financial access? Do we improve the number of visits to well baby care? Do we improve the emphasis on teenage pregnancy? Do we improve nutrition during pregnancy? What about cesarean section rates: Do we try to affect those in some way? Do we encourage a work release for women for a month or two before pregnancy or for a period after? Do we guarantee financial access? What about early intervention programs for infants after they are born, particularly during that first week of life?

What about smoking cessation? What about drug abuse? Obviously the answer is yes, yes, yes, yes, and yes, but all these are competing financially for the small amount of money we have. Which do we target? Which do we focus on, and those of us in maternal and child health in this country and the States are basically responsible for all of those programs. Where do we put the money?

Second, do I target high risk groups in some way, either high-risk or special groups, if I could figure out who or what they were or are? In fact, does that really work? In many States, the high-risk groups that you might target are so small that great improvement in the high-risk group would not significantly change the infant death rate at all or the other parameters that we have looked at over the last 3 days.

So then, what do I target? Probably we use the scatter approach. You do whatever you can with the money you have, and you try to relate more or less to what you think is important, and you hope and you anticipate that what you have done is going to improve the infant death rate. The problem is that you will not find out until 1 1/2 or 2 years later.

Third, what if entrance into early prenatal care is important; how do I do that? Do I do outreach? Do I do a massive media campaign? Do I do education among mothers or fathers or families or teenagers? Do I do a maternal and child health handbook? Do I increase the number of local clinics? Do we provide early pregnancy tests free to women? Do we give money? Do we give gifts? Are there models that have worked in ICE countries?

And fourth, how do I monitor progress? What do I monitor, the infant death rate, the neonatal death rate, the postneonatal death rate, the low birthweight percent, the very low birthweight percent, birthweight-specific mortality, the fetal death rate? And how long does it take me to get these numbers after the programs begin? How do I deal with the fact that the low birthweight trend may be flat? How do I deal with the fact that the postneonatal death rate is going up? How do I deal with the fact that infant death rates are variable year to year? I will not even mention morbidity.

General questions then. Will I continue to get money or even keep my job, if I cannot influence these numbers that are seemingly so important? Or are we missing the boat completely? Should we be focusing on the deaths occurring to normal birthweight babies? Every State is different. Does the plan need to be tailored in each State, by region, or by the United States as a whole? Is there a presentation model to come from these data? Is there a consistent and uniform presentation of these data that makes it useful to us, that makes it applicable to us, makes it easy, makes it sing to us, and is there an application model that follows from these data? At least I know that I do not have to just "fatten up babies" as my goal.

So, what do we need? We need another meeting. We need an intergestational meeting of some kind to decide on a consistent, simple, and informative way to present the data, fascinating data, a wonderful data set, but we need a consistent, simple, informative way to present it. Then is there something we can really learn that has applicability for programs?

Second, we need to analyze in sample States, many of which are larger, of course, than the countries in ICE, to see if they follow the same kind of guidelines. We need to take a sample of some complex and some simple States.

Third, we need to do some analysis of applications that seem to work in ICE countries, and I think you have heard several people say that. Whether they are anecdotal or perhaps, and hopefully, objective, we need to get some models that seemed to have worked and try to match them with the data to see if there is a causative effect.

Fourth, implement appropriate interventions, targeted in some States to match the data, that have the greatest chance of success. We need to implement or design appropriate interventions targeted to States to match the data related to what we found from the first three objectives.

Fifth, ongoing continuous monitoring in the ICE States and all the U.S. States should be undertaken to see if appropriate outcomes are the result of those interventions that we planned.

Sixth, in order to help plan these interventions that I mentioned earlier, I think it would be very helpful to have one or two program people who are responsible at a program level to sit in on the discussion of the presentation of the data or the model that would be developed from the presentation of these data.

I have really appreciated the opportunity to participate in this effort. It has been fascinating information. It is very, very, helpful, but we need so much to take that one additional step.

Thank you very much.

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Discussion

DR. PINNELLI: This is the first time I have attended a meeting of this group. I was very eager to participate in the discussions of the past three days, and I would like to offer some suggestions. I think in the next year or two the group should give more attention to information on the quality of women's pregnancy, delivery, and so on. I think it would be very useful to give more attention to quality issues, because in recent years maternity has become like an illness, not a natural episode in the life of a woman.

I think more study is needed on the problem of the quality of survival of the newborn. We know that the main problem for infants today is not morbidity but the consequences of low birth weight or congenital anomalies. I think it would be very useful to study the quality of survival and the causes and prevention of low birth weight. I think it would be possible to go deeply into these areas in the next year.

Another suggestion is to motivate the study of statistical analysis to compare the results of the various countries and to find the variables that most influence the survival of newborns. I think methodological questions should be emphasized more in the next year or two.

The last question concerns the international data set. How is it possible to obtain and to work on these data? It seems to me that a condition to participate in this group is to have data from linked records. It is possible to participate in processing linked record data to compare the situations in different countries. I would like very much to participate permanently in this group. How can I participate?

DR. FISHER: I think a definition of exactly where we go from here is still an open one. We will have a publication of the proceedings of this meeting, and clearly we are going to pursue the activity in formal and informal ways. So I think certainly we can guarantee that all those who are in attendance will get continued information. Beyond that, I think the question that you posed is a very real question of how broadly we could communicate with others in the community that would want to share, either in getting products of this kind of activity or in actually performing more comparative analysis with the group. So, I think those are questions that will be addressed.

MR. LEON: I just want to reiterate what one of the panelists said about the importance of documenting problems in the data on a country-specific basis. This seems very important to me, particularly if in the next year or two individual countries may want to give the data set to other researchers who have not been at this meeting or have not been involved in ICE and will have even less idea of what the quirks of the data set are. It seems that there is a such a large quantity of data that this is going to be an important consideration--to be able to involve larger numbers of people in the analysis of it--and this makes it even more crucial that it is a properly documented data set in terms of the differences and all the quirks that exist on a country-specific basis.

DR. MCCARTHY: Just two questions, answers to the first one, relatively short, from each of you. Do you think the current legal environment in this country would allow us to perform the kind of audit or performance assessments that are necessary to determine whether or not things are being done right?

We can start with Peter van Dyck. As Chief of MCH in Utah, do you think that you could go and do the type of performance assessment necessary in order to answer some of the hard questions and not feel as if the legal system is on your back?

DR. VAN DYCK: Yes.

DR. MCCARTHY: You could?

DR. VAN DYCK: I can only speak for my State.

MS. FREEDMAN: Yes, I think so, and most States do have peer review statutes that would allow that to happen.

DR. MCCARTHY: Confidential inquiries, unrecoverable in the legal system, currently?

MS. FREEDMAN: Yes, I think so.

DR. KESSEL: I think there are a number of issues related to that. I think that the opportunity here is to turn it around and to demonstrate that the issue is that we do expect quality, and we do peer reviews as professionals on our outcomes.

I think exercising that responsibility will, in fact, diminish some of the litigious nature of the circumstances. I think there are a number of examples about protecting the data for purposes of improving the system. I think there are some problems around the country within different jurisdictions about how that goes, but I think frankly, Brian (McCarthy), the issue is really going to be turned around in the other direction. If we do not do those kinds of audits, I think the law and the system are ready to require those. They may be doing that for different purposes, again, looking for the malpractice components of the problems where something went wrong rather than trying to understand how to respond in a more positive and more favorable way. I think the bottom line is that doing those kinds of audits now is beginning to be recognized as a responsible kind of activity and really comes from the history of maternal mortality reviews and peer reviews that have been generated.

DR. MCCARTHY: I think it would be a very interesting question to actually document, from a legal standpoint, how many States have laws in which inquiries would have information that is unrecoverable through those inquiries.

DR. KESSEL: The problem is the laws are not robust enough to precisely find that out. In other words, what we have done so far is that under the authority of the State health commissioner they have the authority to do it. The question becomes one of the courts, as the law, per se, in this country is obviously tested in the courts. It is tough to even start with a survey. The surveys to date indicate that the authorities do exist to in fact protect the individual from untoward exposure by the collection of that data. The problem is that the tort system will resolve whether that is going to be sustained or not.

DR. MCCARTHY: In case it is not, then there needs to be potential legislation which will guarantee that, I think, before it goes any further. Along the same line, just as a comment, I think it would be extremely helpful to have some of our international colleagues who have been involved in the types of audit that I think need to go on, participate in similar audits in the United States. Likewise, people from the United States should participate in those audits in other countries to see how they are done.

DR. LITTLE: I would like to comment on Brian McCarthy's observation or question. I think, in fact, there are several efforts under way and that in perinatal medicine we have some encouraging developments. JCAHO, the Joint Commission on Accreditation of Hospitals and Health Organizations in this country, now is using an indicator system. Whether it will work or not is a question, but it is interesting that they have chosen obstetrics as the first place to try to implement an indicator system. They are in phase II, the beta phase of their look at this. I happen to sit on their task force. There are some other people who sit on it, and I think it is an indication that audits, or indicator systems are under way in this country. Whether that, Brian, will serve the test of some kind of protection from legal scrutiny is another issue.

There also is another effort under way, which I think Woody Kessel and some other people know about, in the Department of Defense, which looks at cases across the board. Having sat with that group for a while, I have been impressed by the quality assurance audit system that, again, works off a sort of indicator base but has to have some normative information and data. It seems to me at this point in time that there are several efforts under way in the sphere of perinatal medicine that may serve as a lead for the rest of this country. This gets to a general comment or a recommendation that I was not going to make to the ICE group, but I will, having been stimulated by Brian's comment. That is, sitting here largely as an academic person or practitioner involved with hospital and practice organizations, that at some time there should be an interface between this effort and the technical advisory groups of the professional organizations in this country and elsewhere. I can name several individuals associated with the American College of Obstetrics, the College of Nurse Midwifery, the American Academy of Pediatrics, and the American Hospital Association who could, in fact, in an interactive fashion, address some of the questions that have come up from the panel with regard to practice and data collection and the validity of some of those questions and observations. I wonder whether at some time the ICE initiative might lead into that collaborative interface with properly motivated, well-versed people from the practice and specifically the professional sector.

DR. SACHS: I am a practicing obstetrician representing the American College of Obstetrics and Gynecology. I would like to answer Brian's question. There has actually been a national study, State-by-State, reported by Jack Smith who works at CDC in conjunction with Wayne State Law School, reviewing the confidentiality questions and whether this information can be subpoenaed for purpose of a malpractice suit.

As a result of that study--from my interpretation of it--the vast majority of States in this country are protected. The information would be protected from involvement in court cases. I would refer everybody who is interested in this question to call Jack Smith for a copy of his paper.

DR. NASHOLD: We have a birth and developmental outcome monitoring program in Wisconsin that specifically forbids subpoenaing of the data. It is the language of the statute, the enabling statute. It has not yet been tested, but I think this is the type of thing that is coming about in a number of States.

MR. EVANS: May I just offer a comment for those who are interested in the documentation of the ICE data set? There is a paper in the *Acta Obstetricia Gynecologica et Scandinavica* by Eva Alberman as first author, on methods of data collection and analysis for the first ICE data set, which documents a good deal of the questions they have asked.

DR. ROSENBERG: In terms of data and the future of the work of ICE, I think we are on the threshold of a very exciting period in terms of infant and perinatal mortality, and I just would like to make you aware, if you are not, of some developments that are on the threshold of birth. One of these is that in the United States we will be coding cause of fetal death on a routine basis and making that available in a few years as part of our regular data set, and I think that is a very exciting development and can contribute to further work of this group.

Another development is the institutionalizing of the linked file of infant deaths and live births. We have begun with the 1983 birth cohort, and we are now continuing that with the 1984, the 1985, and the 1986 cohorts, and we are hoping that this becomes part of the national vital statistics system. So, the tool that you have been using from a few States is now available for all States in the United States and provides a great wealth of data.

Another, I think very important development is the revision of the standard certificate of live birth and the standard report of fetal death in the United States, which has been adopted virtually by all of the States. It includes new items on maternal complications, risk factors, and so on. These have not even begun to be tapped by many of the States and certainly not on a national basis, and will provide great riches for understanding perinatal mortality and infant mortality.

So, I would just like to emphasize in contrast to the past, we have seen what ICE could do with a very limited, primitive, and crude data set, and I think that has been most encouraging and heartening from the presentations at the previous ICE Symposiums and at this Symposium.

Joel Kleinman's presentation, and other presentations show what you can learn from these data sets, certainly as you get more and more information. So, I would like to say that I feel we are at the threshold of really exploiting what we know and learning a great deal more, and I am looking forward to continuing this process.

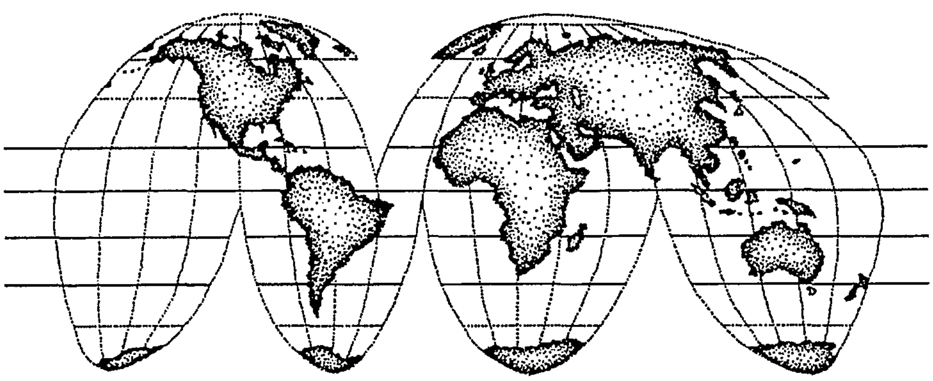
DR. KESSEL: I would just add to what Harry Rosenberg has said. Indeed, we have done so well learning from what ICE has done and, also, there is almost a next generation of the linked data activity under the leadership of NCHS. This linked data set includes information from the Medicaid population in the United States, which begins the process of adding variables to the dataset so that we can see various aspects of the population.

One of the problems that I think the data to date have for us is what does race actually mean per se? I think a number of people have identified a number of the issues, whether it is Jewish or non-Jewish in another country or being black or white in this country or in another country. It is the ability to do not univariate analysis but to really begin to pull together the kinds of variables and develop the kinds of hypotheses and hypothesis testing that I think is in part what Harry Rosenberg is really identifying at the moment.

It has taken us this long with this amount of effort to get a data set that people are comfortable with, as complex as it may be to explain to others some of its limitations and the difference between annual, cohort, and variations in some definitions. I think we have begun to see, if you will, the wisdom of linking information together--and again, this linking of the Medicaid data and the great concern in this country about eligibility for this program and in fact, even if being eligible for this program really makes a difference--and teasing out those other variables. The result is that Harry is right in talking about how we now have some information that with a little more work and energy we can not only do hypothesis generating, but the hypothesis testing that is critical to be able to translate it into the actions for the States and for communities, so that we can really begin to make a difference based on those simple kinds of observations.

DR. KLEINMAN: I feel badly that no one really has come up with any great answer to Peter's very pressing and very cogent questions. I do not have an answer either, but I do think that collaboration among all of us in these ICE countries should move in this direction. I think what Peter was talking about is that we have to take the data and the analysis and begin translating it into program planning and program evaluation. Unfortunately, very little of that was presented. I think England and Wales was the only place where we really presented geographic differentials, and I think as a future ICE activity it would be very useful to see how the different countries use those geographic differentials to improve their program planning and evaluation and resource allocation.

How do different countries use the data, especially in a system where there may be more central planning than is possible in the United States, to really identify problem areas or problem populations? How can you go about evaluating the effects of your interventions? I think there is a lot of opportunity there for collaboration.



Workshop

Issues in the Preparation, Distribution, and Usage of Standardized Data in the ICE Project

by Robert B. Hartford, Ph.D.

Today I am going to share with you some of our experiences in developing the ICE data set, which will be the basis of many of the presentations of the upcoming symposium. In the course of this activity we have gotten a lot of "good experience." Good experience, by the way, is what you find when you are looking for something else.

In this presentation I shall discuss the following topics: the instructions used to obtain the data sets, the timeliness with which they were obtained, the accuracy of the data sets, data quality control, and data comparability.

Instructions

Although we spent considerable time in preparing the instructions for providing data to the ICE Program, many questions still arose. In the future we will make sure that instructions are even more clear and concise. In particular, the format and the layout should be more clearly specified and easier to understand. The code list for the variables must be well specified, including the definitions of variables and the specification of code categories. I think we did a reasonably good job of preparing instructions, although we have discovered some problems resulting from failure to follow our instructions.

Future requests will stress the need to provide the data on floppy disks or computer tape. Using a packing program, which puts the data in a highly concentrated form, helps tremendously. With this approach we can now send a considerable amount of data on a single floppy.

In some instances we received data as printed output. Considerable time was lost in reentering, which also ran the risk of entering incorrect data. In the future, we would ask that instructions be followed more closely in this regard.

We have found that, where possible, it is advisable to use a single computer program to extract the data from the original data bank. For the current data set, an extraction program was written in SAS. Those U.S. States that had SAS were able to adapt the program and we found that worked very well.

Unfortunately, SAS is not available in many other countries or in some U.S. States. In the future we shall suggest that the data be provided in unit record format, rather than the tabular format requested. This should greatly simplify the work for the data providers; all they will need to do is to strip off the variables requested--which will obviously exclude all identifiers--and provide us with the record layout and variable codes. We can then use a single program, modified only to accept the input format, to prepare the desired data set.

Timeliness

We encountered some problems in putting together our current data set in timely fashion. This is an area on which the ICE Working Group should focus in the future. First, we do need to make realistic estimates of resources and time required. I fully appreciate that in many instances the ICE members are not the data managers and must go to a central statistical bureau or other organization to obtain the data or the tabulations. I think we need to be cognizant of the problems those organizations may have, their priorities, and their schedules. In other words, we need to make sure that the resources are available and agreeable before we make promises about delivery dates. Receiving the data only a few weeks before a symposium or a meeting puts undue pressure on the researchers who will use the data, as well as on those of us responsible for editing and checking the data and then putting them into "data-friendly" format.

Because the data were received so late the editing and quality control process was cut short. As a result, some of our presenters encountered data problems while preparing their analyses. Fortunately, we were able to rectify these problems but the presenters lost valuable time while waiting for explanations or corrections.

Data providers need to improve the documentation that accompanies the data. Sometimes data base constraints prevented the providers from following our specifications. In such cases deviations from the instructions need to be clearly documented. For example, we had requested that infant deaths be broken down by age groups, the first group being under 1 hour. England and Wales code age at death as "less than 30 minutes" and "30 minutes to less than 24 hours." This deviation was clearly stated to us while the data set was being prepared in England so we were prepared to deal with it.

Likewise, Germany does not use gestation as a criterion in preparing its late fetal death files; rather birth weight of at least 1000 grams is used. This exception was also clearly explained in the documentation that accompanied the data.

If data are sent in on computer tape, it is very helpful to know the characteristics of the tape. In some instances we were unable to read the tapes. Eventually we remedied the situation by having the data sent on floppies. When the data are sent on floppies, we request that they be sent as flat ASCII files; if on tape, they should be sent as EBCDIC files.

Format

Selecting the data set format proved to be much more troublesome than we had imagined. I have struggled with this issue, and I think only in the last weeks before the conference did I come up with a format that we all like and are satisfied with, at least as far as transmitting the data is concerned. However, the best format for transmitting data is not necessarily the most user friendly form. Nevertheless, I think we have come up with a form that is reasonably compact and efficient, thanks in part to the use of a packing program that reduced the space requirements on the floppies by roughly 85 percent. The format used makes it easy to preview the data, which I find very useful for detecting errors simply by scrolling through the data on a PC screen. Certain errors are very easy to spot--columns appearing out of place or records with nothing but zeros in fields that should have entries, such as the live birth field.

So, just being able to preview the data very rapidly on a screen is useful. Of course, if you have a record length that goes beyond the length of the screen you cannot preview it well, but with our new format that is certainly possible because we have restricted ourselves to about 20 columns.

We can talk about two formats. The first is for transmitting the data from the various sources into the central point where the editors will work on it. The second is a format that will be used to distribute the data to the researchers. While the transmittal format is very efficient, it is not necessarily user-friendly because the numerator and denominator are not on the same record. To deal with this problem, we have developed another format with a very long record length--350 characters--but the denominators are included. While not quite as space efficient as the transmittal format, it is certainly user friendly.

Quality control

Quality control begins at home. There are several different levels of quality control. Part of it has to do with the nature of the data bank that each country uses to produce their contribution to the ICE data base. We must always be alert for problems of quality in the national data sets.

There is also a need for quality control in the programming used to produce the ICE data sets. Thus, there are two opportunities where errors can creep in. Once a country's ICE data contribution is produced, it would be very helpful for the provider to check the data set before transmitting it to us. This can be done by running a few simple frequency counts and cross tabulations to make sure that the data agree with official published data. In most instances this comparison was not done, and we have had several nasty surprises. For some countries we had to request numerous corrections or remakes of their data set before it agreed with published data.

There is always the problem of unlikely or impossible events. This is very often related to a problem in the country's master data bank. Our quality control discovered this type of problem in almost every data set submitted to the ICE. For example, we consistently encountered situations such as a live birth of 42 weeks gestation and less than 500 grams; needless to say, we are somewhat suspicious of such a combination.

Figures 1a and 1b illustrate some of life's little embarrassments that we see in our data, and such things occur in all of the ICE countries in one way or another. Here I have taken birth weight in the finest graduations--100 grams. In almost every case there seems to be a problem in the lowest weight interval. While survival of very low birthweight infants has increased dramatically in recent years, only a few percent of infants weighing less than 500 grams survive. Hence, mortality rates for the lowest weight category should be very close to 1000. Further, we expect a monotonic decline of birthweight-specific mortality by weight, for weights less than 4000 grams. Nevertheless, we see that in most cases the mortality rate of infants under 500 grams is lower than the rate for the 500- to 599-gram weight category. Only Osaka and U.S. blacks show the expected pattern. I was rather surprised at the different patterns of birthweight-specific infant mortality among U.S. whites and blacks. I would have thought the data for blacks would have been more susceptible than the data for whites to under-registration of extremely low birthweight infant deaths, but such is clearly not the case. The data for Israeli Jews and Norway show slightly lower rates at the lower weight category, but the rates are still fairly close to 1000 as is expected. Data in the lowest two or three weight categories for Denmark, Israeli non-Jews, Scotland, and Sweden seem particularly questionable. In the case of Sweden, and perhaps the other populations as well, the "missing" deaths may have been counted, but are to be found in the "unknown" weight category.

Another type of inconsistency encountered is in categories containing more infant deaths than live births. For example, the United States data contain 552 live births of under 20 weeks gestation and under 500 grams, but in the same category we had 556 infant deaths. It is advisable to subdivide live births and infant deaths into the finest possible categories to uncover this type of problem. As presenters generally do not use the finest possible breakdowns in their analyses, most of this kind of inconsistency, which will continue to exist in the ICE data base, will be masked by aggregation. So please be aware that those problems do persist.

Comparability

Comparability, the final issue we shall discuss, is a major concern of the ICE project. In order to make valid comparisons of infant and perinatal mortality among the ICE countries, we must first obtain comparable data. We had a fascinating 3-hour session yesterday afternoon discussing problems of comparability and what we need to do in the future in order to improve comparability.

The official UN/WHO definitions and recommendations are the foundation of comparability. Yes, I know--everyone follows WHO guidelines--or so goes the party line. However, I am requesting that each participating country provide us with copies of official documentation and procedures followed, rather than merely telling us that "We follow the UN definitions."

As an example of problems of comparability, Germany is following WHO recommendations in defining a late fetal death ("totegeboren") as a fetal death of at least 1000 grams in birth weight; all other countries use the 28 weeks of completed gestation to define the late fetal death, an alternative admissible under the WHO guidelines. A fetus that develops normally should weigh about 1000 grams--on the average--at 28 weeks of gestation. However, there is a significant portion of fetuses that do not develop normally and may weigh either much more or less at that gestational age. Furthermore, a substantial portion of fetal deaths are not delivered until some time after death. Their weight at delivery, therefore, may be considerably lower than at time of death. As a result, comparability suffers significantly if weight, rather than gestational age, is used in defining a fetal death.

Differences in coding procedures can also adversely affect comparability as well as completeness of registration. For example, Dr. Joel Kleinman has shown that the lower the required threshold age for registering a fetal death (for example, all products of conception versus 20 weeks gestation), the better the registration at 28 weeks. To improve completeness of registration coverage of fetal deaths of 28 weeks or more of gestation, the threshold should be substantially less than 28 weeks. Unfortunately only four countries use lower thresholds--Hungary, Japan, Norway, and the United States. The respective thresholds are 12 weeks in Japan, 16 in Norway, and 20 weeks, or less, in the United States (several States require that all products of gestation be registered). Hungary registers all products of conceptions. It is very obvious that these three countries do an excellent job in registering all the fetal deaths of 28 weeks and over. There do seem to be problems, however, with completeness of coverage in some of the countries that set the threshold at 28 weeks. Figure 2, showing the late fetal death rate as a function of the perinatal mortality rate, suggests that the fetal deaths may be subject to under-registration in Denmark, Sweden, and among the Israeli Jewish population. Oddly enough, Israeli non-Jews show a much higher than expected fetal death rate for their infant mortality level. We do have reason to expect that a significant portion of small, premature non-Jewish infant deaths go unreported, giving a falsely low infant mortality rate. It does seem strange, however, that there should be greater under-enumeration of infant deaths than late fetal deaths in any population.

Another example of the effect of coding procedures on comparability was due to an error. In one U.S. State we found an error in the written coding procedures existing since 1978. As a result, infants coded as dying within 24 hours of birth were in reality only those who had died on the calendar day of birth. This caused the number of deaths under 24 hours to be understated by as much as 30 percent. I am still suspicious that many countries (not ICE countries) that routinely report deaths under 24 hours are really reporting only those that occur on the calendar day of birth.

There is a lot more we need to know about coding procedures and clinical procedures, particularly in regard to various causes of death and age at death, as well as the determination of whether a pregnancy outcome is classified as an infant death or a late fetal death. I think we are beginning to gain a better understanding of some of this, but we still have a long way to go.

With regard to causes of death, we are particularly concerned with the diagnosis of sudden infant death syndrome, or SIDS. What criteria are used in the diagnosis? In some countries SIDS can literally be an absence of anything else. By contrast, in Sweden, where there is a very high percentage of autopsies of infant deaths, a national committee reviews the medical records to confirm or reject a suspected SIDS diagnosis. At the other extreme are Israel and Japan, where autopsies are relatively uncommon. Interestingly enough, Israel reports a very high SIDS death rate while Japan's rate is extremely low.

Finally, I must warn you against using United States data in 100-gram intervals; the original data were coded in pounds and ounces and then converted into grams. Figure 3 compares the birthweight distributions of Sweden and U.S. whites. Sweden shows a very nice, smooth progression over this weight range; not so with the U.S. data. When using U.S. data, 200-gram intervals are the narrowest that should be used from the ICE data set.

The final problem of comparability relates to the distinction between an infant death and a fetal death. For an infant death to occur first requires that an infant be born alive. As you know, the perinatal mortality rate was originally developed to overcome the apparent inconsistent manner in which countries distinguish between a live birth and a fetal death. In some cases countries used definitions other than the WHO standards, while in others it appeared that the definitions were being interpreted or applied differently. We have anecdotal evidence suggesting that, for example, in some countries, extremely small and/or immature infants who are not judged to be "viable" are routinely classified as fetal deaths, although they may have demonstrated some sign of life. We cannot at this time provide a precise statement of the discrepancies among the ICE countries in this regard; however, we can provide some circumstantial evidence. First, we can examine the proportion of perinatal mortality made up of late fetal deaths. Differential tendencies to designate a birth outcome as a fetal death, rather than a live birth/infant death, should show up as an elevated level of the fetal death portion of perinatal mortality.

It is suggested that distinguishing between a fetal death and a live birth/infant death is most problematic for very premature and/or very low birthweight infants. Therefore, it would be useful to focus only on outcomes below 1000 grams. This approach will be hampered, however, by the registration practices in most of the ICE countries that do not register fetal deaths prior to 28 weeks of completed gestation, as previously explained. The overwhelming majority of fetuses weighing less than 1000 grams will be of less than 28 weeks gestation. For this reason we can focus only on Hungary, Osaka, Norway, and the two United States populations. Figure 4 shows, for outcomes of less than 1000 grams, fetal deaths of 20 weeks or more gestation as a percentage of the perinatal rate, compared with the overall infant mortality rate. In the United States, fetal deaths greater than 20 weeks gestation constitute only 38 percent to 47 percent of the perinatal rate for outcomes less than 1000 grams. In the other populations the percentages range from 83 percent to 93 percent, or nearly twice the percentage in the United States. This suggests that there is a very different diagnostic pattern in differentiating between fetal deaths and live births/infant deaths in the United States as compared with other countries.

For a number of years researchers have suggested that in Japan there was a particularly noticeable tendency to classify as fetal deaths pregnancy outcomes that would be classified as live births in other countries. Unfortunately, lack of birthweight-specific historical trends of perinatal mortality prevent us from examining this issue. However, there is a proxy measure that we expect will correlate highly with the outcome classification--the percentage of infant deaths that occur in the first 24 hours of life. That is to say that most of the infants that might be incorrectly classified as fetal deaths would die anyway within 24 hours of birth. Our final graph, figure 5, shows the trend of this percentage for several of the ICE countries.[1] Indeed, Japan appears as an outlier prior to the 1980's, although its departure from the European norm virtually disappears by the mid-1980's. Furthermore, throughout most of the period since 1950 the United States appears as an outlier on the high side.

It is beyond the scope of this discussion to explore the reasons for these differential patterns in distinguishing between fetal and infant deaths. What is important for the Symposium is that we keep in mind this significant lack of comparability.

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[1]Data for this figure are from the international data bank of the Office of International Statistics of NCHS and include all birth parities.

I hope this brief overview of some of the problems we encountered in preparing the data set to be used in this week's symposium will help in interpreting the results to be presented and in helping to prevent the recurrence of the problems in the future.

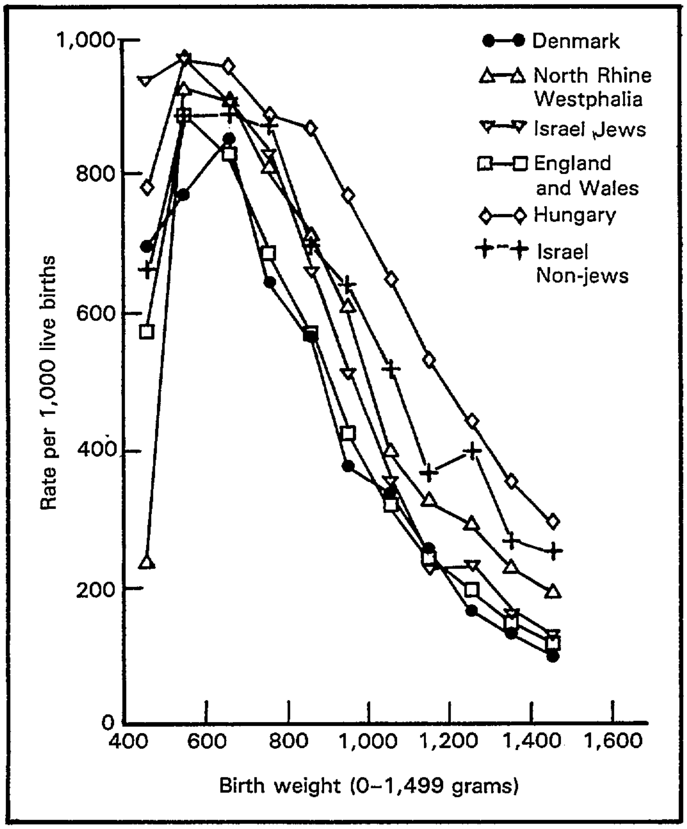

Figure 1a. Infant mortality rate, by birth weight in 100 gram intervals: ICE countries, 1980–85

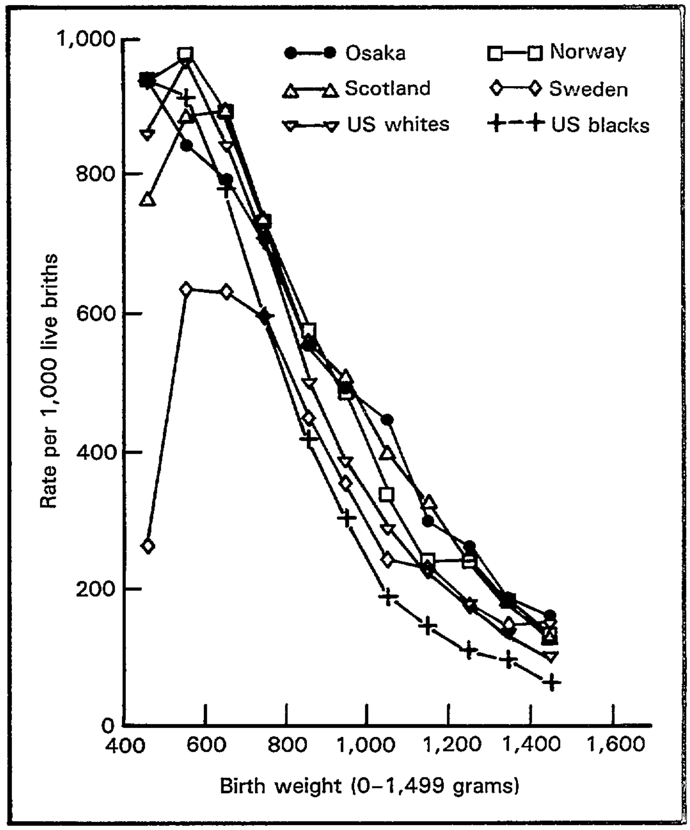

Figure 1b. Infant mortality rate, by birth weight in 100 gram intervals: ICE countries, 1980–85

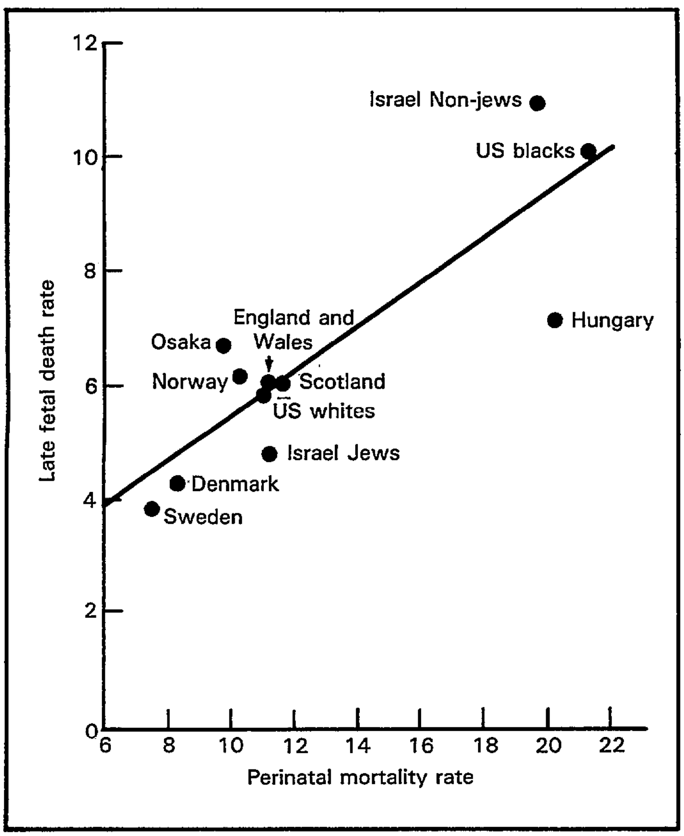

Figure 2. Late fetal death rate by perinatal mortality rate: ICE countries, 1980–85

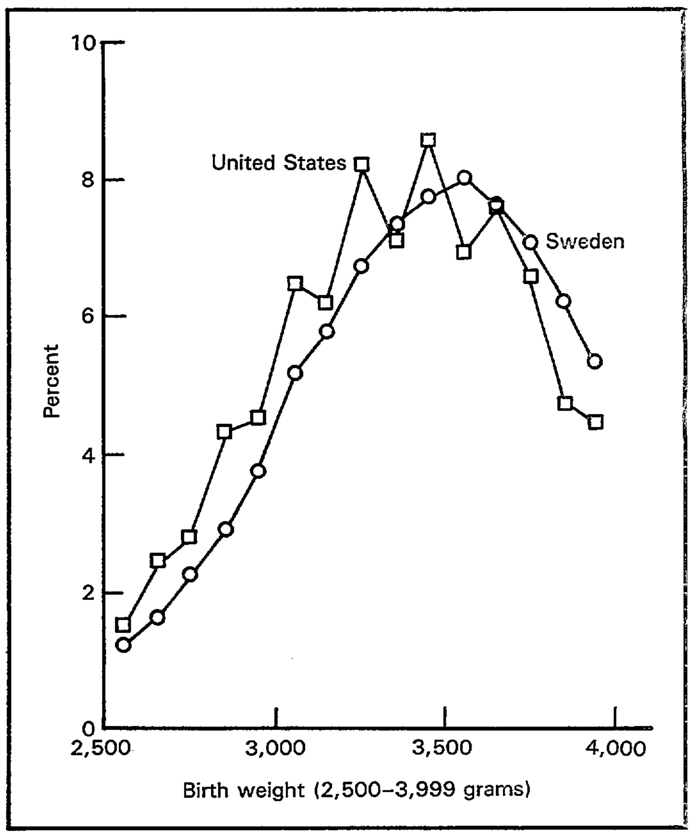

Figure 3. Percent birth weight distribution Sweden and the United States whites, 1980–85

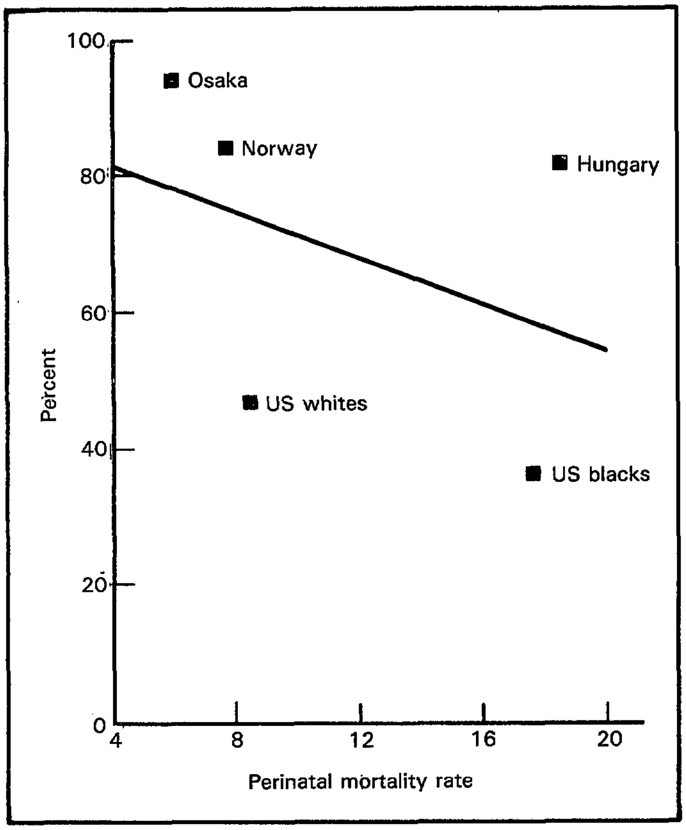

Figure 4. Fetal deaths of 20 or more weeks gestation as a percentage of the perinatal mortality rate, for outcomes of 1,000 grams or less: Selected ICE countries, 1980–85

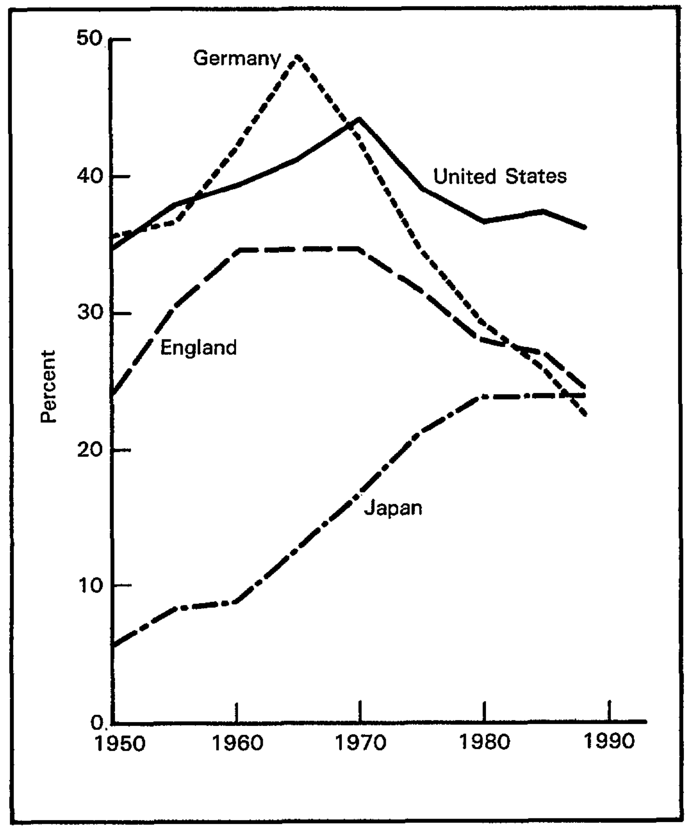

Figure 5. Percent of infant mortality under 24 hours: England and Wales, Germany, Japan, and the United States, 1950–88

Methods of Standardization for Birth Weight With Clinical Applications

by Petter Karlberg, M.D., and Aimon Niklasson, M.D.

Utilization of rapidly developing computer techniques has made it possible to accumulate and analyze a vast amount of data from the perinatal field. For instance, a 3 1/2-inch 2 megabyte disc can hold information on about 10 million births with nine variables from the International Collaborative Effort (ICE) database.

How to use such information will be discussed together with clinical applications. For illustration, data from four other perinatal and infant mortality studies will also be used: a 1973 international comparative study sponsored by WHO; the 1972-73 Comparative Study between Göteborg and Palermo; the 1977-81 Sweden study; and the 1982-86 Göteborg study.

ICE data

Of the nine variables in the ICE data base, five are discrete (country, year, type of event, plurality, and race) and the other four (gestational age, age of death, cause of death, and birth weight) are grouped for analytic purposes. Due to technical reasons, data from six of the countries have been selected: Denmark, England & Wales, Israel, Norway, Sweden, and United States with the two subpopulations U.S. blacks and U.S. whites.

Mortality rates

The stillbirth and infant mortality rates measure the extreme risk--that is, the risk of dying. In figure 1 the stillbirth and infant mortality rates, the latter in cumulative age components, are shown graphically for each of these countries/subpopulations, arranged in order of declining infant mortality. However, even in components related to age at death, the information is crude. The two basic factors--the quality of health care and the risk structure of the actual perinatal population--cannot be differentiated (figure 2) (1).

Immaturity (low gestational age) and deviations in size at birth are the primary indicators of vulnerability (death). Often only birth weight (BW) is available as an index. Mortality in relation to birth weight will indicate quality of care; the birthweight distribution indicates the risk structure of the actual perinatal population. The crude mortality rate is the product of these two parameters. This has to be considered in comparisons between populations/subpopulations as well as within a population.

Since low birth weight is related to high risk in many analyses, the events are grouped in <2.5 kilogram and ≥2.5 kilogram categories, or further divided into <1.0, 1.0-1.4, 1.5-2.4, and ≥2.5 kilogram groups. However, grouping in 500-gram classes (or smaller) through the whole range provides improved information, since the degree of vulnerability and age at death may be looked upon as a dose-response relationship. Assuming primarily a normal distribution offers conceptual and practical advantages. Graphing birthweight-specific mortality rates within suitable birthweight classes on a probability scale is a comprehensive tool; the smoothing of classes and cutoff limits that results provides a basis for sharpened visual comparisons, as this scale stretches out the tails at each end of the distribution.

In figure 3 the birthweight-specific infant mortality rates are given for England and Wales, Israel, Sweden, and U.S. blacks and whites. The U.S. black rate is the lowest within the birthweight range 0.5-2.4 kilograms, but at 2.5 kilograms crosses over toward the highest levels, together with England and Wales and Israel. U.S. whites and Sweden have similar rates for the lower birthweight classes--about the middle of the distribution--

and have the lowest rates at the higher birth weights. Comments are provided below on the different patterns.

Birthweight distribution

The birthweight distribution of all births can be depicted as cumulative percentages in the same kind of graph. On the probability scale small differences in the important lower and higher values are recognized easily.

Figure 4 presents birthweight distributions for U.S. blacks and whites and Sweden. For each population the high-risk lower tail is clearly seen. The commonly used cutoff levels such as the percents below 2500 grams, 1500 grams, and 1000 grams may be read off directly, as well as the median values (where each curve crosses the 50 percent line). The birthweight distribution of U.S. blacks is shifted toward the left. That is, it has in general a lower birth weight at each percentile in relation to U.S. whites, with the median 250 grams lower; the proportion below 2500 grams is 12 percent as compared with 5.5 percent for whites; and below 1500 grams is 1.5 percent compared with 1 percent for whites. Sweden is somewhat further to the right in relation to U.S. whites, the median is 50 grams higher; the proportion below 2500 grams is 4.4 percent; and below 1500 grams is 0.6 percent. There are obvious differences.

Combining the two models

Combining the birthweight-specific mortality rates and birthweight distributions provides insight regarding observed differences in the crude mortality rates. In figure 5 the two measures are combined in one graph for U.S. blacks and whites and Sweden. The number of infant deaths in each birthweight class of a live birth population of 100,000 is included as a comparable measure of interest (= the product of the mortality rate per 1,000 and the class percent of total live births).

To illustrate the direct interactions, the percent of total live births, birthweight-specific mortality per 1,000 live births, and the number of infant deaths in each cell in a 100,000 population are given for each birthweight class in table 1. The birthweight-specific mortality rates decline continuously with increasing birth weight up to 3.5-3.9 kilograms. The number of deaths per cell also declines from the low weights to reach a minimum at 1.5-1.9 kilograms, then rises up to the 3.0-3.4 kilogram cell before falling off again. The same pattern exists for all three populations. The relatively low birthweight-specific mortality rate of U.S. blacks in lower birthweight classes does not compensate for the increased number of births in these classes. In the higher birthweight classes it is the opposite. Such a combined graph yields a rich aggregate of information and, when familiar, may stimulate a reassessment of clinical priorities and/or practices and lead to biological understanding. It emphasizes the importance of the birthweight distribution in studies of infant mortality.

In figure 6, differences in birthweight distributions are also seen between the Nordic countries of Denmark, Norway, and Sweden. Denmark has a 150-gram lower median than the other two countries but no difference in the lower tail. There are also differences in birthweight-specific mortality rates, calling for analysis (figure 7). Furthermore, the graph illustrates the different birthweight-specific patterns of neonatal and cumulated infant mortalities. For example, the cross-national differences in postneonatal mortality increase with increasing birth weight, indicating the influence of sudden infant death syndrome. In a survey of the five Nordic countries, ranked in order from Iceland (the highest) to Finland, Norway, Sweden, and Denmark, the range of median birth weights is 200 grams (2). Similar differences are seen among the 21 city districts of Göteborg, the second city of Sweden with a population of 450,000 (3).

These two methods may be used to evaluate the relationship between the basic variables (birth weight, age at death, and cause of death), through the measurement of: a) birthweight-specific and (cumulative) age-specific death rates; and b) birthweight-specific and cause-specific death rates for all causes or selected causes, and at selected ages of death. A detailed analysis of cause of death and age at death has shown that a grouping of the ages at death before and from 28 days after birth is rational and meaningful for clinical applications. The method may be used for comparison between years (trend analysis). Further examples are found in earlier publications (4,5).

Gestational age

Birth weight is used owing to its general availability. However, combining birth weight with gestational age (GA) gives improved information from the clinical point of view.

Gestational age determines and explains the features of the birthweight distribution in two main ways: a) low gestational age limits fetal growth and results in low birth weight; b) low birth weight in relation to gestational age (BW/GA) defines hampered and/or retarded fetal growth (light for date, small for gestational age, or intrauterine growth retardation), as well as accelerated fetal growth (large for date), which again is the subject of increasing interest. A general shift toward somewhat lower gestational age may reduce birth weights in general. Even here, large groupings and cutoff limits are often used in clinical concepts: these concepts can be related to gestational age, such as preterm (<37 completed gestational weeks, sometimes divided into <28 weeks and 28-36 weeks), term (37-41 weeks), and postterm (>=42 weeks); they also can be related to BW/GA, such as "light for date" (below a certain level, such as the 10th or 5th percentile, or <2 SD below a reference standard).

In the ICE data, gestational ages (in completed weeks) are grouped in the categories <28, 28-33, 34-36, 37-39, 40-41, and 42+ weeks. Figure 8 shows the BW/GA relationships for Sweden based on the cross-tabulation of birth weight in 500-gram groups and the selected gestational age groups, with calculated neonatal mortality per 1,000 live births for each cell. The mean values of birth weight and gestational age in each cell, taken from the new Swedish reference standard, are marked and connected to a mean curve. There are some outliers and unreasonable values, which are marked with parentheses. As expected the table shows high risks at low gestational age and birth weight, decreasing with increasing gestational age and birth weight. However, there is an indication of increased risk with deviation from the main BW/GA relationship, not only toward low birth weight for gestational age ("light for date"--intrauterine growth retardation) but also toward the positive side ("large for date"). The information will be improved with smaller cells in the matrix as illustrated in figure 9a. The material is from a Swedish 5-year perinatal cohort study, 1977-81 (about 500,000 births) (6). The cells are based on 250-gram birthweight groups and 1-week gestational age groups. In the figure, rising rates of early neonatal mortality in each cell are indicated with increasingly dense crosshatching. The pattern pointed out above is now more obvious and precise. BW/GA distributions and the mortality rate per cell may be depicted in 3 to 4 dimensions (figures 10a and 10b). Such exercises provide visual illustrations of the risk domains within birth weight and gestational age categories.

Birth length

The introduction of birth length (BL) in relation to gestational age defines short length (stunting) and in relation to birth weight (BW/BL) defines wastage (lean/obese) (7). The latter relationship is illustrated in figure 9b.

The discussion so far has attempted to show that graphical presentation of the material, grouped in ordinal classes and cross-classified, offers rich but condensed visual information. However, it is often emphasized that the small number problem caused by splitting up the material into many groups makes analysis difficult or impossible. There is an answer to that.

Mathematical models

Mathematical models can be used to smooth the variations and at the same time take care of individual values. Such models describe relationships with a limited number of parameters, and usually the visual differences can easily be statistically tested.

Figure 11 illustrates how a mathematical model represents the individual class values in birthweight-specific mortality, taken from the 1972-73 Comparative Study between Göteborg and Palermo on Perinatal and Infant Mortality (1). Using the same material, different models were tested and evaluated (8).

The BW/GA measure for given gestational ages can be transformed into the continuous variable, standard deviation scores (BWsds), for each individual. This variable can then be used for simple statistical analysis. Using the new Swedish reference standard of size at birth in mathematical functions of the means and standard deviations for given gestational ages, it is easy to determine the standard deviation scores for a total population/subpopulation or selected groups (9).

Mortality rates related to birth weight and gestational age can be further statistically analyzed, forming the basis for clinically useful graphical presentations. With known distribution within each week of gestation of the total population and of newborn infants who had died during the first week after birth, "iso-morts" can be constructed for early neonatal mortality in a matrix of gestational age in weeks and BWsds. The risk related to the relationship between gestational age and graded, retarded, and accelerated fetal growth can be depicted.

The birthweight distribution of a perinatal population/ subpopulation or selected group can be described in terms of the mean and standard deviation of transformed BWsds, normalized for sex and gestational age, and simple statistical methods may be used for comparison. The normalization may go farther, to parity, maternal age, size, smoking habits, and nationality. The method has been applied to the analysis of the birth weight distribution in the 21 districts in Göteborg (3).

In the event that birth weight alone is available, mathematical modeling is of significant use. Fryer et al. have shown that the birthweight distribution, with its dominant normal subpopulation and a pronounced lower tail and smaller upper tail, can be described as a primary dominant Gaussian component and a smaller but broader second component by using techniques for decomposing mixtures of normal distributions (8,10-12). For the Swedish sample in the WHO collaborative study, the primary component accounted for about 90 percent of infants, with a mean of 3500 grams and standard deviation less than 500 grams, and a secondary component with a mean of 3300 grams and standard deviation of 1000 grams. This subpopulation model fits the data very closely, as seen in figure 12.

Furthermore, similar analysis of the birthweight distribution of seven countries in a 1973 WHO-sponsored perinatal study supports the interpretation of the major component (13). It is argued that standardizing this primary subpopulation provides a sensible basis for making international comparisons of birth weight. In figures 13a and 13b the cumulative distributions of birth weight for three of the participating countries (Hungary, Japan, and Sweden) are presented, first in absolute form and then standardized (14). Although Japan and Sweden show quite different levels in 13a, the plots are virtually identical in 13b even though Hungary still has a heavier lower tail. Birthweight-specific early neonatal mortality rates can be standardized in the same way, also displayed in figures 13a and 13b. The parallel courses of the standardized birthweight-specific mortality rates indicate an improved description of the biological events. An example showing calculated birthweight-specific mortality for the primary and secondary populations is shown in figure 14 (8).

Conclusion

The discussion has been focused on birth weight, a basic factor in perinatal-neonatal analyses. The aim has been to show how information, variables, and calculated parameters in tables or stored in computers can be extracted and condensed into graphical presentations, keeping the primary grouping but providing broader perspectives to see beyond cutoff limits. The objective of this approach is to elucidate possible relationships or interactions for clinical considerations and for planning further analyses. Furthermore, we have tried to point out that application of mathematical models will facilitate statistical analysis for comparisons and will also stimulate clinical and biological considerations and understanding.

Acknowledgments

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Table 1. Percent distribution of live births by birth weight, birthweight-specific infant mortality rates, and number of deaths in a population of 100,000 live births with the same birthweight distribution, 500-gram groups, U.S. whites, U.S. blacks, and Sweden, 1980-85.

Birthweight class (Kg.)	<0.5	0.5-0.9	1.0-1.4	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5+	Unknown	Total
					U.S. blacks							
Percent of births*	0.38	1.1	1.3	2.4	7.3	23	38	21	4.8	0.84	0.12	100
BW-specific mortality+	957	525	106	43	18	8.0	5.3	3.0	4.4	8.7	318	
n/100,000$	364	561	135	101	130	186	202	80	21	7	40	1827
					U.S. whites							
Percent of births*	0.10	0.32	0.49	1.0	3.4	14	36	33	11	2.3	0.10	100
BW-specific mortality+	881	600	154	57	23	7.5	3.7	2.6	2.6	3.4	191	
n/100,000$	88	192	75	57	76	102	132	83	28	8	19	860
					Sweden							
Percent of births*	0.01	0.18	0.42	0.89	2.8	12	33	34	14	3.0	0.71	100
BW-specific mortality+	259	482	179	60	21	6.4	3.1	2.4	2.2	2.3	143	
N/100,000$	3	87	75	54	57	74	102	82	31	7	101	672

*Cell percent of total live births.
+Birthweight-specific mortality per 1000 live births in each cell.
$Number of infant deaths in each cell of a live birth population of 100,000.

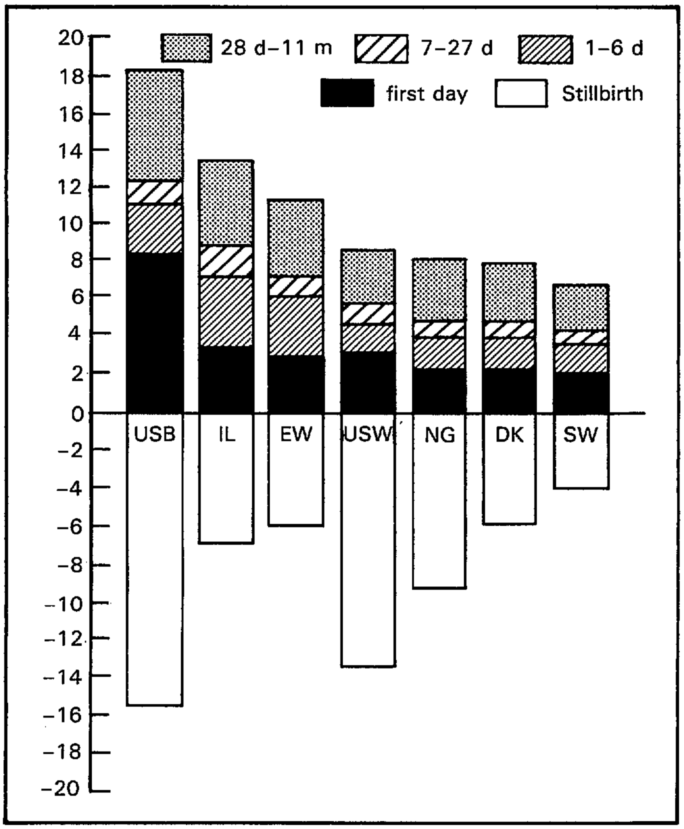

Figure 1. Stillbirth and infant mortality rates in selected ICE countries

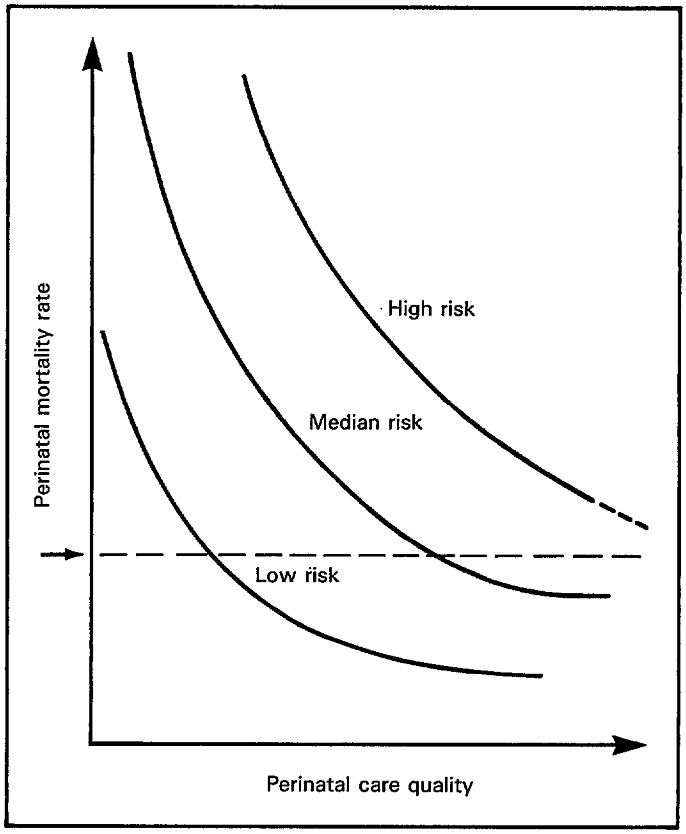

Figure 2. Schematic relationship between perinatal mortality and perinatal care quality with respect to different type of risk populations

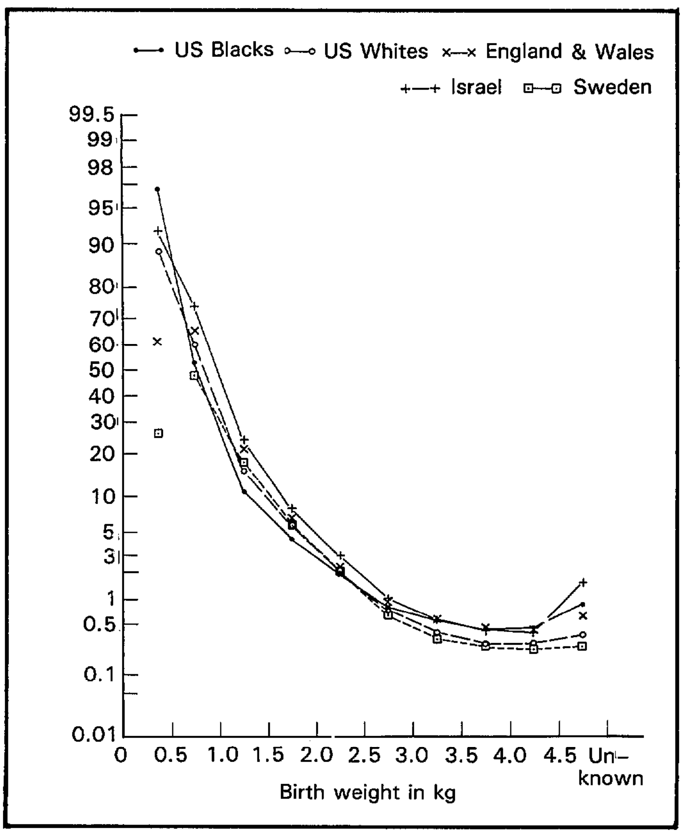

Figure 3. Birthweight-specific infant mortality (in 500 g classes) on a probability scale: Selected ICE countries, 1980–85

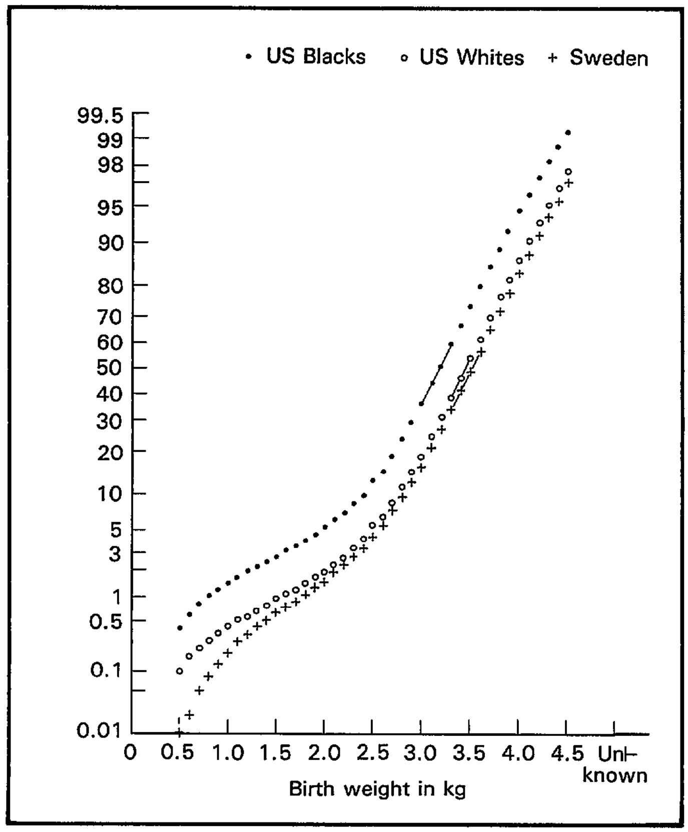

Figure 4. Birthweight distribution (in cumulative percentage and in 100 g classes) for livebirths on probability scale: Selected ICE countries, 1980–85

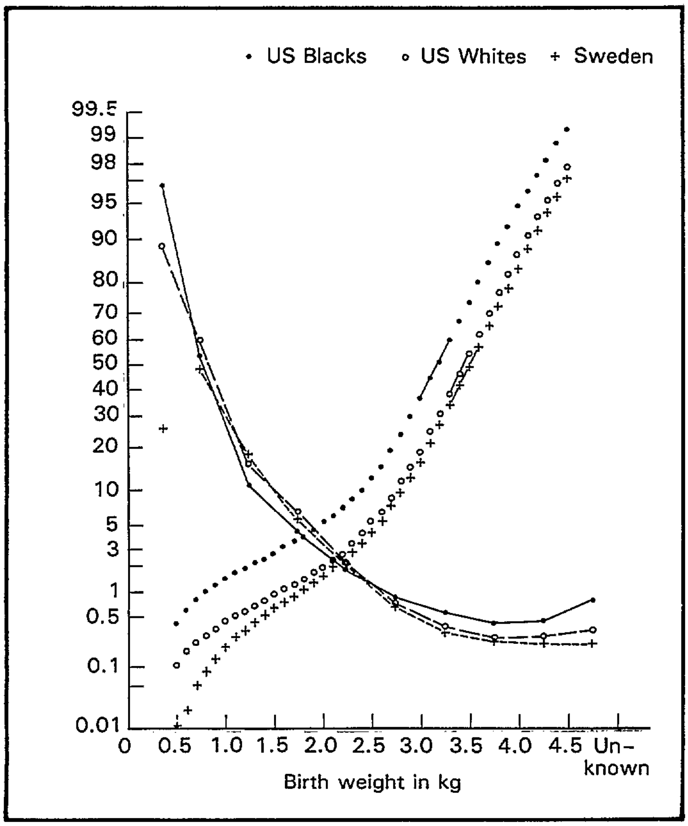

Figure 5. Birthweight-specific infant mortality in 500 g groups and cumulative birthweight distribution in 100 g groups for live births on probability scale: Selected ICE countries, 1980–85

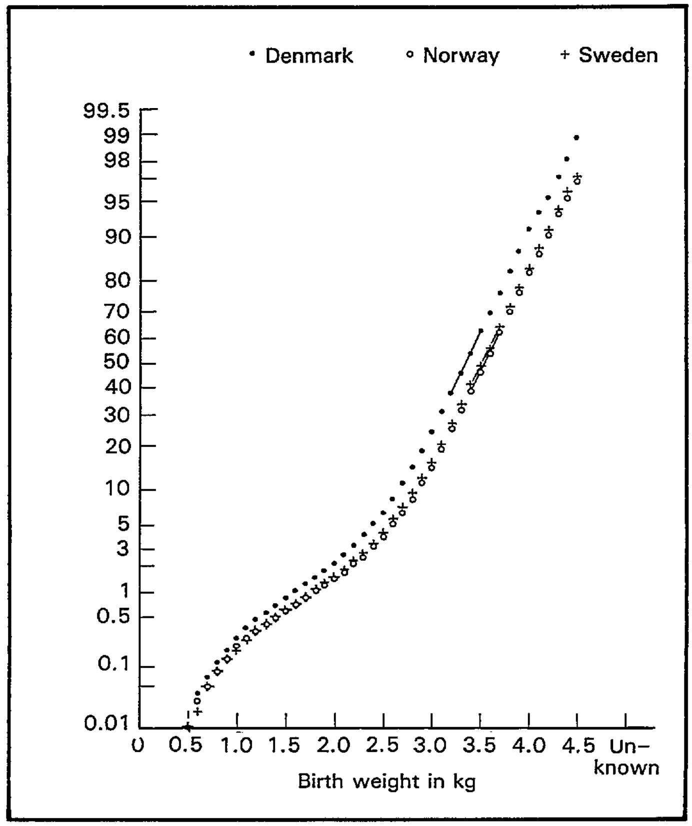

Figure 6. Cumulative birthweight distribution in 100 g groups for live births on probability scale: Denmark, Norway, and Sweden

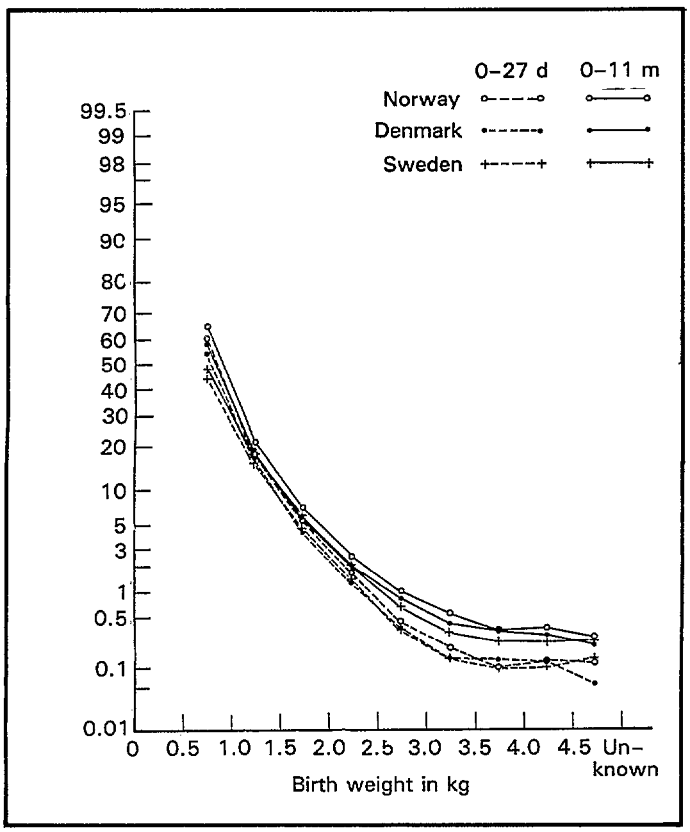

Figure 7. Birthweight-specific mortality in 500 g groups: Denmark, Norway, and Sweden

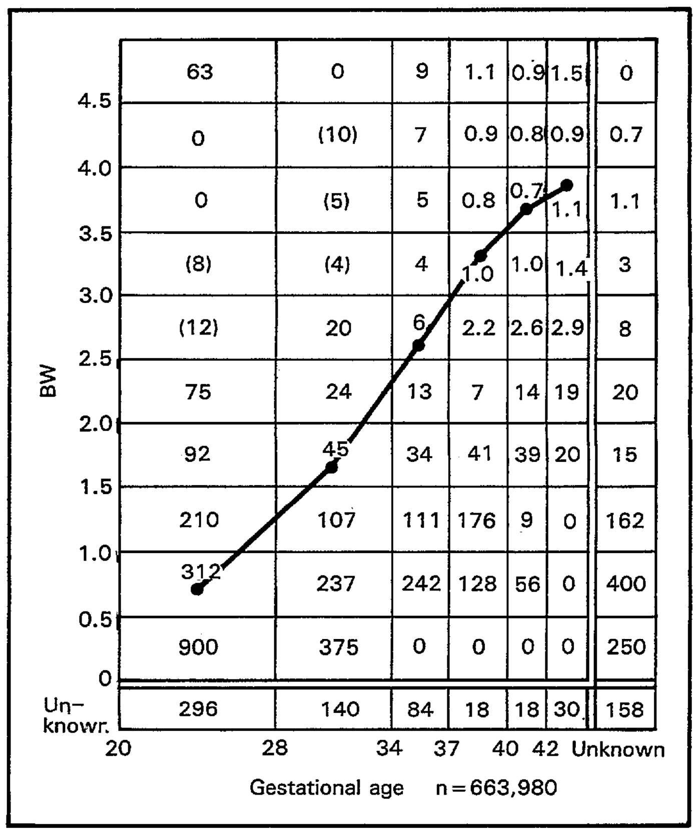

Figure 8. Neonatal mortality from the Swedish ICE data in relation to birthweight and gestational age. Superimposed is the new birthweight mean for each cell taken from a new Swedish reference standard (9).

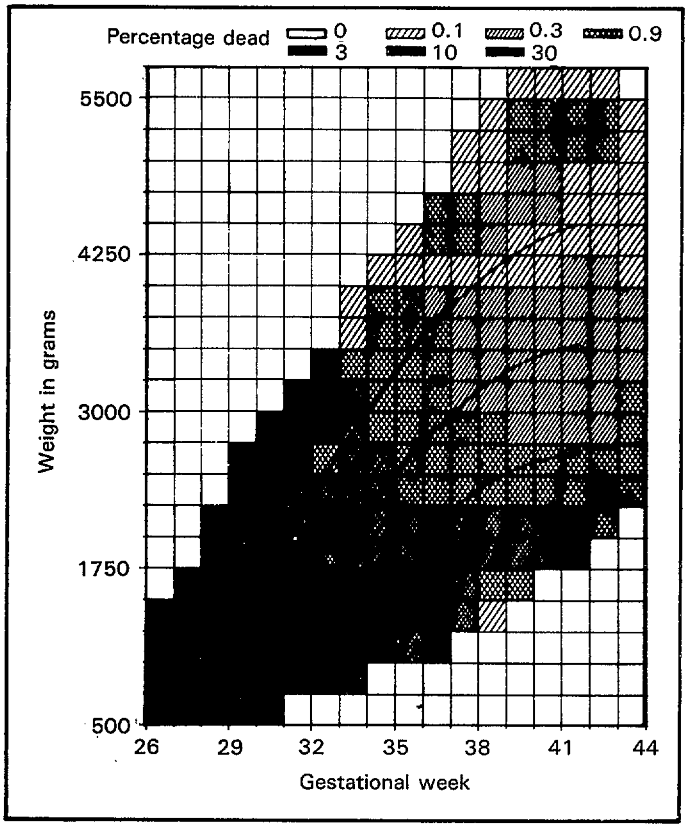

Figure 9a. Early neonatal mortality for female infants in relation to birth weight and gestational age in a Swedish 5 year perinatal cohort study (1977-81, N=500,000)

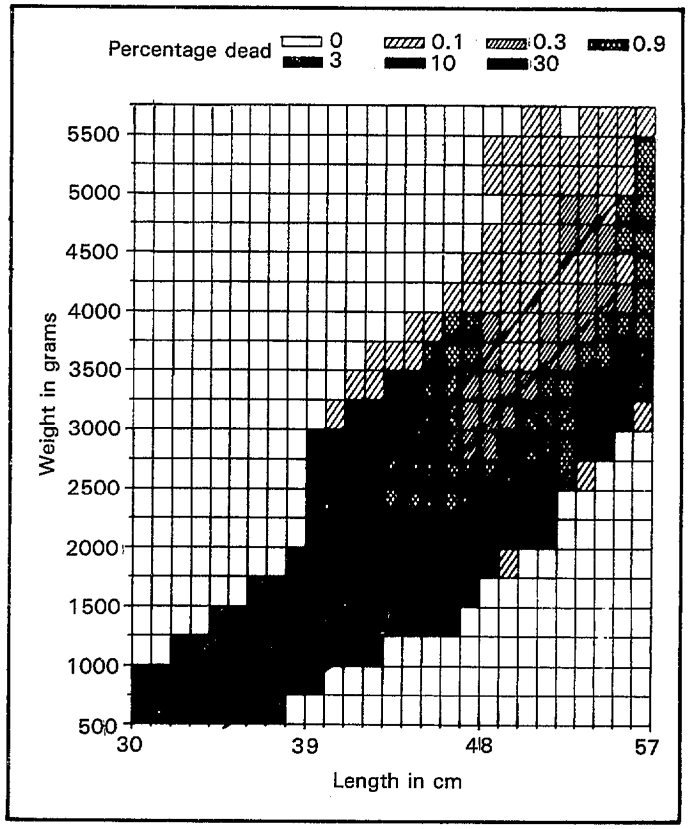

Figure 9b. Early neonatal mortality in relation to birth weight and birth length in a Swedish 5 year perinatal cohort study (1977-81, N = 500,000)

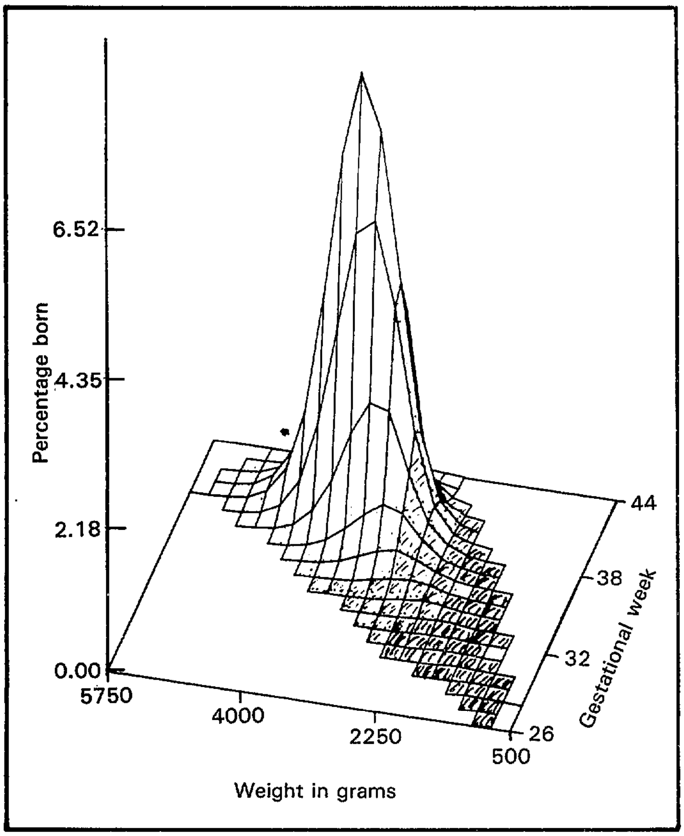

Figure 10a. Early neonatal mortality in female infants in relation to birth weight and gestational age as in figure 9a, but also giving the percentage in each cell of the total number of live births along the axis perpendicular to the "bottom plate"

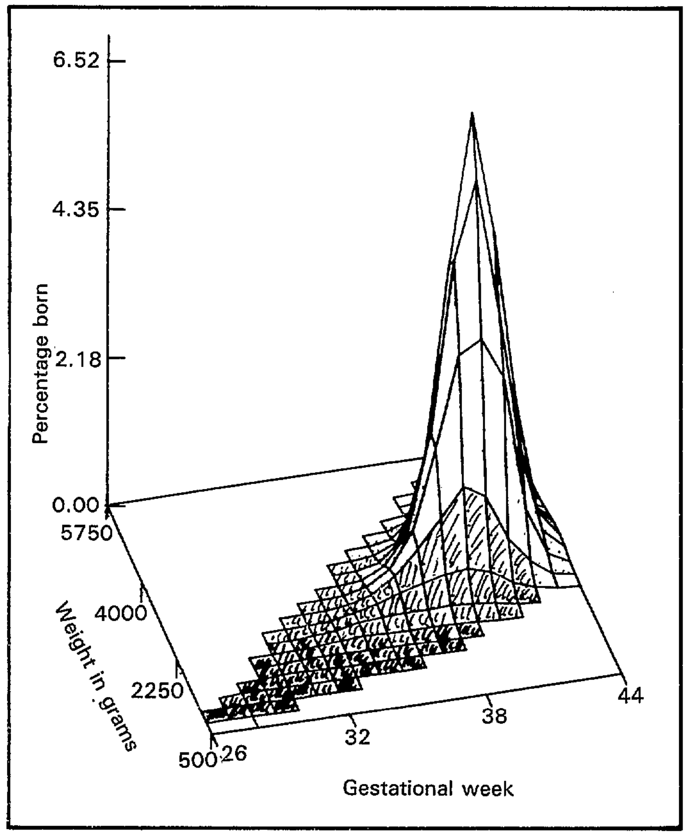

Figure 10b. Same as figure 10a, but "bottom plate" rotated (seen from different angle) in order to show the different risk below or above mean birthweight at comparable gestational age

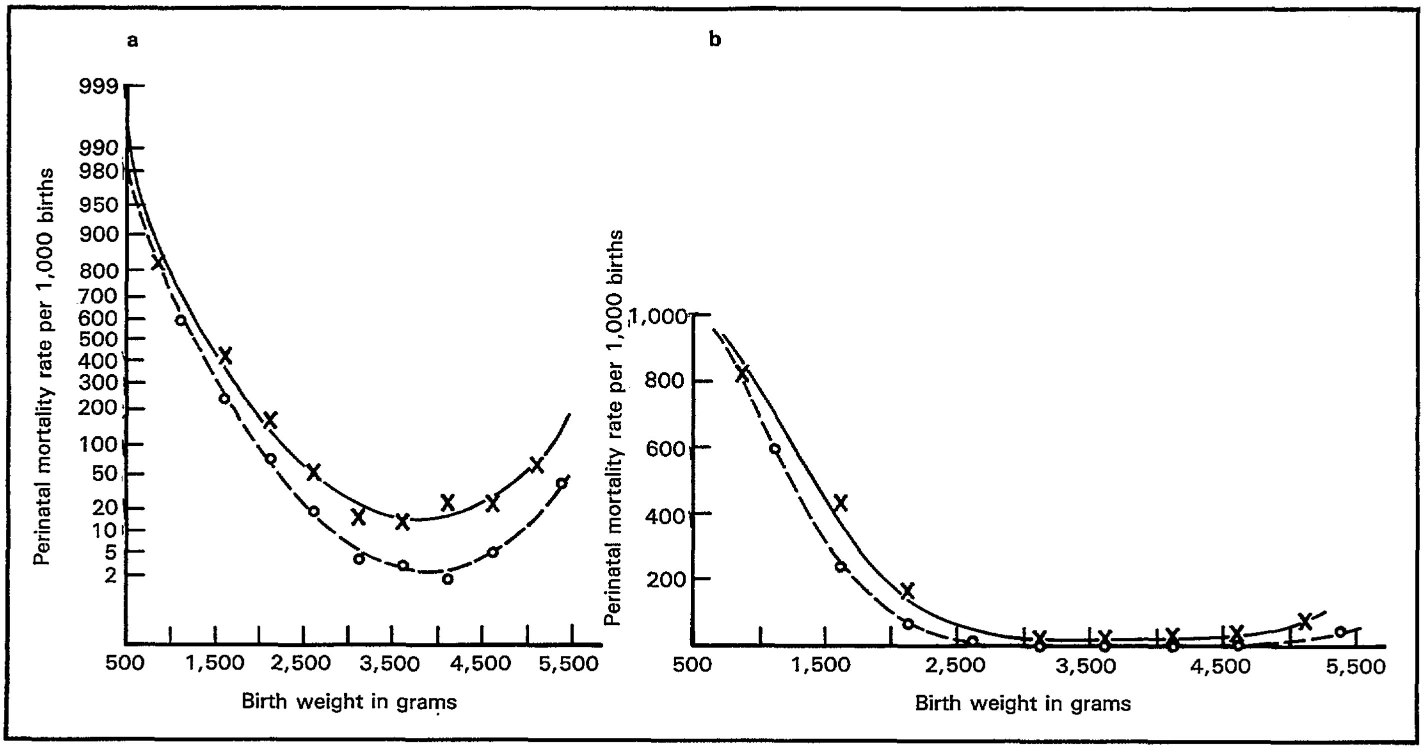

Figure 11. The relationship between perinatal mortality rate and birthweight (Goteborg-Palermo Perinatal Mortality Survey 1972–73) on a probability scale (a) and a linear scale (b)

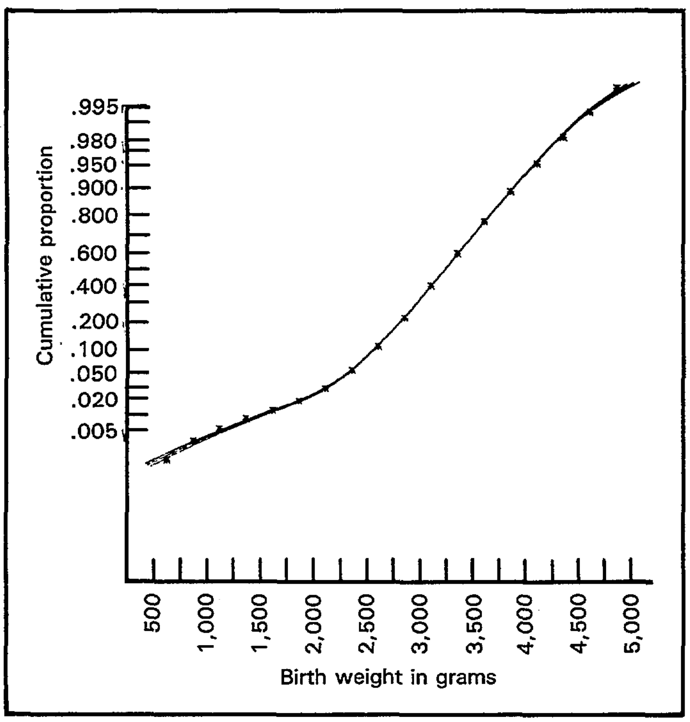

Figure 12. Cumulative distribution of birthweight for Sweden

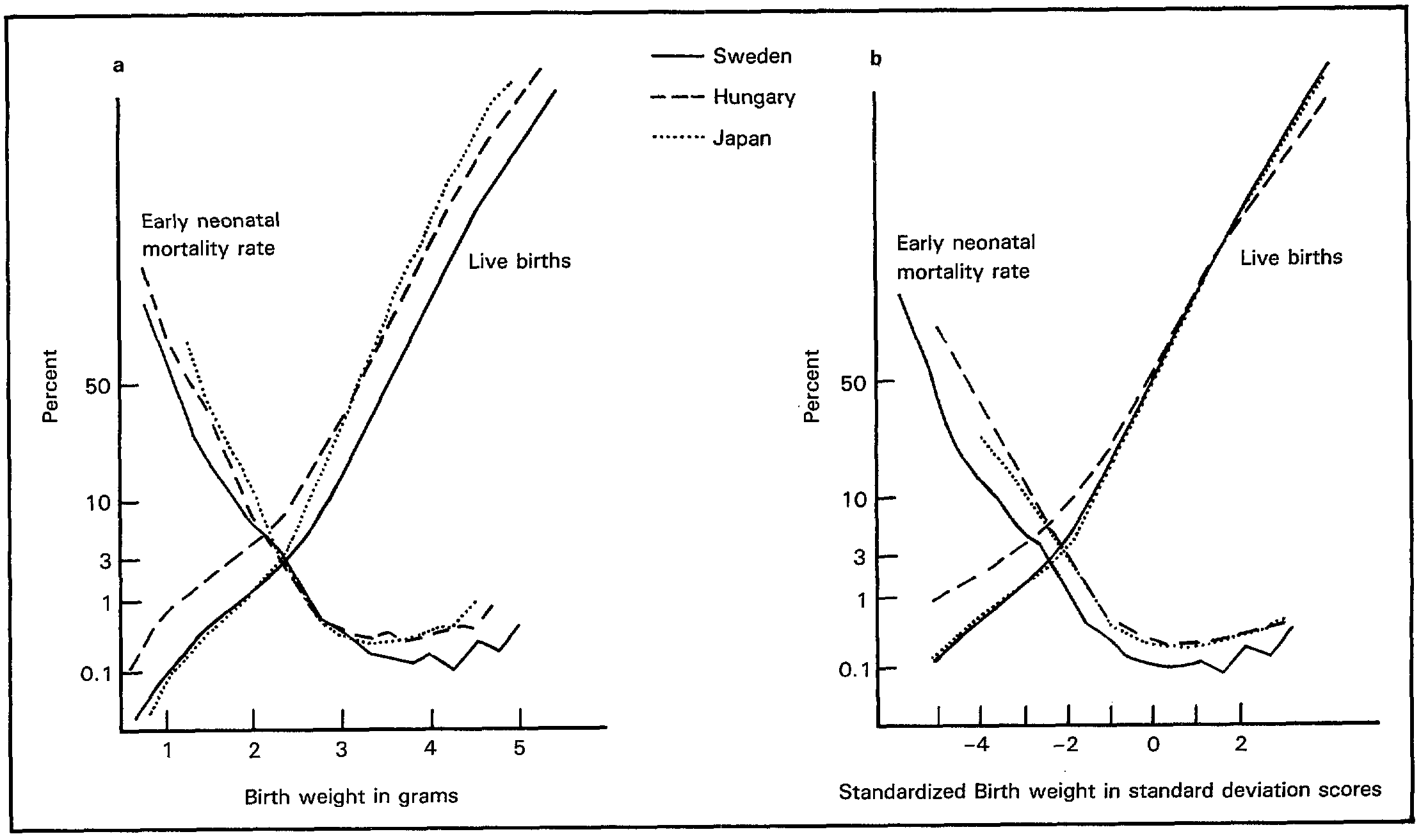

Figure 13. WHO International Comparative Study. Probability plots showing cumulative distribution of birth weight for live born infants and birthweight-specific early neonatal mortality

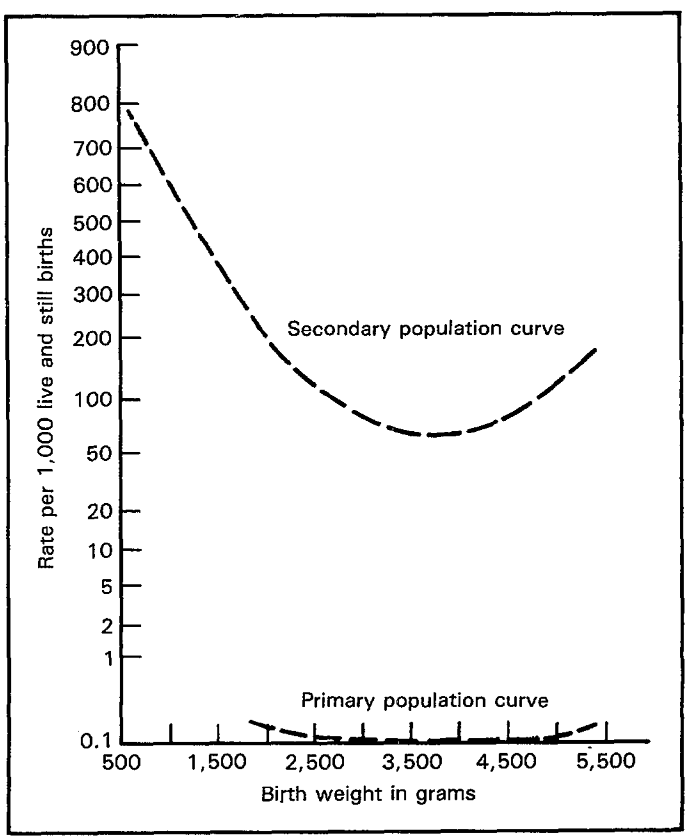

Figure 14. Perinatal mortality curves by birth weight for decomposed primary and secondary populations separately

Discussion

MR. ROTHWELL: Are there questions on this presentation? I had trouble with the three-dimensional graphs. What were the others showing?

DR. KARLBERG: The three-dimensional graphs showed X-axis gestational age, Y-axis birth weight, perpendicular axis percentage in each cell of the total number of live births, and color was used to present the early neonatal death rates. The two graphs were seen from different angles.

MR. EVANS: That, also, is contours of mortality, but it is only drawn approximately. Is that right?

DR. KARLBERG: Yes.

MR. EVANS: You have not drawn those to scale, because they are not showing the asymmetry as clearly as I would have expected.

DR. KARLBERG: That was just a sketch. The iso-morts come a little further down.

MR. EVANS: But it will, also, be asymmetric about the horizontal axis because of your colored pictures. As you say, when you turn around the corner, it is white on one side and green on the other.

DR. KARLBERG: Yes. Thank you. (After adjustment.) I am glad that you picked up the message from my sketch.

MR. EVANS: Could I make another comment? There is a new paper on applied statistics in the latest issue of the Journal of the Royal Statistical Society by Martin Bland, who has been doing centile curves right down to very, very low gestations. He has got quite an elegant method, a very simple method for dealing with means and standard deviations because they tend to be proportional to one another, if you look at it on a log scale. You end up with something that is really a reduction in the number of parameters you have.

DR. KARLBERG: Earlier I worked along the same lines, but when we analyzed our cohort of 500,000 births using the Box-Cox transformation, we found that the distributions are relatively wider at low gestational ages than at term. Furthermore, normal distribution is reached at a power of about 0.5.

MR. HOFFMAN: Could I just ask you to elaborate a little more, as you promised in your talk, on those babies who are born preterm but relatively heavy and especially from a clinical standpoint, since you have data within your own city. Have you looked at those records carefully, and have you analyzed and thought about the clinical implications?

DR. KARLBERG: Not yet, as we would like to get the reference standards ready first. The findings in the birth weight-gestational age relationship are in accordance with the ones in the birth weight-birth length relationship. Miscalculated gestational age cannot be the cause.

MR. HOFFMAN: So, there is an increased risk with heavy birth weight?

DR. KARLBERG: Yes, there seems to be.

MR. HOFFMAN: Relative to birth length?

DR. KARLBERG: Yes, down to 32 or 33 weeks of gestational age.

MR. HOFFMAN: So, it is somehow disproportionate growth?

DR. KARLBERG: Yes. Our speculations are that fetuses with accelerated growth go into labor somewhat earlier and the "light for dates" stay a little longer than the "appropriate for dates."

DR. ALBERMAN: There is a little bit of evidence that the ones that go post term are perhaps the slow growers, and this is one of the things we might be looking at in the future.

DR. KARLBERG: Yes, I agree. It is a very interesting and clinically important subject. Here also, possible differences between determination of gestational age from last menstrual period and from ultrasound measurements have to be considered.

Life Table Analysis of Feto-Infant Mortality

by Finn Børlum Kristensen, M.D., Ph.D., and Flemming Mac, M.Sc.

Ratios like the stillbirth rate, perinatal mortality rate, infant mortality rate, etc., are well established within vital statistics and epidemiology. These well defined measures of mortality serve as a means of comparison between populations and over time. However, the information that is available in several national or regional medical birth registers is not fully utilized when mortality is only expressed by, for example, the infant mortality rate.

With information in a birth register on gestational age and duration of life in fatal cases and with all stillbirths and deaths within the first year of life recorded, you have the data that is needed to use straightforward life table methodologies to express the survival of the population that is covered by the register.

The following presents the results of life table analyses of data in the Danish Medical Birth Register (MBR), which covers all births to residents in Denmark (1).

Materials and methods

The material was comprised of the 1983-87 singleton birth cohorts, which counted 263,322 births (263,041 single births with gestational age recorded). Through record linkage between the national birth registration and the registration of causes of deaths, stillbirths and deaths in the first year of life are routinely recorded in the MBR. The product limit (Kaplan-Meier) method was used to estimate the survival of the 5-year cohort (2). The 95 percent two-sided confidence limits of the estimates were calculated as described by Peto et al. (3).

In the MBR the survival of the fetus was recorded in completed weeks of gestation at time of birth, and the survival of live born babies was recorded in completed hours during the first 3 days of life, in completed days during the rest of the first week, and in completed weeks during the next 3 weeks. Date of birth and date of death were recorded as well.

The feto-infant survival analysis was based on information on gestational age at birth and duration of life after birth. Time of death in live born babies was calculated as the combination of gestational age at birth and duration of life in completed weeks. As a result, survival was expressed in completed weeks after last menstrual period (LMP) irrespective of time of birth and irrespective of method of establishing gestational age.

Problems of classification of fatal cases into early neonatal deaths, stillbirths, and late abortions can be anticipated in the vicinity of 28 weeks gestation. Because only late fetal deaths after 28 completed weeks gestation (stillbirths) are recorded in the MBR, problems of classification of deaths in babies with very low gestational ages were reduced by restricting the feto-infant survival analysis to a followup of unborn fetuses and live babies from 31 completed weeks, the first events occurring during the subsequent week up to the completion of the 32nd week. Live born babies who were born with a gestational age that was less than 31 completed weeks and who survived into the followup period were included in the analysis.

In the survival analysis of live born babies, Kaplan-Meier estimates were computed at completion of each hour during the first day, at completion of each day during the first week, and at completion of each subsequent week of followup. Babies who died within the first hour of life had survived zero completed hours.

Censoring of cases that were no longer in the risk population due to other causes than the event of interest was only done in the analysis of competing causes of death. The relatively small group of babies who emigrated during the followup period was not censored.

In the analysis of causes of death we applied a feto-infant classification of stillbirths and infant deaths we made following previously published principles (4). The clinico-pathological classification was based on information on underlying causes of death (fetal and neonatal factors) (ICD, Eighth revision), time of death, and in some cases gestational age and fetal death in relation to onset of labor (5). Table 1 depicts the groups.

Infant deaths were divided into seven cause of death groups, which were proposed by the ICE group on the basis of the underlying cause of death (6). The groups are shown in table 2.

Results

Figure 1 shows the survival function of the 1983-87 singleton birth cohorts. Zero on the horizontal scale indicates 31 completed weeks after LMP. The vertical scale shows the fraction of survivors. At no time during the followup period did the fraction include less than 99 percent of the initial population at risk. Nearly all of the babies were unborn at the beginning of the followup, but after 10 or 11 completed weeks of followup, which is 42 to 43 weeks after LMP, practically all babies had been born. During the period in which the babies were born the survival curve was relatively steep, indicating that the stillbirths and many of the neonatal deaths occurred during this period.

From 11 weeks to about 25 weeks, that is 43 to 57 weeks after LMP, the curve was less steep and after that it had an even flatter appearance. Live born babies were only followed up for 1 year in the MBR. As a consequence, complete followup was only possible for about 45 weeks after LMP, because some very preterm babies born live at about 24 to 25 weeks of gestation had in fact survived for 52 weeks at that time. This means that there was a selective loss to followup of infants who had been very immature at birth from about 45 weeks. This may have caused biased estimates after 45 weeks.

Analysis of causes of death may be of some help in the interpretation of the shape of the curve in figure 1. Figure 2 shows mortality divided into 6 groups. The largest part of the mortality, due to congenital malformations or inborn errors of metabolism (group DK 1), occurred within the first 10 weeks of followup from week 32. After that the curve, which is the border between area DK 1 and area DK 2, flattened, which means that few additional deaths occurred due to congenital malformations after that time.

The large group, DK 2, includes unexplained deaths prior to the onset of labor, and its borderlines were parallel from about 11 weeks of followup, at which time nearly all babies were born. Few deaths due to intrapartum events such as asphyxia and birth trauma (group DK 3) occurred after 10 to 11 weeks of followup. Group DK 4 includes deaths due to consequences of preterm birth, which again took practically all of its share of deaths during the first 10 to 12 weeks of followup. Group DK 5 includes deaths due to other specific conditions such as sudden infant death syndrome (SIDS), infections, isoimmunization and other conditions. The majority of these deaths occurred from week 10 to 25 of followup.

Figure 3 depicts survival functions for four social groups and a residual group, group I being the highest in the hierarchy. The curve of social group IV was steeper at all times during followup, both in the weeks with fetal and neonatal deaths and later on, when the slopes of social group I and II were very small. Figure 4 shows that social group IV differed from social group I very early during followup as indicated by the 95 percent limits.

Figure 5 shows survival curves for babies who did not die from unexplained death before labor. They may however have died from other causes in which case they were censored from the denominator. Prevalence of deaths due to this cause were nearly twice as large in social group IV as compared with group I.

Figure 6 shows survival curves for babies who did not die from SIDS, infections, or other specified conditions. The slope of social group IV was much steeper than that of social groups I and II, even in the latter half of the followup period. Social group I and II crossed each other twice. Whether this observed crossover was statistically significant was not tested.

Figure 7 shows the survival curve of all live born single births in Denmark from 1983 to 1987. Please recognize that the horizontal scale changes twice. The first 25 data points after birth (B) indicate 0-24 completed hours of the first day of life, the next 6 points 2-7 completed days of the first week, and the rest of the points each completed week of the first year of life. During the first four hours about one-half of the first day deaths occurred. First day mortality was a little larger than mortality during the rest of the first week. From three completed weeks of life to about 16 to 20 weeks the curve had more or less the same slope, after which it had a smaller slope.

Figure 8 depicts infant mortality grouped as proposed by ICE (6). Only a few deaths due to asphyxia occurred after 6 weeks of life. ICE group III includes deaths due to immaturity and contributed only a few deaths after 10 to 12 weeks of life. ICE group IV, deaths due to infections, contributed little to overall mortality. ICE group V comprised all SIDS cases, the large majority of which were seen between 1 and 20 completed weeks of life.

Survival analysis and graphic presentation of mortality should be further explored by those registries that have good quality data. The figures in this paper can be seen as steps in that direction.

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Table 1. Clinico-pathological classification of underlying causes of feto-infant deaths based on fetal and neonatal factors

DK 1.	Congenital anomaly: Deaths that had their origin at conception or during embryogenesis.
DK 2.	Unexplained death prior to the onset of labor: Deaths due to asphyxia and other unexplained antepartum deaths (e.g., premature rupture of membranes, placental abruption, placenta previa, placental insufficiency, and cause unknown).
DK 3.	Intrapartum events: Deaths before or after birth due to events occurring during labor.
DK 4.	Conditions consequent upon preterm birth: Deaths due to pulmonary immaturity, hyaline membrane disease, cerebral hemorrhage, or infarction in preterm babies.
DK 5.	Other specific conditions: All other deaths due to intracranial hemorrhage. Deaths due to isoimmunization or infection, and deaths due to other specific miscellaneous conditions including unequivocal cot death.
DK 6.	Unclassified deaths: Inadequately documented deaths.

Table 2. ICE functional classification of infant deaths

ICE 1.	Congenital anomalies
ICE 2.	Asphyxia-related conditions
ICE 3.	Immaturity-related conditions
ICE 4.	Infections
ICE 5.	Sudden infant death
ICE 6.	Deaths due to external causes
ICE 7.	Specific conditions other than above
ICE 8.	Remaining causes

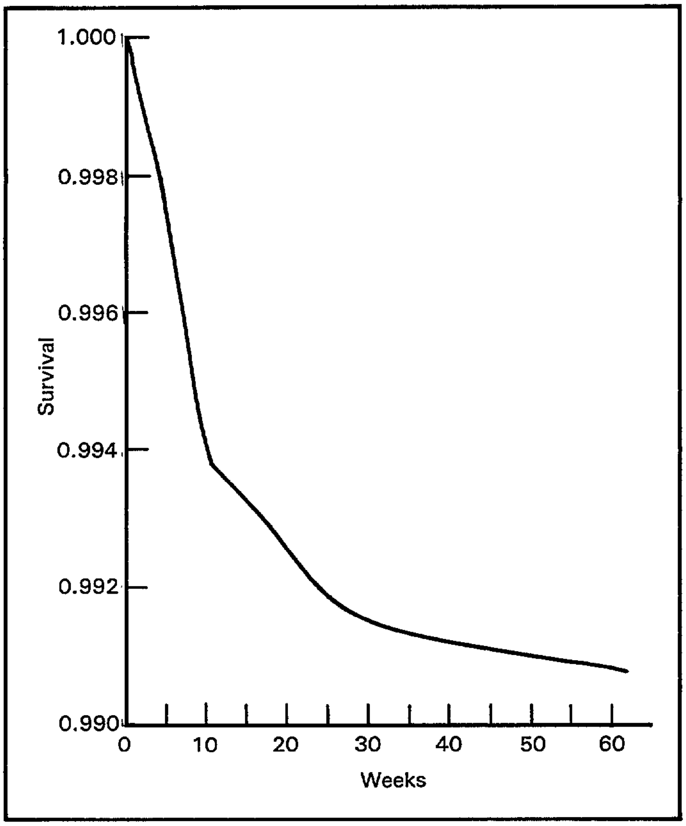

Figure 1. Survival function from 31 weeks of completed gestation for liveborn and stillborn single births: Denmark, 1983–87

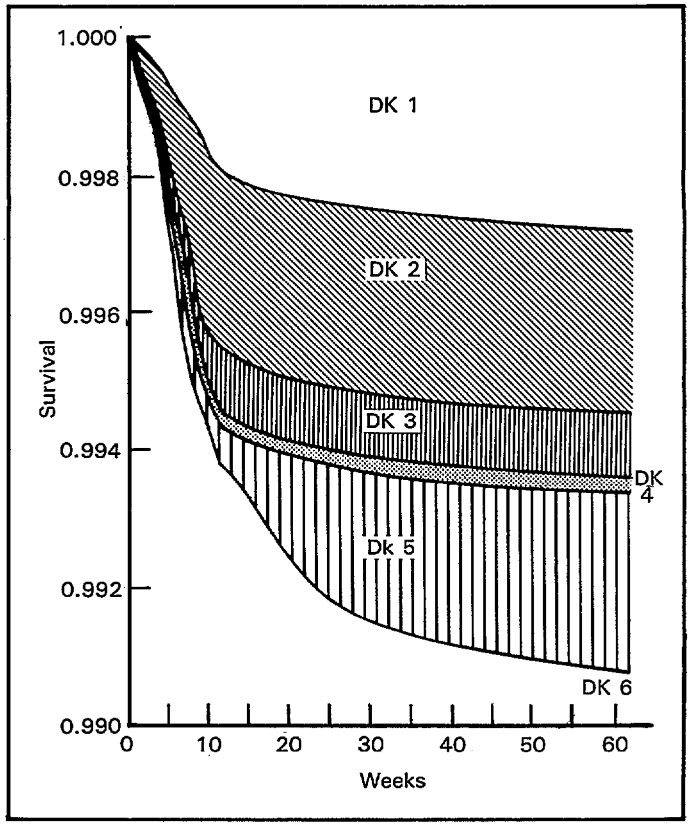

Figure 2. Survival function from 31 weeks of completed gestation by Danish cause of death groups for liveborn and stillborn single births: Denmark, 1983–87

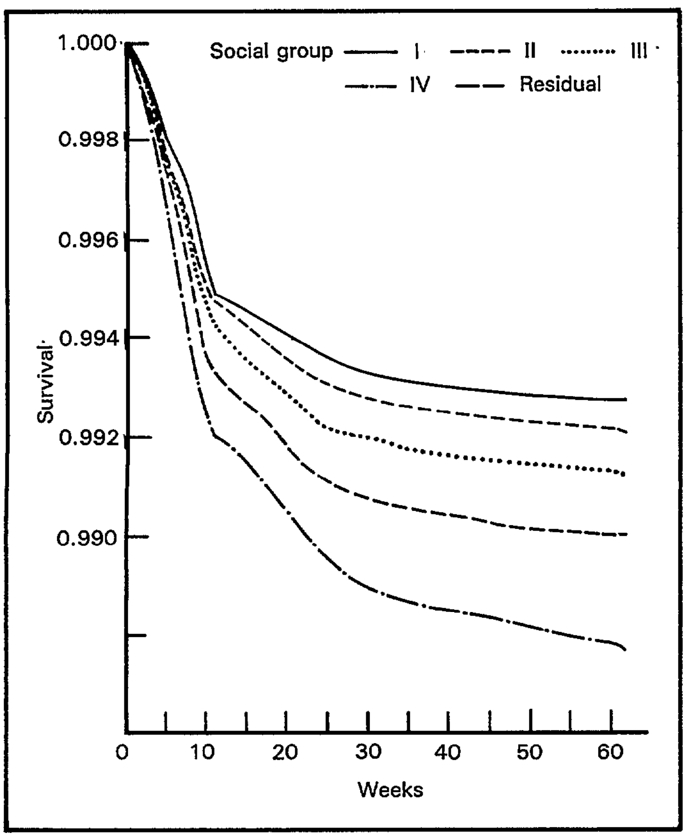

Figure 3. Survival function from 31 weeks of completed gestation by social group for liveborn and stillborn single births: Denmark, 1983–87

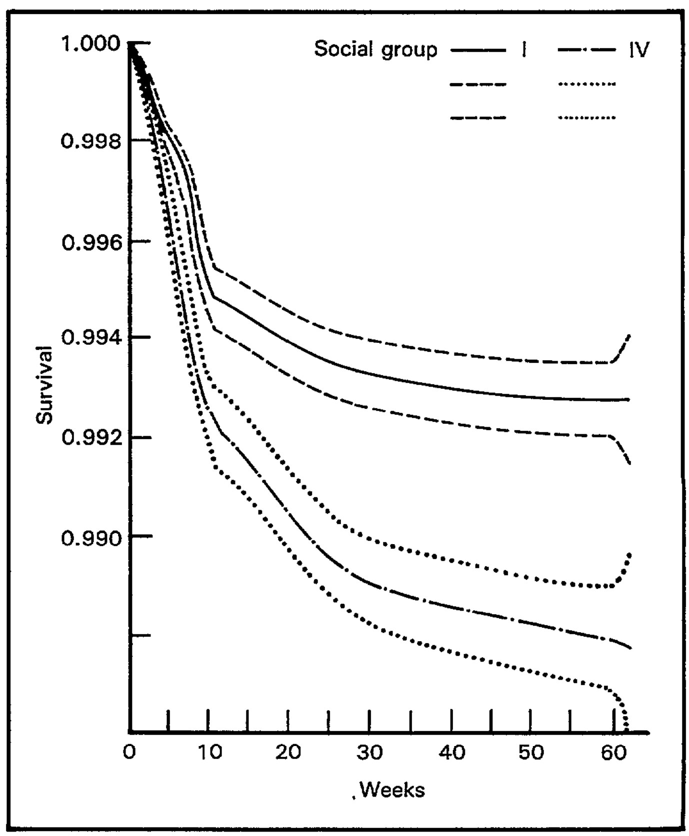

Figure 4. Survival function from 31 completed weeks of gestation by social group with 95 percent confidence limits, for liveborn and stillborn single births: Denmark, 1983–87

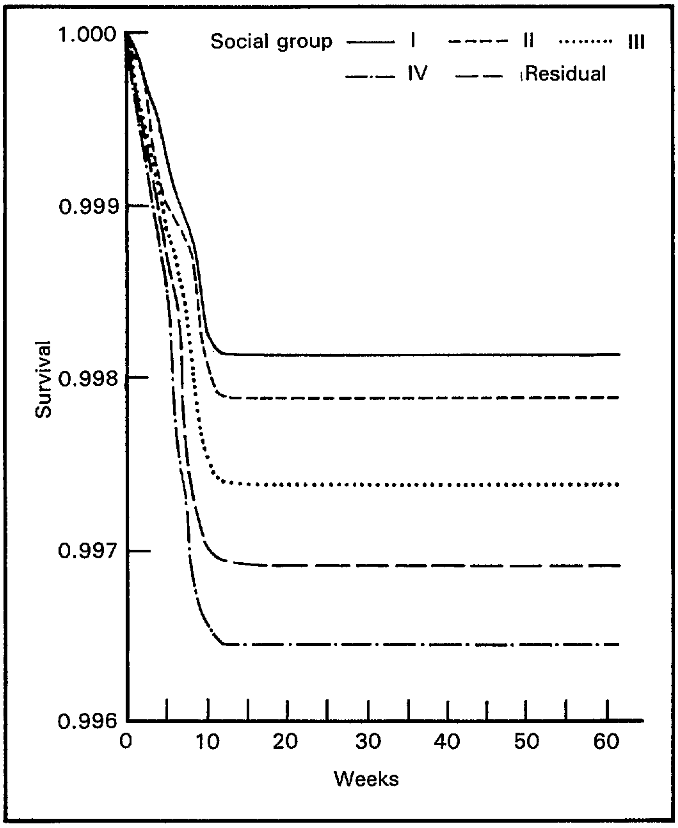

Figure 5. Survival function from 31 completed weeks of gestation by social group for liveborn and stillborn single births not dying from unexplained death before labor: Denmark, 1983–87

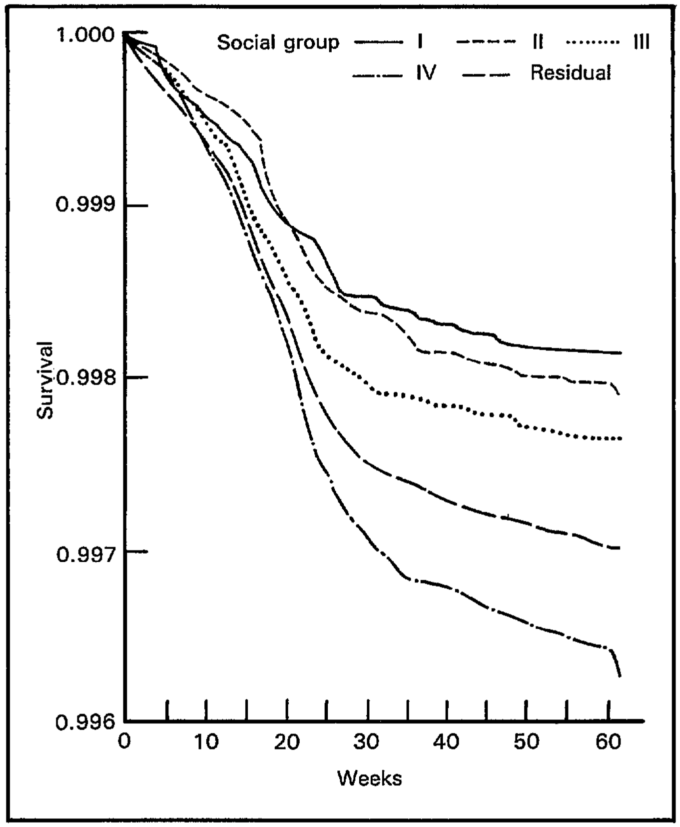

Figure 6. Survival function from 31 completed weeks of gestation by social group for liveborn and stillborn single births not dying from SIDS, infections, or other specified conditions: Denmark, 1983–87

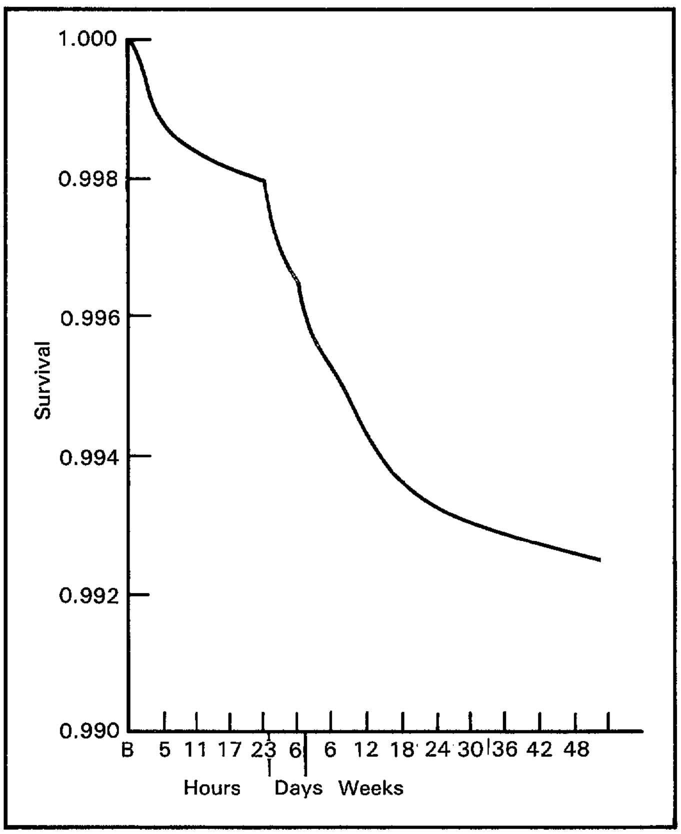

Figure 7. Survival functions from birth for liveborn single births: Denmark, 1983–87

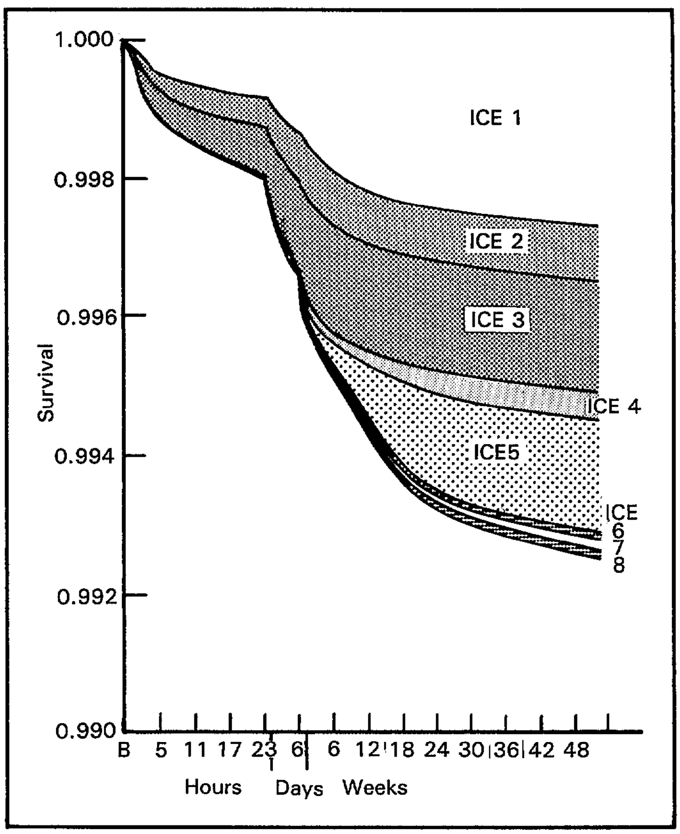

Figure 8. Survival function from birth by ICE cause of death groups for liveborn single births: Denmark, 1983–87

Discussion

MR. HOFFMAN: I am really struck with that slide concerning SIDS (figure 8). It is almost a continuation of what else is going on in the first week of life, you know, just a gestalt. I do not know if anyone else has that comment or if you can say anything further about it. I am really surprised.

DR. KRISTENSEN: Yes, that so much of the mortality is actually due to SIDS, is that what you mean?

MR. HOFFMAN: More that it just continues the same slope that exists since birth in the first week of life.

DR. HARTFORD: There is an artifact in here, too. It is the way Susan Cole and I constructed the cause categories. Congenital conditions, of all the conditions, is the one that is more evenly spread over the entire first year. After that, the cause categories are generally rank-ordered by when they occur. In other words, the mean age at death of asphyxia is very early. Immaturity is a little bit after that, with SIDS and external causes occurring primarily in the postneonatal period, and so that is why you see a continuation. It is when one cause category begins to produce deaths after another ceases. That is, the picture depicts a time ordering of the causes.

DR. KRISTENSEN: I hope this is not just the result of your classification but rather the result of the actual causes of death which, of course, were entered into the birth register together with the time of death. The conclusions that I draw are on the basis of the data and the reclassification into a short list, but it seems very reasonable that the timing of deaths due to different causes should be like that.

MR. HOFFMAN: I guess what I am struck by is that the slope does not change much in the way you have shown your picture. So SIDS maintains a rate of mortality that obviously in the first week of life is probably not SIDS but other causes.

MR. EVANS: It is not SIDS according to my records.

DR. KRISTENSEN: It is SIDS. I have used the numbering of the groups as it appears in the publication of the ICE classification scheme in the *Acta Obstetricia et Gynecologica Scandinavica*. In that article, SIDS was the fifth group, but anyway, it is SIDS.

MR. HOFFMAN: I think it may have changed because other specific conditions is number 5 in the newer update.

DR. ALBERMAN: May I just go back to the earlier slide? I think it is a beautiful presentation, but could you just tell us a bit more precisely about the scale at the bottom, starting at zero? Am I right in saying that zero means all the pregnancies that you know about that have reached 31 weeks?

DR. KRISTENSEN: No, the starting point is 31. So, if you have an infant that is in gestational age 31, and it is live born, you have a followup period of 52 weeks.

This is a new way of addressing it, and I do not know because as you heard from my interpretation, I had all the time to take into account where all the births had happened. But time of birth is not indicated in the feto-infant curves.

DR. ALBERMAN: It is very nice. I just wondered whether there is some way of making the axis a bit more easy to understand.

DR. KRISTENSEN: Maybe I should have gone more into that. Of course, it is on the basis of the gestational age and then the actual duration of life. It may be confusing, but in some ways you can say that if the baby is in week 31, you have an interest in seeing what is actually the risk or the survival possibility of the fetus or the newborn, no matter if it is a fetus or a newborn.

DR. BERGSJØ: It seems to me that for international comparisons this might be one way to overcome the problem of the definition of live birth versus stillbirth. In other words, you start with a cohort of fetuses, mainly fetuses and some live children.

DR. KRISTENSEN: Yes.

MR. EVANS: But you do not include all live births. You do not include live births that occur before 31 weeks and died before 31 weeks.

DR. KRISTENSEN: That is right. That is the reason why the mortality is less than 1 percent--because there is very high mortality in those relatively few babies who are born before 31 weeks and who do not survive into that period. So, that is the tradeoff that you have to take when you restrict the material in order to get rid of the problems around 28 weeks of gestation.

MR. EVANS: May I just ask one other question, and that is why you did not plot the survival on a log scale? In a number of instances, there was a slight implication that the death rate was constant and you would be able to see that a little more easily using a log scale.

DR. KRISTENSEN: The data were read into a spreadsheet, but the graphic presentation part of the spreadsheet did not include a good logarithmic scale. So, that is one of the reasons. So, technology has not yet solved all the problems.

MR. ROTHWELL: Other questions? If not, then I will provide a few comments on the three presentations, and I promise they will be short since the speakers did such a splendid job with their presentations.

With Bob Hartford's paper, I would like to take a different approach to the data he presented. To me, what Bob was presenting were issues relating to ensuring that we are providing comparable estimates from the participating countries. With different regulations, health care structures, and data systems among our countries, this is indeed an important issue.

However, how far can we push these traditional reporting systems? What new quality control procedures will have to be introduced? The very fact that we are having this meeting indicates that the determinants and interventions relating to infant mortality still remain a perplexing national issue for many countries, and this is especially so for the United States. The infant mortality question causes us to "tease-out" finer and finer distinctions in our data, while using the same old data collection methods. For example, we are constantly examining smaller and smaller weight groupings, comparing finer pairings of gestational age and birth weight, developing surrogate measures for social groupings, and analyzing differential outcomes of these groupings by cause of death, gestational age, and birth weight. How far can we push these systems without re-examining how we collect these data? There should be a direct relationship between our ever increasing utilization of these data and quality control measures instituted at the source. We also need to understand the existing quality control systems that are now instituted at the source in all the participating countries. Common definitions and common algorithms do not assure comparability.

For example looking at Bob's data, we see that the United States seems to be an outlier for many of the measures and as Bob has indicated, we are outliers among ourselves when one examines our individual State data. What could be causing this? Are the differences real or artificial? To partially address these questions, we need to keep two things in mind. Who is completing the record and what are they dealing with? Does the person providing the information understand the difference in reporting a death for less than a day by a 24-hour clock set at the time of birth versus reporting by calendar day? Is there a reporting or administrative ease in reporting a fetal death versus a birth and an ensuing early infant death? Is there a difference in the concept of viability, both clinically and socially, on the part of the attendant, among our countries, States, and hospitals? What is the potential magnitude of misclassification if these differences exist? Are there differences in how our various systems react to the social stress on the family affected by these events? As most of you know, the vital statistics system in the United States is not just for the statistical sciences or for measuring health outcomes. The system has very distinct legal purposes. Those legal purposes were created by various social requirements that affect both the system and what is reported by it. In summary, we have to ensure our quality control at the source matches the specificity of our analysis and understand the social and administrative factors that may cause reporting differences.

The last two presentations were extremely thought provoking, especially from a graphical perspective. So often we get lost in tables, and it is hard to focus on relationships between the variables being examined. This is especially so when more than two variables are being considered. Three-dimensional graphics is an excellent tool for both exploratory analysis and presentation of involved relationships to an audience.

As we examine birthweight distributions, as was done so well by Petter Karlberg, it is very important for us to examine that part of the distribution relating to normal weight births dying prematurely. I think back to when I was director of a State health statistics agency in a State with exceedingly high infant mortality. When examining issues relating to low birth weight and causes of death associated with low birth weight, it was easy to forget about this part of the distribution. Yet in my former State, approximately 20 percent of the neonatal deaths and 53 percent of the postneonatal deaths were to infants with a birth weight exceeding 2500 grams. In fact, over 60 percent of the black postneonatal deaths were to infants with a birth weight greater than 2500 grams. Also the distribution of causes of death for those normal weight births changed considerably by age of the infant. We here, especially those from the United States, must remember to consider these deaths to normal weight infants.

These are exhilarating times. First, it is spring with all the flowers and green leaves signaling new life and renewed hope. My thoughts go back to younger days. Second, it is a time in Eastern Europe when there seems to be more freedom of expression, more freedom to practice one's religion, and more freedom from repression. Yet right here, here in the United States, many will never know these freedoms, will never say "Mother," will never leave the hospital.

We must keep in mind the underlying reason for why we have come from so far to meet together this week. Yesterday for those of you who were in downtown Washington, D.C., you may have seen or heard the abortion demonstration. That demonstration was held by people who wish to make the provision of abortion services in the United States illegal. In the United States we call people with this position "Pro-Lifers." However, we do not need to know our respective positions on abortion to state that we here are pro-life in the broadest meaning of the term. We are the true pro-lifers for we are trying to find the "key" that will improve the life expectancy for those infants who have opened their eyes, who have taken their first breath, and who have seen the light of day.

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