Feeding practices and growth of children under 20 months of age in Madrid

by

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Summary (in English)

The feeding habits of 344 children under 20 months of age were obtained from mothers using the dietary history method supplemented with questions on milk feeding and weaning.

Infants were remarkably similarly fed. No relations were found between breast-feeding and socioeconomic group, age of the mother or sex of the baby. Neither did socioeconomic group, sex or birth weight of the baby influence the timing of complementary feeding; however, the latter was significantly correlated to both mother's age and feeding method at the age of three months.

In addition, six anthropometric measurements of the children were taken. These anthropometric results showed that the children were, on average, taller and heavier, but leaner than those of relevant national and international growth references.

Fifty one samples of home-prepared baby meals together with 46 food diaries of infants of seven and eight months were collected. The meals were analysed chemically and the diaries were calculated for daily intake of energy, macronutrients and six minerals. The meals had high protein but low fat content, with accordingly a low energy density. The children's mean daily nutrient intake showed also high protein and low fat levels due to the meals; nevertheless, intakes of energy and minerals were adequate. About 20% of the baby meals had a high sodium level.

Children in this study were apparently well-fed and thriving. Compliance with present guidelines on infant nutrition is high, just minor changes are needed to improve actual practices: breast-feeding should last longer, complementary foods should be introduced later and salt and sugar should be avoided in baby meals. Mothers, particularly those in the low socioeconomic group, need better understanding of gluten and its introduction into the infant's diet.

Summary (in Spanish)

Esta tesis trata de la alimentación y el crecimiento de niños pequeños, basándose en datos obtenidos en Madrid.

Los hábitos alimentarios de 344 niños menores de 20 meses de edad fueron obtenidos interrogando detalladamente a las madres sobre la alimentación actual y habitual del niño, más ciertas preguntas sobre la alimentación con leche y el destete.

Los niños reciben una alimentación muy parecida. Parece que ni el nivel socioeconómico de los padres, ni la edad de la madre, ni el sexo del niño influyen sobre la lactancia ni sobre la alimentación del bebé en general; sólo se encontró correlación estadística entre el inicio de la alimentación complementaria por un lado y la edad de la madre y el tipo de lactancia (materna o artificial) a los tres meses por otro.

Además se midieron seis valores antropométricos de cada niño. Los resultados indican que los niños son ahora, en general, más altos y más pesados, aunque más delgados que los de otros estudios nacionales e internacionales que se usan como referencias.

Se recogieron 51 muestras de comidas preparadas por las madres en sus casas para sus hijos de entre 7 y 8 meses de edad, así como 46 diarios exhaustivos de sus dietas. El análisis químico de las comidas mostró que contenían mucha proteína pero poca grasa, siendo concomitantemente escasa su densidad energética. El análisis dietético de los diarios muestra asimismo alta ingesta de proteínas y baja de grasas, aunque la cantidad de energía y minerales ingerida diariamente es adecuada. El 20% de las comidas contenía sodio en exceso.

Los niños estudiados tenían aspecto sano y bien nutrido. Las madres siguen bastante bien las indicaciones médico-dietarias actuales, sólo se desvían de ellas en algunos detalles: el amamantamiento debería durar más, el momento de introducir alimentos complementarios debería retrasarse y convendría abstenerse de echar sal y azúcar a las comidas. Las madres deberían saber mejor qué es el gluten y cuando puede aceptarse en la dieta infantil.

Summary (in Dutch)

Dit proefschrift bespreekt de voeding en groei van jonge kinderen in Madrid. De voedingsgewoonten van 344 kinderen die jonger waren dan 20 maanden, werden verkregen van de moeder met behulp van de *dietary history* methode, aangevuld met vragen over het gebruik van melk- en bijvoeding.

De kinderen hadden een opmerkelijk gelijk voedingspatroon. Er werden geen relaties gevonden tussen borstvoeding en het sociaaleconomische niveau van de ouders, de leeftijd van de moeder of het geslacht van de baby. Noch beïnvloedden het sociaaleconomische niveau en het geslacht of geboortegewicht van de baby het moment van de eerste bijvoeding. De leeftijd van de moeder en het type melkvoeding op de leeftijd van drie maanden, borst- of zuigelingenvoeding, waren significant gecorreleerd aan het tijdstip waarop met bijvoeding werd begonnen.

Uit de resultaten van zes soorten anthropometrische metingen bleek dat de kinderen gemiddeld langer en zwaarder waren, maar tevens slanker dan die van relevante nationale en international groeicurves.

Eénenvijftig thuis bereide babymaaltijden en 46 voedingsdagboekjes werden verzameld. Het gehalte aan eiwitten, vetten, koolhydraten en zes minerales in de maaltijden werd chemisch bepaald. De dagelijkse opname van dezelfde voedingsstoffen werd berekend met behulp van de dagboekjes. De maaltijden hadden een hoog eiwit en laag vetgehalte, wat resulteerde in een lage energetische waarde. Als gevolg van de samenstelling van de maaltijden was ook de dagelijkse eiwitopname hoog en die van vet erg laag. De opname van energie en mineralen was echter voldoende. Ongeveer 20% van de maaltijden had een hoog natriumgehalte.

De kinderen in dit onderzoek zagen er goed uit en waren over het algemeen goed gevoed. Met het langer geven van borstvoeding, het later introduceren van bijvoeding, en het vermijden van zout en suiker in babymaaltijden zouden de voedingsgewoonten nog beter overeenkomen met de huidige richtlijnen voor kindervoeding. Tevens moeten moeders beter geïnformeerd worden over gluten en gluten-bevattende produkten en wanneer deze aan een baby kunnen worden gegeven.

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LIST OF ABBREVIATIONS AND SYMBOLS

&	and
°C	degrees centigrade
a.m.	*ante meridiem*, before noon
AAP	American Academy of Pediatrics
Ca	calcium
CHO	in tables: carbohydrates
cm	centimetre
DHSS	Department of Health and Social Security
EC	European Community
En%	energy percent
ESPGAN	European Society of Paediatric Gastroenterology and Nutrition
et al.	*et alii*, in references to literature: and other authors
FAO	Food and Agriculture Organization
Fe	iron
g	gram
i.e.	*id est*, that is to say
K	potassium
kcal	kilocalories
kg	kilogram
kJ	kilojoules
max.	in tables: maximum value
mEq	milliequivalent
Mg	magnesium
mg	milligram
min.	in tables: minimum value
MJ	megajoules
ml	millilitre
mm	millimetre
N	number of elements in a sample
Na	sodium
NCHS	National Child Health Examination Survey
NL	the Netherlands
p.	page in referred publication
p.m.	*post meridiem*, after noon
prot.	in tables: proteins
SD	standard deviation
U.K.	United Kingdom
U.S.	United States of America
v/w	volume per weight
WHO	the World Health Organization
Zn	zinc

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PROLOGUE

From the book by Jaime Bonell (1786), 'Perjuicios que acarrean al género humano y al Estado las madres que rehusan criar a sus hijos y medios para contener el abuso de ponerlos en Ama.':

> *"Aunque las pasiones nacieron con el hombre, y los vicios tardaron poco en corromper su corazón, no podemos no obstante negarles a los primeros siglos aquella sencillez de costumbres, que la vanidad, el luxo, y los deleites han desterrado de nuestros tiempos. A pesar de la distinción de clases, que la autoridad, la fuerza y las riquezas introduxeron desde luego en la sociedad, no se desentendieron los nobles de las obligaciones naturales, ni pretendieron los ricos eximirse por dinero de su cumplimiento. El gobierno de la familia, y la educación de los hijos eran cargos indispensables de toda clase de padres, y aun de los mismos Soberanos: la economía doméstica, y la crianza de los hijos eran la primera ocupación de las madres: ninguna se corría de ser nutriz de sus hijos; antes las mismas Reinas tenían a mucha honra criarlos a sus pechos."*

pp. 11-12

> *"El mal exemplo de las mugeres nobles arrastra las del estado medio, que ambiciosas de parecérseles buscan mil pretextos para no criar, y fingen mil males en caso de hallar resistencia de parte de los maridos. Con este el abuso se ha calificado de prerogativa de gente de forma, ¿y quál es la muger, que no aspire a parecerlo? Asi vemos, que en las ciudades principales, aun entre la plebe, las madres mas acomodadas hacen gala de poner sus hijos en Ama, y si las demás no siguen la moda es porque no se lo permiten sus cortos medios. El influxo pues, que tienen en toda la sociedad las acciones de los individuos del primer estado en las costumbres de los demás, es otra razón moral por la que están las madres tanto mas obligadas a criar sus hijos, quanto mas distinguida es su clase en la república."*

pp. 31-32

> *"El delicado estómago de un niño tierno apenas se halla en estado de digerir otro alimento, sino el que en la leche le preparó quasi digerido la naturaleza: quando sus órganos tienen fuerzas para llevar alimentos de mayor consistencia, la misma naturaleza suele darlo a conocer con la salida de los dientes, que son los primeros instrumentos de la digestión. Toda papilla añadida a la leche antes de esta edad es un manantial de indigestiones y crudezas,...."*

p. 150

From the book by Jaime Bonell (1786), 'Damages that bring man and the State the mothers who refuse to breast-feed their children and means to detain the mis-use of wet-nurses':

"Although passions were born with man, and vices did not take long to currupt his heart, we cannot however deny the sincerity of customs that existed in the first centuries and which vanity, lust and excess have banished from our times. In spite of the differences in classes that authority, force and wealth centainly introduced into society, the nobility did not neglect their natural obligations, nor evade their duties, through money. Governing the family and educating the children were eludible responsabilities of every class of parents, including even the Royal Family: domestic economy and the children's upbringing were the principal occupation of the mothers: none shirked from nursing their children; even the Queens themselves were proud to suckle their own offspring."

"The poor example set by the noblewomen drags along those of the middle class, who being anxious to imitate, seek countless pretexts for not breast-feeding and feign endless illnesses on encountering resistance from their husbands. As such, this abuse has been called a privilege of the well-to-do and which woman does not aspire to appear so? Thus we see that in the main cities, even among the common people, mothers that can afford it take pride in wet-nursing their children and if the rest do not follow the fashion, it is only because of their meagre resources. The influence, therefore that throughout society the actions of individuals in the upper class have on the habits of others, is another moral reason for mothers to be more obliged to nurse their children, the more distinguished their class in the republic."

"The delicate stomach of a tender baby is hardly able to digest any food other than the readily digested milk provided by nature; when his organs are strong enough to tolerate foods of greater consistency, nature itself will make this known with the appearance of the first teeth, which are the first instruments of digestion. Whatever pap is added to milk before that time is a source of indigestion and disorders...."

CHAPTER 1

INTRODUCTION TO THE THESIS

An introduction to actual trends in infant feeding
and to the assessment of growth in children
in relation to the aims of this study

1.1 Infant feeding in perspective

Infant feeding is a subject of much interest as it is the main determinant for adequate growth and development in the first year of life. A baby who is not fed, will die in a matter of days, whereas adults have reserves and may sustain life without the intake of any food for several weeks. Also, inadequate feeding in the first year of life has far-reaching consequences, as the child is still very vulnerable.

To cope with the young infant's dietary needs, one kind of food suffices: human milk. In earlier centuries, newborns who could not be breast-fed by either their own mother or a wet-nurse, faced an almost certain death. At the end of the 19th century, the first special infant milks were developed and these milks lowered enormously mortality among those infants who could not be breast-fed. The quality of these special milks has improved over the years by approximating each time more the composition of human milk. Actually formula-feeding is no longer considered a factor to impair an infant's growth and development in affluent societies. But as nature is difficult to imitate, breast-feeding is still considered to be the best way to feed a baby. This persuasion is difficult to prove scientifically, but the nutritional composition of human milk that adapts itself continuously to the infant's needs, its immunological factors, its protection against allergies, and factors such as hygiene, adequate temperature, the favourable influence on the development of the lips and oral cavity, and the emotional aspects of the interaction between mother and child, are all characteristics that confirm the superiority of breast-feeding compared to any other feeding method at this moment.

Infant feeding is however, more than breast or infant milk alone. In the transition period from an exclusively milk diet to a diet based on family foods, special foods may be used that are adapted to the physical limitations of the baby. These foods may be home-made or industrially manufactured.

So, in addition to the life-sustaining role of infant feeding and its direct influence upon growth and development of the baby, infant feeding has also important economical and social aspects. To mention a few, the baby foods market in seven Western European countries (Belgium, France, Germany, Italy, the Netherlands, Spain and the U.K.) had jointly in 1992 an estimated value of 2593 million ECU, aprox. 2010,- million pound sterling (ERC Statistics International PLC, 1993). As most parents want the best for their child, they are willing to spend money and time on products that are destined to their child. Another example is the present legislation in Western European countries that allows the mother (or father) to take paid-leave from work which varies from several weeks to months, depending on the country, once a baby is born. The incidence of breast-feeding often shows a drop at the moment the mother has to return to work. Maternity leave also has its social impact. For instance, some companies prefer male employees so as to avoid the "complications" of the working female. A last example of the socioeconomic aspects is the fact that infant feeding is surrounded by lots of myths and prejudices. Any mother will confirm, that, whether she wants it or not, advice is given to her by family, neighbours and other persons in her environment on how she ought to feed her baby.

So, it may be clear, that the feeding of infants and young children continues to be a subject of interest that is worth further investigation.

1.2 Actual trends in infant feeding

1.2.1 Breast-feeding

Several important changes have taken place in infant feeding in the last decades. In this century a gradual decrease has been observed in Western Society in the number of mothers breast-feeding their babies and the period an infant is breast-fed. In the seventies, the minimum was reached in infants being breast-fed by their mothers. Since then an upsurge in breast-feeding has been observed (Martínez et al., 1981; Hitchcock et al., 1981; Underwood and Hofvander, 1982; Florack et al. et al., 1984; Persson and Samuelson, 1984c; Whitehead and Paul, 1984; Fomon, 1987; Hitchcock and Coy, 1988; Vestermark et al., 1991).

Several characteristics have been found that are associated with more breast-feeding.

Socioeconomic group. The fact that mothers of high socioeconomic status breast-feed more and for longer periods than mothers of low socioeconomic groups has been documented by several authors in Europe, the U.S. and Australia (Morgan and Mumford, 1977; Marlin et al., 1980; Owles et al., 1982; Persson and Samuelson, 1984c; Whitehead et al., 1986; Jones, 1987; Fomon, 1987; Hitchcock and Coy, 1988 and 1989; Vestermark et al., 1991; White et al., 1992). Paul et al. (1988) even found in Cambridge, that up to the sixth month breast milk intake varied according to the social class of the father. Infants coming from the non-manual classes had a higher breast milk intake than those from the manual grades. The greater intake in the higher social classes was the result of a greater intake in milk per feed and the effect was more pronounced in boys than in girls. A clear explanation for this observation cannot be given.

Mother's education. The higher the level of the mother's education, the greater the probability that she will breast-feed her baby and that she will do so for a longer period (Martínez et al., 1982; Florack et al. et al., 1984; Vestermark et al., 1991; White et al., 1992). Persson (1985b) found that the mother's education was the main predictor of the prevalence of breast-feeding in children of three months, but adds that in his study, the educational level of the mother was considered mainly as a classification of social group and similar results were obtained when a socioeconomic classification was used in the analysis.

Mother's age. The age of the mother appears to be another factor that influences the probability that she will breast-feed. Older mothers breast-feed more than younger mothers (Marlin et al., 1980; Florack et al., 1984; Vestermark et al., 1991; White et al., 1992). Persson (1985b) found in Sweden that younger mothers, under 25 years, and older mothers, over 34 years, generally breast-fed for a shorter period than average. He suggested, though, that the attitude of the older mothers may still reflect the feeding patterns of the seventies, ten years before the study was carried out. This may be true as in a more recent study in Denmark Vestermark et al. (1991) observed a significant correlation between maternal age and duration of breast-feeding, where mothers of 35 years or more breast-fed the longest period.

Sex of the baby. The possible influence of the sex of the baby on incidence and prevalence of breast-feeding has not been extensively studied. Morgan et al. (1976) in the U.K. found a tendency for boys to be breast-fed more often than girls. White et al. (1992), however, did not find any influence of sex of the baby on breast-feeding in a national representative sample in the U.K., although baby girls were breast-fed for a longer period by mothers in Scotland. Vestermark et al. (1991) in Denmark reported that the sex of the child did not influence the duration of breast-feeding.

Other factors that have been related to breast-feeding are regional differences (White et al., 1992), experiences with previous babies (Jones, 1987; Vestermark et al., 1991; White et al., 1992), smoking habits (Florack et al., 1984; Persson, 1985; White et al., 1992), maternal employment status (Martínez et al., 1981; White et al., 1992) and entry of children into day care (Weile et al., 1990).

1.2.2 Infant milk formulations

The European Community (EC) defines infant formulas as "foodstuffs intended for the particular nutritional use by infants during the first four to six months of life and satisfying by themselves the nutritional requirements of this category of persons" (EC, 1991). Follow-on formulas are defined as "foodstuffs intended for the particular nutritional use by infants aged over four months and constituting the principal liquid element in a progressively diversified diet of this category of persons" (EC, 1991). However, the name of products manufactured entirely from cow's milk proteins, shall be infant milk and follow-on milk respectively (EC, 1991). In this thesis the names infant milk and infant formula will be used synonymously, as well as follow-on milk and follow-on formula.

Infant milk formulations have undergone important changes in their composition. Since the fifties, butterfat has been substituted for vegetable fat, protein content has decreased, the casein-whey ratio has been altered to approximate the ratio of human milk, the use of flour and sucrose as ingredients has been abolished, iron and other micronutrients are now being added, and the energy density has decreased slightly (Fomon, 1993a; I. Beck, Nutricia Nederland, personal communication).

1.2.3 Complementary feeding

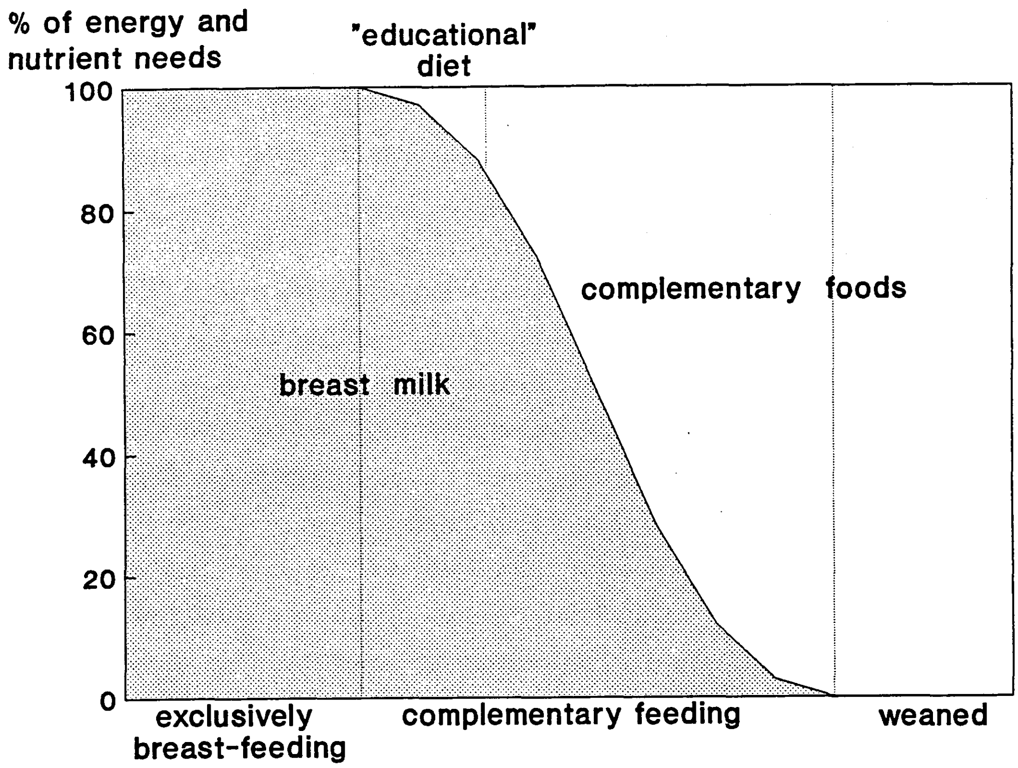
At a certain moment, the volume of human milk theoretically needed to cover the infant's energy and nutritional requirements becomes so large, that it is unusual for a mother to provide, or an infant to take, such quantities. A food supplement should then be introduced. Complementary foods are therefore all foods other than human milk or infant formula to be used in a young child's diet. This definition corresponds with the one given in 1982 by the European Society of Pediatric Gastroenterology and Nutrition (ESPGAN). Complementary food, weaning food and solid food are used synonymously.

Weaning is the process of introducing complementary foods to the breast- or formula-fed child so that in time these new foods contribute a substantial amount of the child's energy and nutrient intake (Wharton, 1989). Weaning represents one of the most crucial dietary events in an infant's life. Both incorrect timing of introduction and use of inadequate foods may impair a child's health and development. In developing countries the introduction of contaminated weaning foods or foods with an inappropriate composition may lead to diarrhoea, disease, growth failure and, ultimately, to death of the infant (Whitehead, 1985; Wharton, 1989; Walker, 1990; Cohen, 1994). Particularly the low fat content of complementary foods, and hence their low energy density, is a main problem (Walker, 1990). In the Western world, more concern is likely to be related to the immunologic response to "foreign" food protein, to obesity and to the risk of cardiovascular diseases (Whitehead, 1985; Walker, 1990). Care should be taken to make sure that the obsession to avoid fat in the diet is not extended to the infant's diet. A reduction in fat content to 30 energy percent, as promoted for the adult's diet, is undesirable for an infant (EC, 1989/1990).

The age when additional food is needed depends on many interrelated factors, including the mother's health and nutritional status, the quality and quantity of milk produced, and the infant's birth weight, gestational age and health. Because of the different factors involved, the age when breast milk alone becomes inadequate to allow satisfactory growth varies between populations and between individuals (Underwood and Hofvander, 1982; Seward and Serdula, 1984; Department of Health and Social Security, DHSS, 1988).

Underwood and Hofvander (1982) illustrated this concept as shown in figure 1.1.

Figure 1.1 Pattern of infant feeding as drawn by Underwood and Hofvander (1982)



In the early seventies, when breast-feeding had its lowest incidence, an early start with solid foods was also common (ESPGAN, 1982; Fomon, 1987). This early start with complementary foods may partly have been encouraged by manufacturers of infant foods in the promotion of their products, but it also seemed to have been perceived by mothers as helpful in getting their infants to sleep through the night as well as demonstrating, in a competitive manner, their baby's precocity (Anderson and Ziegler, 1987). Together with the trend back to breast-feeding, there appears to be a delay in the introduction of complementary foods (Persson and Samuelson, 1984c; Whitehead et al., 1986; Horst et al., 1987b; Fomon, 1987).

The data from Horst et al. (1987b) in the Netherlands are an example of changes observed in many industrialized countries and show how quickly weaning habits may change. In the Leiden pre-school study, they found that in 1980, 25% of mothers gave the first weaning food before the age of 6 weeks. At an age of about 3 months, almost all infants received complementary feeding. However, only four years later in 1984, two thirds of mothers introduced the first weaning food at age 3 months or later, see table 1.1.

Table 1.1 Age of introduction of the first complementary food in the infant's diet between 1980 and 1984 (Horst et al., 1987b).

age	1980		1982		1984	
≤6 weeks	n=36	24,2%	n=12	10,8%	n=7	5,2%
±2 months	n=62	41,6%	n=35	31,5%	n=38	28,4%
±3 months	n=45	30,2%	n=51	45,9%	n=54	40,3%
≥4 months	n=6	4,0%	n=13	11,7%	n=35	26,1%

Also with regard to the introduction of complementary foods, correlations have been found with certain factors.

Breast-feeding. Breast-feeding mothers usually start later with weaning foods than mothers who bottle feed their babies. In the U.K., Morgan et al. (1976) saw in the mid seventies that all 3% of the infants that received solids in the first week of life, were bottle-fed. In 1990, although introduction of complementary foods in the U.K. was later than in the seventies, still bottle feeding mothers started earlier than those who breast-fed (White et al., 1992).

In the U.S., Marlin et al. (1980) studied the feeding patterns of 39 infants and found that by the age of eight weeks 83% of the formula-fed infants were receiving solid foods, compared to only 31% of the breast-fed infants. Giblin Wolman (1984) reported that breast-feeding made a significant difference in the timing of the introduction of weaning foods. Brogan and Fox (1984) studied infant feeding practices of low- and middle income families in Nebraska and observed that infants fed only breast milk were introduced to solids later than infants fed only formula or a combination of formula and breast milk. In Australia, Owles et al. (1982) also saw that many more formula-fed than breast-fed infants were consuming solids at 6 weeks and 3 months. Hitchcock and Coy (1988) made similar observations in 1984 and 1985 in Tasmania and Western Australia.

The duration of breast-feeding appears also to influence the timing of the introduction of weaning foods. Both Giblin Wolman in the U.S. (1984) and Persson and Samuelson in Sweden (1984c), found a positive correlation between the age at introduction of solids and breast-feeding duration.

Socioeconomic group. In the U.K. Paul et al. (1988) found in a group of all breast-fed children, that manual social groups started weaning earlier than non-manual. The differences were not, however, statistically significant. White et al. (1992) in a national representative sample of the U.K. found a strong relation between the age of introduction of solid foods and socioeconomic group as defined by the current or most recent occupation of the head of the household. The high socioeconomic groups started later with weaning foods. The results might be explained by the high prevalence of formula-feeding among mothers in the low socioeconomic group, as the type of feeding is also strongly related to timing of weaning. However, White et al. commented, that when the results were examined separately for breast and formula-feeding mothers within each socioeconomic group, the differences between groups were still apparent. Persson and Samuelson (1984c) observed that mothers characterized by higher socioeconomic group were more prone to a not-too-early introduction of solids and semi-solids.

Mother's education. In the U.S., Brogan and Fox (1984) found that age of introduction of complementary foods was positively correlated with annual income and mother's education. Also Quandt (1984) saw in a group of breast-fed children, that mothers with more years of education tended to introduce solids later. Persson and Samuelson (1984c) made the same observation in Sweden. In the Netherlands, Hoffmans et al. (1986) noticed that children of less well-educated mothers appeared to derive significantly more energy from solids than children of educated mothers at the age of four months.

Mother's age. Quandt (1984) observed no relation between the timing of the introduction of complementary foods and the age of the mother.

Birth weight. White et al. (1992) reported that for babies younger than four months, babies with higher birth weight tended to receive solid foods earlier. Birth weight, however, had little effect on the introduction of complementary food beyond the age of four months.

Sex of the baby. Paul et al. (1988) found that in a group of breast-fed infants, solids were introduced to the boys earlier than to the girls.

Other factors studied are geographical differences and smoking habits of the mother (White et al., 1992).

Several studies have been undertaken to examine the influence of complementary foods on breast milk or formula intake.

Quandt (1984) assessed the role of complementary foods in the diet when first introduced, by studying longitudinally 45 infants that were exclusively breast-fed from birth. She found that, in a dietary sense, complementary feeding appeared to be a substitute for breast-feeding in infants younger than four months, but at later ages it supplemented breast-feeding.

Also Marlin et al. (1980) observed that solid foods given to infants under three months replaced breast or formula milk on a caloric basis, rather than supplement, since energy intakes did not increase significantly when supplemental foods were added to the liquid diet.

Cohen et al. (1994) studied the effects of age of introduction of complementary foods on breast milk intake, total energy intake and growth of infants in Honduras. They assigned low-income primiparous mothers who had exclusively breast-fed for four months at random to one of three groups: continued exclusive breast-feeding to six months; introduction of complementary foods at four months with *ad libitum* nursing from four to six months; and introduction of complementary foods at four months and maintenance of baseline nursing frequency from four to six months. Compared to intake at four months, breast milk intake decreased in the two groups that introduced complementary foods, but was unchanged in the exclusively breast-fed group. Total energy intake including solids, and growth did not differ between groups. Results indicated that breast-fed infants self-regulate their total energy intake when other foods are introduced. Cohen et al. concluded that introduction of weaning foods before the age of six months contributed no advantages to these infants. There may be disadvantages if there is increased exposure to contaminated weaning foods, as is the case in Honduras.

These studies support the actual recommendation to delay the introduction of complementary foods until the age of 5 or 6 months.

Hardly any mention is made on complementary feeding in relation to formula-fed infants, but as the nutritional composition of infant milks is supposed to approximate that of human milk, conclusions for breast-feeding are also applicable to infant formulas, i.e. if exclusive breast-feeding can no longer meet the nutritional need of a growing infant, then exclusive infant milk cannot either.

The following international and national paediatric groups have published recommendations for the introduction of weaning foods: ESPGAN (1982, 1990), the American Academy of Pediatrics (AAP, 1992), the DHSS in the U.K. (1988) and the Study Group Infant Nutrition in the Netherlands (1991). Their recommendations can be summarized in ten guidelines:

1. Complementary foods should not be offered to a healthy baby before the age of three or four months nor later than six months. ESPGAN and the DHSS mention three months at the lower limit, whilst the AAP and the Dutch Study-group recommend four months as the minimum age.

2. Foods should be introduced as single ingredient foods. Only the AAP gives this guideline.

3. Foods should be introduced one by one. This recommendation is given by both the AAP and the Dutch Study-group.

4. The sequence of foods is not critical. This advice is given by both the AAP and ESPGAN.

5. Gluten should be avoided until the age of six months. ESPGAN states that gluten should not be introduced before the age of four months and that even postponement until the age of six months may be advisable. The Dutch Study-group mention as the minimum age six months. There are no guidelines at present from the U.K. regarding gluten-containing foods.

6. Nitrate-rich vegetables should be avoided in the first months. The guideline to keep the nitrate content of the diet as low as possible in the first months comes from ESPGAN, the AAP and the Dutch Study-group.

7. No salt should be added. While the DHSS calls for moderation in the use of salt, the AAP and the Dutch Study-group recommend the addition of no salt at all.

8. No sugar should be added. As with salt above.

9. No potentially allergenic foods should be given before the second half year. In infants with a family history of atopy, the introduction of these foods should be postponed till after the age of 1 year. This guideline is given by ESPGAN. The Dutch Study-group is of the opinion that in infants with a family history of atopy, potentially allergenic foods can be given in the second half of the first year.

10. The continued use of breast milk or iron-fortified infant formula is recommended throughout the whole first year. This recommendation comes from all four paediatric groups.

The fact that no official guidelines exist in Spain for infant feeding, does not mean that no attention is given to this subject. Already in 1946 an extensive article by Osuna Jiménez (1946) appeared in the *Revista Española de Pediatría* (Spanish Journal of Paediatrics) with recommendations on the introduction of complementary foods into the infant's diet. According to the author, exclusive breast-feeding could not satisfy the baby's nutritional needs from the age of four months onwards. He advised to initiate complementary feeding at that age, but emphasized that an incorrect weaning process could cause serious problems during infancy and might even have consequences for the rest of the person's life. He gave the following introduction scheme, see table 1.2.

Table 1.2 Introduction scheme for complementary foods by Osuna Jiménez (1946)

Age in months	Food to be introduced
4	fruit juice
5	cereals
6	purée of vegetables
7 to 8	bread
9	first supplements of animal albumins (muscular meat, viscera and offal, egg yolk)
12	whole egg, lean fish, preserved fruit, stewed fruit, etc., and gradually larger quantities of bread, rice and pasta

With respect to the introduction of cereals, Osuna recommended to start with rice or wheat flour. The presence of gluten in wheat flour was not known at the time, as Dicke only wrote in 1950 his famous work on the relation between wheat and coeliac disease (Peña, 1991). Bread could be given from seven or eight months onwards, according to Osuna Jiménez. Sometimes bread might be substituted by biscuits or a piece of cake, but the author warned about the higher fat and sugar content of these products. Salt could be added in small amounts to the purée of vegetables. Osuna Jiménez suggested the introduction of egg yolk before the egg white, as the former is less allergenic. He warned however for traces of the egg white attached to the yolk.

It is striking that most of the recommendations given by this Spanish paediatrician in 1946 still hold true almost fifty years later. His guidelines are similar to those published in several articles in the eighties in Spanish paediatric journals on infant feeding in the first year of life and on weaning foods in particular. The first articles were a direct consequence of the guidelines on complementary feeding published by ESPGAN in 1982. As Spain has no national guidelines on infant feeding, ESPGAN recommendations have been adopted by most Spanish paediatricians as their standard. Recommendations in recent years do not differ significantly from those of ten years ago. Only a tendency can be noticed to further delay the introduction of certain foods. Table 1.3 gives an overview of the recommendations on weaning by several leading Spanish paediatricians.

Table 1.3 Recommendations on weaning given by leading Spanish paediatricians

author	introduction compl. feeding	order of food introduction	introduction of cereals	type of cereals	introduction of gluten
Tormo (1983)	4-6	-	4-6	-	4-6
Herrero (1983)	4-6, preferably 6	variable	4-6	single grain	6
Vitoria (1986)	4-6	variable	4-6	single grain	6
Polanco (1990)	6	-	6	-	7-8
Martínez & Hernández (1993)	5-6	variable	5-6	-	8

author	fruit	vegetable, potatoes	nitrates	pulses	bread
Tormo (1983)	5-6	-	-	-	-
Herrero (1983)	6	6	no nitrate-rich vegetable in infancy	-	-
Vitoria (1986)	5-7	5-7	avoid during first months	-	6-7
Polanco (1990)	8-9, juice 6	8-9	-	18-24	9-12
Martínez & Hernández (1993)	6-8	7-8	avoid till age of 9 months	-	-

author	meat	fish	egg	yoghurt, cream cheese	salt	sugar
Tormo (1983)	6	11-12	11-12	-	-	-
Herrero (1983)	6	9	yolk: 8 white: 9	-	cover basic needs	delay
Vitoria (1986)	-	7-8	yolk: 7-8 white: 8-10	7	avoid	avoid
Polanco (1990)	6	9-12	12	9	no salt-rich foods	no sugar-rich foods
Martínez & Hernández (1993)	6	10	11, first yolk then white	12		

1.2.4 Energy and nutrient intake

Present day infants, both breast-fed and formula-fed, have been found to have lower energy intakes compared to infants a generation ago (Prentice et al., 1988). Already in 1984, Whitehead and Paul (1984) concluded that infants eat less nowadays. They called it one of the major enigmas in the new infant food intake patterns and wondered why children did not eat more once supplementary and complementary feeding had been introduced, thus bringing their energy intakes up to the sort of levels which used to be encountered in the sixties and seventies. They gave two possible reasons. The first one might be that mothers, worried about obesity, no longer provided so much food and did not encourage their children to "eat up" as they used to. Another, more speculative explanation could be that the decidedly lower energy intakes of babies during the period when they were exclusively breast-fed might in some way condition the child to be satisfied with less later on in infancy. More research is needed before anything more definite can be said on this subject.

Several investigators have reported on the lower energy intakes of breast-fed infants. Hoffmans et al. (1986) found in the Leiden pre-school children study in the Netherlands, that formula-fed infants at 4 months of age had significantly higher energy intakes than breast-fed infants. No indication was found that feeding practice during infancy influenced food intake at 16 and 28 months.

In the U.S., Stuff and Nichols (1989) observed that energy intake of human milk-fed infants did not increase after solid foods were added to their diet, but was maintained at approximately 20% below recommended levels. Energy intake appeared to reflect infant demands. Dewey et al. (1992) and Heinig et al. (1993) also confirmed in the DARLING study the lower energy intake of breast-fed infants, even when the breast-fed and formula-fed groups were matched for characteristics such as parental education and the timing of introduction of solid foods. There were no differences between both groups in energy from solid foods at any time.

Lower energy intakes for formula-fed infants compared to the 1973 WHO/FAO recommendations for energy have also been reported (Leung et al., 1988).

1.2.5 Cow's milk

Whole cow's milk is a good source of energy, protein, calcium, thiamine, riboflavin and vitamin A. Lately, however, unmodified whole cow's milk is thought unsuitable for children under one year of age. Basically, two reasons are given for not recommending cow's milk during the first year of life. Firstly, the median protein intake of infants fed cow's milk is 20 to 100% higher than that of infants fed infant- or follow-on milks between six and 12 months and it is two to three times higher than the calculated "safe level of protein intake", thereby also increasing the potential renal solute load. Secondly, infants taking cow's milk are at risk of developing iron deficiency (ESPGAN, 1990; Fomon, 1990 and 1993b; Ziegler, 1990; AAP, 1992).

The incidence of iron deficiency anaemia at 12 months of age is substantially higher in cow's milk fed infants than in infants fed iron-fortified formulas. This aspect has received a lot of attention in literature. Lönnerdal (1990) states that the iron supply from cow's milk or formula needs to be assessed from three different perspectives: the amount of iron provided by each type of milk, the bioavailability of iron in each source and the possible loss of iron caused by cow's milk. Cow's milk is a poor supplier of iron and iron absorption from cow's milk appears to be low. Infant milks contain between ten and hundred times more iron, which is assumed to have at least the same bioavailability as cow's milk's iron or better because of the addition of vitamin C and other organic acids to infant formulas.

Tunnessen and Oski (1987) and Oski (1990) commented that the introduction of whole cow's milk prior to the first birthday was associated with an increased risk of occult gastrointestinal bleeding and an increased incidence of iron deficiency anaemia. Wharton (1990) also referred to these two phenomena. In addition, Lozoff et al. (1991) concluded from a study that they carried out in Costa Rica, that children who had iron-deficiency anaemia were at risk for long-lasting developmental disadvantage as compared to their peers with better iron status. Sheard (1994) concluded in a review on iron deficiency and infant development that iron deficiency anaemia alters mental and motor development in infants. These findings emphasize the necessity of adequate iron supply in young children.

Finally several authors concluded that the use of an iron-fortified formula in the second half of the first year resulted in a more balanced intake of nutrients (Montalto et al., 1985; Horst et al., 1987a). Montalto furthermore found that infants taking cow's milk received more table foods, which accentuated the nutritional imbalance of cow's milk rather than complementing it. The overall diet of infants fed cow's milk was deficient in iron and linoleic acid, and excessive in sodium, potassium and protein.

Authorities in the area of infant nutrition have expressed the recommendation that breast- or iron-fortified formula-feeding be continued until at least the end of the first year, thus delaying the introduction of cow's milk (DHSS, 1988; ESPGAN, 1990; Fomon, 1990; Wharton, 1990; Study Group Infant Nutrition, 1991; AAP, 1992). Wharton (1990) even extends his recommendation on the use of follow-on milks to the age of 2 years while ESPGAN mentions the age of 3 years. Afterwards semi-skimmed or whole cow's milk can satisfactorily substitute these formulas.

1.3 Infant feeding and growth

Many scientists have shown interest in the effect of diet on growth. Particularly the effect of the type of milk feeding in the first months on growth has been studied extensively. A major problem encountered in the interpretation of these studies is the definition of a breast-fed and a formula-fed infant. Should an infant be exclusively breast-fed or not and for what period in order to be defined as breast-fed. Also the introduction of complementary foods should be taken into account.

Differences in growth patterns have been observed, now that infant feeding habits have changed. Breast-fed infants have been found to grow faster than formula-fed infants during the first three months of life, but afterwards growth appears to slow down, both in weight (Hitchcock and Owles, 1981; Whitehead and Paul, 1984; Persson, 1985a; Paul et al., 1988), and in length (Salmenperä et al., 1985; Whitehead and Paul, 1984; Paul et al., 1988). Dewey et al. (1992) noted that the lower energy intakes of breast-fed infants were accompanied by significantly lower weight gain but not length gain than formula-fed infants.

In 1977 Taitz suggested that it is not formula-feeding itself, but its application that might explain the accelerated growth of formula-fed infants. He found the following common habits explaining the overfeeding of these infants: hyperconcentration of the formula, differences in composition and the widespread practice of adding sucrose to the feed in those days. The precise way bottle feeds are made up has altered over the years. Although this was mainly in response to concerns about formula milks being made up in an over-concentrated manner, as mentioned before, the new strategies have inevitably influenced the consumption of others nutrients too. It is therefore possible that growth patterns in formula-fed children also have been influenced (Whitehead et al., 1986).

Ferris et al. (1980) investigated the influence of feeding method in the first two months on weight gain up to six months by studying longitudinally 92 mothers and their daughters. They did not find any differences in weight between the infants fed breast milk or formula alone, but did so between girls fed formula and solids and infants fed breast milk and solids. There was a tendency for higher weight in relation to height in the infants fed formula and solids. Warrington and Storey (1988a) reported that formula-feeding and the early introduction of solid foods did not increase the child's subsequent weight gain. Persson (1985a) commented that there was no difference in attained weight or length from six months onwards, although in the first months velocities in weight and length gain differed between breast- and formula-fed infants.

Birkbeck et al. (1985) looked at the long-term effect of the method of infant feeding on growth. They found that children who were exclusively breast-fed in the first three months of their life were significantly taller and slightly heavier at seven years of age than those exclusively formula-fed. However, most of the differences could be explained by several other familial (congenital and environmental) factors. Birkbeck et al. warned therefore to be careful in interpreting correlations between the method of infant feeding and findings in later childhood, since they might reflect differences between the characteristics of feeding rather than effect of the feeding method itself.

Only Owen et al. (1984) found that both sex and feeding had a significant effect on gain in length and weight during the first 9 months. Formula-fed infants tended to gain weight and length faster than did breast-fed infants, so the former were bigger than the latter at ages three, six and nine months.

The Cambridge Growth Study in the U.K. was designed to measure the growth and energy and nutrient intake longitudinally throughout infancy as well as to investigate the factors influencing breast-milk intake. A high proportion, 90%, of the infants in this study were initially breast-fed, declining to 65% by 12 weeks, 54% by 24 weeks and 18% by one year. Both breast-fed and formula-fed infants showed an increased weight gain compared with standards in the first six months, followed by a more pronounced relative decline, with only the breast-fed boys showing a slightly slower growth after nine months compared with those formula-fed. Mean head circumference during the first year was about one centimeter greater than those presented in standard growth charts, whereas skinfold measurements were smaller. The Cambridge Growth Study also showed that weaning practices were at least as important for weight gain as mode of milk-feeding in the first months of life (Paul et al., 1986, 1988, 1990, 1994).

More recently in the U.S., the DARLING (Davis Area Research on Lactation, Infant Nutrition and Growth) study was designed to longitudinally document nutrient intake, growth, morbidity and activity of matched cohorts of infants who were either breast-fed or formula-fed for more than 12 months. Infants exclusively breast-fed for less than 2 months and with total breast-feeding less than 3 months were included in the formula-fed group. In the final formula-fed group most infants received formula at least once a day by two weeks of age. The results of this study indicated that growth patterns of breast-fed infants differ from growth of infants fed modern infant formulas who are given solid foods no earlier than four months and are similar with respect to parental characteristics and infant birth weight. Differences in weight were the most pronounced, whereas length of breast-fed and formula-fed infants was generally similar and there were no differences in head circumference (Dewey et al., 1992). Interestingly, differences in weight were most evident during the second six months of life, after the introduction of complementary foods (Dewey et al., 1992). The difference in fatness between the two groups during the first year could be explained by differences in energy intake. Total energy intake of the formula-fed group was significantly greater than that of the breast-fed group at three, six and nine months (Dewey et al., 1993).

1.4 Assessment of growth and nutritional status

1.4.1 Anthropometry

Anthropometry is widely used as a tool to estimate the nutritional status of populations and to monitor the growth and health of individuals. The most popular measurements are age, weight and height. Other frequently used measurements are head circumference and mid upper-arm circumference. Chest circumference and skinfold thickness are less commonly used. Anthropometric measurements as such hardly provide any information. They become meaningful by comparison to a reference.

A growth reference is a data set representing the distribution of a given anthropometric measurement based on a specified reference sample of children as it changes with some covariate, usually age, in the two sexes (Cole, 1993).

One of the most important uses of such grouped data is for making comparisons between communities or countries. Obviously for the latter purpose the reference must be internationally accepted. This does not necessarily mean that the reference is also a target or optimum. There has been much misunderstanding on this point. The main quality required of an international reference is that it should be derived from a large sample and that the statistical parameters describing the sample should be properly worked out. At the beginning of the seventies, a wide variety of systems for recording and interpreting anthropometric data had arisen, with different standards used for purpose of comparison and variable systems for classification of growth deviation, not only from country to country but even among areas within the same country (WHO, 1978). Therefore the WHO presented in 1978 a growth chart for international use in maternal and child health care.

Three types of indicators are used to express the results of the comparison of one's own data to those of the reference: percent of median, SD-scores or standard deviation scores and percentiles.

The percent of median expresses the value observed in a percentage of the median of the reference population, where the median is set at 100%. This indicator was widely used some twenty years ago, but has fallen in disuse because it had several disadvantages. Its curve is not normalized, making statistical manipulation more complicated, interpretation of extreme values is not consistent across age and height groups, nor is the interpretation of cut-off values consistent across indices. For example, 60 percent of median weight-for-age represents severe malnutrition, whereas 60 percent of median weight-for-height, at any age, would be incompatible with life (Smith, 1989).

The SD-scores or Standard Deviation scores are often denominated with the term "Z-score". Jelliffe and Jelliffe (1989) commented that this is merely a confusing statistical code term and preferred the term "Standard Deviation score". SD-scores express the number of standard deviations below or above the reference median of the value observed. The formula to calculate the SD-score is as follows:

$$\text{SD-score} = \frac{\text{individual's value - median of the reference population}}{\text{standard deviation of the reference population}}$$

The values of the standard deviation below and above the median may be different when the distribution of the measurements of the reference population is not symmetrical. In that case separate standard deviations have to be calculated for the lower and upper halves of the distribution. The WHO is the greatest promoter of the use of SD-scores as this indicator has several advantages over the others, namely the curves are normalized and the interpretation of extreme values is consistent across age and height groups. The physiological meaning or consequences of extreme values may differ, however, across age and height groups. Other advantages of the SD-scores are that the interpretation of cut-off values is consistent across indices and that they can correctly identify children with extreme values.

Percentiles, finally, express what proportion of the reference population has values less than the one observed. Percentiles are most commonly used in industrialized countries and have all the advantages of the SD-scores, except for the ability to identify children with extreme values, point of crucial importance in underdeveloped countries, which explains the preference of the WHO for SD-scores.

For many purposes, the most useful way of describing the nutritional status of a population is to present an estimate of the number or proportion who might be considered at risk. In principle such an estimate is given by the number outside the reference population. In practice it is conventional to use cut-off points. Frequently used cut-off points are the 3rd and 97th percentile, or 2 Standard Deviation scores. In certain circumstances, it may be necessary to use other cut-off points.

Height and weight are the most commonly used anthropometric measurements. They are generally set out in relation to age or to each other. The three most frequently used anthropometric indices are therefore weight-for-height, height-for-age and weight-for-age. The two preferred anthropometric indices for nutritional status are weight-for-height and height-for-age, since these discriminate between different physiological and biological processes (WHO working group, 1986).

Weight-for-height is very useful in populations where the exact age of the child is unknown, which is important in underdeveloped countries. However, in industrialized countries this index is also popular because of its sensitivity to weight change over a short period. Height-for-age is the appropriate index to determine very short and tall children. It has been shown that weight-for-height and height-for-age together account for more than 95% of the variance in weight-for-age. This means that weight-for-age represents the sum of information given by the other two indices (WHO working group, 1986).

The main types of nutritional deficits that indices of weight and height may elucidate on the lower side of the curve are "wasting" and "stunting". Wasting, or thinness, indicates a deficit in tissue and fat mass compared to the amount expected in a child of the same height or length, and may result either from failure to gain weight or from actual weight loss. Stunting signifies slowing in skeletal growth (WHO working group, 1986). There are several important differences between wasting and stunting: one can fail to gain height, but one cannot lose it. Moreover, linear growth is a slower process than growth in body mass. Wasting and stunting represent therefore different processes of malnutrition. Weight gain and weight loss can occur in a short period. Favourable and unfavourable circumstances will be more quickly reflected in weight than in height indicators. Weight-for-height is therefore considered an indicator of the present state of nutrition, while height-for-age is thought an indicator of past nutrition (Waterlow, 1977).

On the upper side of the curve, obesity is the main nutritional deficit that can be detected.

Waterlow (1977) proposed to cross-tabulate the SD-scores for height-for-age and weight-for-age to determine the prevalence of wasting and stunting in undernourished populations and the prevalence of obesity in populations where overnutrition is a problem, see table 1.4.

Results must be interpreted carefully. Trowbridge et al. (1987) saw that in some child populations, low height-for-age, suggesting chronic malnutrition, may paradoxically be accompanied by relatively high weight-for-height, suggesting obesity. Studying these children in more detail, they found that their high weight-for-height was not obesity but was instead associated with lower body fat and greater lean tissue or lean tissue hydration that may reflect dietary, environmental, or genetic influences. Weight-for-height cut-offs for wasting or obesity may require therefore different interpretations in different populations.

Table 1.4 Cross tabulation in SD-scores of weight-for-height and height-for age as proposed by Waterlow (1977)

		SD-scores height-for-age		
		≤-2 (stunted)	-1,9 to 1,9	≥2
SD-scores weight-for-height	≤-2 (wasted)	short and underweight	normal length and underweight	tall and underweight
	-1,9 to 1,9	short with normal weight	normal length with normal weight	tall with normal weight
	2,0 to 2,9	short and overweight	normal length and overweight	tall and overweight
	≥3	short and very overweight	normal length and very overweight	tall and very overweight

Frisancho (1990) commented that although the approach of Waterlow has the advantage of being based upon easily obtainable measurements, the method is ineffective for accurately distinguishing the truly malnourished child from the simply underweight, or the obese child from the muscular and large-framed one. In other words, excess weight does not necessarily imply excess fat, and underweight is not necessarily associated with protein-energy malnutrition.

1.4.2 Appropriateness of currently used growth references

Various studies have questioned the adequacy of actual growth charts for the present generation of infants and particularly for breast-fed infants (Underwood and Hofvander, 1982; Owen, 1984; Seward and Serdula, 1984; Persson, 1985a; Paul et al., 1988; Wood et al., 1988; Wright et al., 1993). Most currently available growth standards are based on data obtained in earlier years, when infants were predominantly formula-fed and early introduction of solids was common practice. Applying these growth charts to exclusively breast-fed infants may lead to false conclusions. Growth charts furthermore are largely based on formula-fed babies who, because of the time when measurements were made, must have received old-type milk formulations (Whitehead and Paul, 1984).

Hitchcock and Owles (1981) reported already in 1981 that healthy breast-fed Australian infants had weight increments in the second three months of infancy which were well below standard figures for normal weight reported from Britain, and more closely resembled data from developing countries. They suggested that this apparent decline in somatic growth by breast-fed infants in the second quarter of infancy is a normal physiological phenomenon and secondly, that the differences between the Australian and British infants reflect changes in feeding methods between the 1950s, when information for the British Tanner and Whitehouse growth standards was collected, and the 1980s, time of the Australian study.

Whitehead and Paul (1984) reviewed different growth charts that are being used in some industrialized countries and concluded that although there is some conformity in growth rates after four or five months of age, this is by no means so before this time. These deviations become of critical practical importance when the growth standards are used to identify the onset of lactational inadequacy and the need to introduce complementary feeding. Actual charts may worry mothers as their baby's patterns of growth level off at two to three months after an initial growth spurt relative to the reference, and finally start falling away. Complementary feeding may then quickly be introduced and breast-feeding given up altogether while their babies are just following "normal growth" for exclusively breast-fed infants.

Dewey et al. (1992) considered it reasonable to conclude from the DARLING study that it is normal for breast-fed infants to gain weight less rapidly than current reference data suggest, as the slower growth rates and lower energy intake of breast-fed infants were not associated with any harmful consequences of morbidity, activity level or behavioural development.

Wright et al. (1993) compared weight data of more than 3000 children from Newcastle, U.K., with the Tanner and Whitehouse, the American NCHS and the recently collected Cambridge growth references. Their data matched best with the Cambridge reference and important discrepancies could be seen with both the Tanner and NCHS curves. Feeding method could not explain these-discrepancies as formula-feeding with early weaning remained common in Newcastle, with a pattern similar to the time when the Tanner and Whitehouse data were collected. Wright et al. suggested consequently that the move towards both higher rates of breast-feeding and more physiological milk formulations appeared to have produced a substantial change in the normal pattern of weight gain in infancy.

1.5 Accuracy in the collection of data

1.5.1 Dietary intake methodology

The collection of food consumption data is an essential part of food consumption surveys conducted for nutritional, medical and economical purposes. Various methods are used to collect these data. The choice of method depends mainly on the aims of the survey, the size of the sample needed, the funds and personnel available. The purpose of the survey determines the accuracy of the data needed and this again affects the choice of method (Pekkarinen, 1970). In most cases the choice of method is a compromise between the factors mentioned above. The most frequently used methods in the collection of food consumption data of infants are the 24-hour recall, the food record method and the weighing method. These methods with some of their advantages and disadvantages will be discussed.

24-hour recall. The 24-hour recall is an interview method in which the food consumption of the previous day is being recalled as accurately as possible (Pekkarinen, 1970). This method was used in the Leiden Pre-school Study in the Netherlands to determine the energy and nutrient intake of children from four to 28 months. A validation study was carried out to verify the accuracy of the collected data in two ways. Firstly, the validity of the Dutch food table, supplemented with data on commercial baby foods, was tested. Secondly, the 24-hour method was validated against the duplicate portion technique. With exception of sodium and iron, energy and nutrient intake of six months-old non-breast-fed infants were significantly higher than those obtained after chemical analysis of the duplicate portion. Overestimation could be partially explained by the use of the Dutch food table. On a relative level, the results of the 24-hour recall and the duplicate portion technique corresponded well (Horst et al., 1988).

Persson (1984a) found that group mean estimations obtained through 24-hour recalls and seven-day weighing records, respectively, are close to each other. He concluded that the 24-hour recall may be used as a quicker and cheaper way to make group mean estimations of food intake in childhood.

Food record and weighing methods. The most accurate data on food consumption are obtained by weighing. The principle of the weighing method is that all food components used for the preparation of the meals, the cooked food, amounts eaten at meals, the food left over, plate waste, discarded foods, snacks, etc. are weighed daily during the survey period (Pekkarinen, 1970). The food record method is based on the same principle as the weighing method, but amounts are recorded in household measures. The food record method gives less accurate results than the weighing method, but the degree of accuracy obtained by this method is sufficient for many purposes.

The main advantage of these methods is that the amounts consumed can be recorded more accurately than by any other method. Disadvantages are that the size of the sample is limited since much work and trouble is involved with the use of this method. Secondly, the sample is seldom representative, as random sampling cannot be used and volunteers have to be selected who are willing and able to spend time on weighing and recording. Finally, the method is expensive and trained personnel are needed for control and supervision (Pekkarinen, 1970).

The length of the recording period is determined by the daily variation in energy and nutrients to be studied in the survey population, and by the precision required as set in the aims of the study. Black et al. (1983) examined the day to day variation in energy intake in infants up to 18 months to estimate the number of days needed to assess energy intake of groups of individuals with a specific degree of confidence. The number of daily records needed to classify individuals in relation to each other not only depended on how variable individuals were within themselves, but also on how much they differed between themselves. To assess a single individual with any degree of accuracy needed many more days of record than were necessary for a group of individuals. Kylberg (1986) studied not only the daily variation of energy, but also of several nutrients, to estimate the number of daily records needed to classify individual infants into the correct category with high or low intake with a specified degree of accuracy.

In conclusion, the 24-hour recall is suitable to calculate the average intake of energy and nutrient intake of a group, although the results may overestimate to a certain extent the real intake. The food record method will provide more accurate data. The weighing method gives the most reliable results and is particularly indicated for the classification of individual infants within a group. The number of daily records needed depends on the variability between and within infants, and on the degree of confidence required.

1.5.2 Reliability of mother's recall

Studies looking at the accuracy of the mother's recall of birth weight and length of her children have found that both of them are generally remembered well (Eaton-Evans and Dugdale, 1986; Vobecky et al., 1988; Harlow, 1989). Also infant feeding habits, data on breast-feeding and its duration are generally remembered accurately by the mothers (Eaton-Evans and Dugdale, 1986; Launer et al., 1992). The risk of errors is greatest in the correct recall of the moment of introducing other foods, like infant formula and solids (Eaton-Evans and Dugdale, 1986; Vobecky et al., 1988; Launer et al., 1992).

Launer et al. (1992) found that retrospective infant feeding data based on maternal recall of events up to 18 months in the past could be used with confidence in epidemiological studies. Persson (1984a) reported that the validity of retrospective data on breast-feeding at the age of six months was good, but that the reliability seemed to decrease over time, as six months later about a quarter of the mothers who had stopped breast-feeding before the age of six months added one or two months to their previous answer. With regard to the influence of the respondent's characteristics, Haage (1988) observed that ethnicity, education and socioeconomic group were more important for accurate recording than the length of the recall period, whereas Eaton-Evans and Dugdale (1988) did not find any influence of level of education nor of the number of children the mother had and the recall period. It may be important to note, that Haage's respondents who provided the least accurate data were Malay rural residents with no or little education, whereas Eaton-Evans and Dugdale's low socioeconomic group were urban mothers with at least basic schooling.

1.6 Aims of the present research

In Spain, little information is available on infant feeding habits beyond the first few months of life. In the U.K., for instance, surveys on infant feeding practices are being carried out every five years since 1975. The first survey looked only at attitudes and practices in England and Wales, whereas the later ones covered the whole of Great Britain, as well as Northern Ireland in the latest version of 1990. Although it may be argued that feeding habits in Spain will be similar to those in other Western European countries now that international recommendations on infant feeding are available and the European Community regulates the composition of infant foods and facilitates the commercialization of the same product in different countries, no scientific work has proved this. The need was therefore felt to study feeding practices of infants and young children in Spain. As Spain has 40 million inhabitants and over 500,000 square kilometres, it was physically impossible for one single person to undertake such a task and limitations had to be made. Consequently, Madrid was chosen as the best location for a first exploratory investigation. Madrid is the capital, in which more than 10% of the Spanish population lives. Although it is not representative for the country as a whole, as habits in rural areas may differ from those in a metropolis, Madrid is important as a trend-setter for the rest of Spain.

The aims of the study in Madrid were multiple. Three socioeconomic groups were defined and an answer was sought to the question whether infant feeding practices differed between socioeconomic groups. Similitude and differences of infant feeding habits in Madrid with those in other countries, particularly those of Western Europe, were to be established by comparing the results with both recommendations from national and international paediatric advisory groups, and infant feeding practices elsewhere as described in the literature. At the same time, as nutrition is one of the determining factors of growth in infancy, the absence of under- and overnutrition on a population basis was to be checked. Finally, more insight was required into the nutrient intake of the older infant. As home-prepared meat-based meals were considered an equal source of nutrients to commercially prepared meals, the nutritional composition was to be examined. In addition, the contribution to the daily nutrient intake of both the meals and of special infant milk formulations, was to be confirmed as these foods were thought to be crucial for a balanced diet.

To seek an answer to these questions, the feeding patterns of 344 children under 20 months of age in Madrid were first studied. The sample was stratified in such a way that each socioeconomic group comprised about a third of the sample. Information was obtained on breast-feeding and on the use of other types of milks. The moment of introduction of each complementary food, as well as cultural practices related to it, were recorded. These results were compared to national and international guidelines on infant feeding. The possible influence of the socioeconomic status was investigated. To complement the data on feeding habits, anthropometric measurements were taken to compare growth of these children with national and international growth references.

In a second phase, 51 home-prepared meat-based meals for children seven to eight months old were chemically analysed for macronutrients and a number of minerals, to examine their nutritional value. The results were compared with the composition of human milk, with commercially prepared meals and with the guidelines for these products, as well as with the results of a similar study in the U.K. The contribution of these meals and of infant milk formulations to the total daily nutrient intake was estimated based on information kept in special food diaries by the mothers of the children.

Chapter Two describes in detail the methods that have been used for both parts of the research.

CHAPTER 2

METHODS

After a short introduction to Spain
and its health care system,
a description of the methods used for this research is given.

2.1 Introduction

2.1.1 Spain

Spain lies in the extreme southwest of the European continent, occupying most of the Iberian Peninsula. Spain has about 40 million inhabitants of which about ten percent live in the capital, Madrid, and its suburbs. Since 1986, Spain is a full member of the European Community. Spain is divided into 17 *Comunidades Autónomas* or autonomous regions, of which Madrid is one. The national government delegates tasks and services to the regions.

Daily life in Spain is very similar now to that of other industrialized western European countries. Even so, Spain shows some peculiar practices that are relevant to this study, the most obvious of which is the organization of the day and the scheduling of the meals. Lunch, which is usually the main meal of the day, is eaten between 2 p.m. and 3 p.m. Traditionally this was followed by a nap, the famous siesta. Around 6 p.m. the *merienda*, a light meal or snack, may be taken, particularly by children. Supper is taken between 9 p.m. and 10 p.m. and even later during the hot summer.

Business, shopping and school hours reflect this pattern. There is a long break, lasting between two and three hours, in the middle of the day, during which virtually everything is closed, except for bars, restaurants and large department stores. The workday resumes in the late afternoon, between 4:30

p.m. and 5:30 p.m., and continues until around 8 p.m.

Due to heavy traffic and long travelling times between home and work on the one hand, and international contacts on the other hand, more and more companies in the big cities are changing their office hours to European schedules, reducing the length of the midday-break and ending between 5 p.m. and 6 p.m.

Spanish cooking varies greatly from region to region. The Catalan and Basque cuisine are the most elaborate and prestigious. Spanish food is frequently thought to be very spicy, but this is not so. The most widely eaten meat is pork, while in much of the country lamb is eaten on special occasions. Spaniards have long consumed large amounts of fish and seafood. Pulses, specially lentils and chick-peas, form an important part of the Spanish diet. Spaniards frequently drink wine or beer with their meals. They also drink bottled mineral water, even though the tap water is perfectly safe. At breakfast and after meals coffee is the almost universal drink. Few people drink tea, but herbal infusions, such as chamomile, are popular. Domestic and imported soft drinks are widely available.

Since the 1960s Spain's increasing prosperity and the generalized availability of health care have combined to improve health and welfare. By the beginning of the 1990s Spain had more doctors per capita than the average for the European Community. The health system is administered by the national Ministry of Health through a department known as the National Institute of Health (Insalud). However, as the system of regional autonomy developed, responsibility for health care began to pass to some regional governments. The system provides a full range of services in clinics as well as in general and specialized hospitals.

However, health care is not a government monopoly. There are many doctors who have their own offices and clinics outside the government-funded system, and many private insurance plans are available.

2.1.2 Madrid

Madrid is the capital of Spain, its largest city, and a national centre of arts and industry. With its surrounding province, also called Madrid, it forms one of the new autonomous regions of the post-Franco era.

Madrid lies in the geographical centre of the Iberian Peninsula at an altitude of 635 meters above sea level, making it one of the highest capitals in Europe.

Being the centre for government, finance and insurance, is a factor that has long contributed to the prosperity of the capital, as well as tourism and transportation. After the Spanish Civil War, the city became an important manufacturing centre as well.

The flow of migration to Madrid, attracted chiefly by the city's expanding industrial belt, has created a modern population, culturally and genetically quite representative of the entire Spanish nation.

2.1.3 The Spanish neonatal and postnatal health care

Birth rates began to fall slowly and continuously at the beginning of the 20th century, but this decline stalled during the 20 years after the Spanish Civil War when the Franco regime encouraged large families. The birth rate fell below 20 per 1.000 in the late 1960s and declined rapidly thereafter. In the autonomous region of Madrid, the number of births in 1989, which was the year of recruitment of the children in this study, was almost half that of 1974, see table 2.1 (Comunidad de Madrid, 1993).

Table 2.1 Live births in the autonomous region of Madrid

1970	83,442
1974	94,526
1980	72,841
1985	56,890
1989	50,911

Other than information from family and friends, mothers receive advice on how to feed their babies from their obstetricians and at antenatal classes. Antenatal classes are given both in clinics that work under the government system, as well as in private clinics. These classes are attended by the mother on a voluntary basis.

Nearly all children are born in hospitals or maternity homes. In 1989 50,613 deliveries took place in the region of Madrid, of which 50,387 (99,6%) in hospitals and clinics (Comunidad de Madrid, 1993).

After discharge from the hospital, the family paediatrician takes further care of the medical check-ups of the child. The paediatrician is the "general practitioner" for children. In the government health service system, every family is assigned one general practitioner for the health care of the adults and one paediatrician for the health care of the children, both working in the medical centre of their district. Parents with higher than average incomes may prefer to take their child to a paediatrician who has his own practice or one shared with other professionals. Many of these doctors have agreements with private insurance companies.

The paediatrician continues to counsel the mother on the feeding of the infant. The frequency with which the mother visits the paediatrician varies considerably and depends mainly on the advice of the paediatrician and the need felt by the mother.

2.1.4 Vaccination centres

Both the regional and the municipal health authorities provide centres, where infants can be vaccinated free of charge. Some paediatricians with private practices also vaccinate infants, but they charge for this. Only recently have the district medical centres of the government health service system also started to administer vaccines free of charge. At the time of the research infants were vaccinated according to the vaccination scheme as shown in table 2.2. Since then hepatitis B vaccination has been included in the scheme.

Table 2.2 Spanish national vaccination scheme

Age	Vaccines			
3 months	tetanus	diphtheria	whooping cough	polio
5 months	tetanus	diphtheria	whooping cough	polio
7 months	tetanus	diphtheria	whooping cough	polio
15 months	parotitis	measles	rubella	
18 months	tetanus	diphtheria	polio	
6 years	tetanus	polio		
11 years	rubella *(girls only)*			
14 years	tetanus	polio		

The regional health authorities provide vaccination services in various centres, geographically distributed over the city. The most important one by far in number of vaccines administered is one located in Núñez de Balboa street. It is the only vaccination centre in the city that opens not only in the morning during weekdays, but also in the afternoon and on Saturday mornings.

In 1989, almost 9,000 infants of three months were vaccinated in this vaccination centre alone (Lola Barranco, Comunidad de Madrid, Consejería de Salud, Dirección General de Prevención y Promoción de la Salud, personal communication), which corresponds with almost 18% of all births in 1989 in the whole province of Madrid.

Recruitment of the study population in vaccination centres had two advantages. First, the mothers visiting the centres came from all over Madrid, including some from the farthest suburbs. This implied that children vaccinated in these centres were seen by many different paediatricians. The diversity of residence and paediatricians attending the baby, improved the representativeness of the final sample.

Secondly, the recruitment of children at only two locations had logistical advantages for the investigator.

2.1.5 Permission for the study

Permission was obtained from the Regional Health Services by the investigator prior to the study.

2.2 Study on feeding habits and growth

2.2.1 The population under study

Recruitment of most of the children took place during weekdays in the vaccination centre of Núñez de Balboa between the end of December 1988 and May 1989 between 5 and 8 p.m. At the beginning of the study, about five mothers could be seen each afternoon and the data collection exercise completed, but as time passed this number decreased due to the desired stratification of the sample, i.e. as the desired numbers of children were reached for a certain age-group in a certain socioeconomic group, more time was spent waiting for a mother with a child whose characteristics were still needed, who also fulfilled the study's entry requirements and who was willing to participate.
As the centre in Núñez de Balboa is visited by people from all over Madrid and from all socioeconomic groups, although with a slight preference for those in the middle and high ones, it was decided to recruit about half of the low socioeconomic group population in another centre, the vaccination centre of Vicente Muzas street in the east part of Madrid. In 1989, more than 1,000 infants of three months were vaccinated in this centre (Lola Barranco, Comunidad de Madrid, Consejería de Salud, Dirección General de Prevención y Promoción de la Salud, personal communication). Recruitment at that location took place between June and September 1989 between 9 a.m. and 2 p.m.

Mothers of babies younger than one and a half years, who visited the vaccination centres, were invited by the nurses who administered the vaccines to participate in the study. Mothers were told that questions on feeding habits would be asked and the baby would be measured. This would take about half an hour. The interview and measurements took place before the administration of the vaccine, as this might upset the baby, distract the mother and make anthropometric measurements more difficult to perform. The majority of the invited mothers agreed to collaborate. According to the nurses, those who declined mainly explained that they had no time available at that moment. The babies had fasted for at least one hour; this was required by the nurses to prevent loss of an oral vaccine by regurgitation; however, children 15 and 16 months old were not required to do so.

The objective was to recruit 300 children, 60 in each of the age-groups of three, five, seven, 15 and 18 months. Furthermore, in each age-group infants would be classified into high, middle or low socioeconomic group according to the occupation of the head of the household, usually the father's occupation. Infants would be stratified until about the number 20 was reached in each socioeconomic group for each age-group.

The final study population consisted of 344 children, as the nurses could not always correctly classify the baby before inviting the mother to participate in the study. In addition to the infants in the age groups corresponding to the vaccination scheme, some infants of other ages were measured. This was because their mothers were late in bringing them to the vaccination centre according to the vaccination scheme. The sample included one pair of twins, a boy and a girl of 16 months in the high socioeconomic group and one adopted girl of 18 months in the high socioeconomic group.

Excluded were infants with severe illness in the neonatal or research period, with a birth weight below 2,500 g, with congenital abnormalities, with neurological damage or having a non-Spanish parent.

2.2.2 Stratification of the sample

The infants were classified into high, middle or low socioeconomic group according to the occupation of the head of the household, usually the father. In case of doubt, the mother's occupation was taken into account to make a decision on classification.

Included in the high socioeconomic group were persons engaged in work normally requiring university qualifications or higher technical degree standard or "third degree titles" (*títulos de tercer grado*) as defined by the *Instituto Nacional de Estadística* (National Institute of Statistics) in Spain (Instituto Nacional de Estadística, 1988). Examples of professions in the high socioeconomic group are: architect, teacher, lawyer, physiotherapist.

Included in the middle socioeconomic group were persons engaged in manual and non-manual skilled occupations that do not require university qualifications or higher technical degree standard. This corresponds with the Spanish "second degree titles, second cycle" (*títulos de segundo grado, segundo ciclo*). Examples of professions included in the middle socioeconomic group are: bank employee, secretary, sales representative, shop owner.

Included in the low socioeconomic group were persons engaged in partly skilled or unskilled occupations requiring no school or "primary or secondary titles, first cycle" (*analfabetos, sin estudios, títulos de primer grado y de segundo grado, primer ciclo*) of the Spanish system. Examples of professions included in the low socioeconomic group are carpenter, taxi-driver, waiter, cashier.
Table 2.3 gives an overview of the sample by socioeconomic group and sex of the infant.

Table 2.3 Composition of the sample by socioeconomic group and sex of the infant

socio-econ. group	sex	age in months																	total	
		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
high	male	9	-	8	1	13	3	-	1	-	-	-	-	10	2	-	9	-	56	122
	female	12	1	12	2	12	3	-	-	-	-	-	-	10	2	-	11	1	66	
middle	male	12	-	13	-	9	1	1	-	-	1	-	-	12	-	-	13	1	63	115
	female	12	-	7	1	13	-	1	1	-	-	-	-	8	1	-	8	-	52	
low	male	11	-	9	-	13	1	1	-	1	-	-	-	7	-	-	10	-	53	107
	female	9	-	11	-	8	2	-	-	-	-	-	-	14	-	-	10	-	54	
total		65	1	60	4	68	10	3	2	1	1	0	0	61	5	0	61	2		344

2.2.3 Representativeness of the sample for the Madrid population

Geographical representativeness. To make sure that the study population really came from all over Madrid, the 344 children included in the final sample were classified according to the postal district of their residence. The capital of Madrid is divided into 50 postal districts. Table 2.4 shows the results of this classification. No district represented more than 7.8% in the final sample, confirming the geographical diversity of residence of the sample.

Table 2.4 Classification of the sample according to postal district of residence

postal district	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
number children	7	21	10	2	2	12	13	6	3	3	3	2	0	3	10	5	23	0	6	14	0	22	3	0	3
postal district	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
number children	1	8	14	9	14	3	0	27	5	2	9	15	0	2	4	0	6	24	1	2	0	1	0	0	2
postal district	suburbs																								
number children	22																								

Distribution of socioeconomic groups in Madrid. Table 2.5 gives an overview of the population of the city of Madrid of 10 years and older, who were not studying, in 1986 by socioeconomic group (Comunidad de Madrid, 1993)

Table 2.5 Overview of the Madrid population by socioeconomic group.

illiterate	46,667	
has reading capability but no other studies	618,438	
studies of first grade and second grade, first cycle	846,785	
TOTAL LOW SOCIOECONOMIC GROUP	1,511,890	(68,8%)
second grade, second cycle	382,296	
TOTAL MIDDLE SOCIOECONOMIC GROUP	382,296	(17,4%)
higher technical degree	109,921	
university	189,400	
TOTAL HIGH SOCIOECONOMIC GROUP	299,321	(13,6%)
Unable to classify	3,926	(0,2%)
Total population: 2,197,433		

The sample does not reflect the proportions of the socioeconomic groups of the population in Madrid, as it was stratified to obtain about a third of the sample from each socioeconomic group to be able to observe possible differences in feeding behaviour and growth. These differences in proportions have been taken into account when analysing the results.

Maternal age of women giving birth in Madrid. Maternal age was grouped in classes of five years, starting with 15-19 years (from the 15th to the 20th birthday) and ending at 45-49 years, following the age-groups as presented by the statistical department of the autonomous community of Madrid (Comunidad de Madrid, 1993), see table 2.6. The maternal age distribution did differ somewhat between this study and the Madrid population, however, not by much: a slight over-representation of age 20-24 years in the study data was balanced by a slight under-representation of age 25-29 mothers; similarly for age 35-39 and 30-34. If the mother's age were to be grouped in classes of 10 years, i.e. 10-19, 20-29, 30-39 and 40-49, then our (weighted) age distribution was close to that of the Madrid population.

Table 2.6 Age of the mothers in each socioeconomic group and in the whole sample weighted for socioeconomic group, compared to the age of all mothers who gave birth in 1989 in Madrid

age in years	socioeconomic group high	middle	low	sample, weighted	Madrid 1989
10-15	0 (0%)	0 (0%)	0 (0%)	0 %	9 (0%)
15-19	0 (0%)	1 (0.9%)	4 (3.7%)	2.7%	1,787 (3.5%)
20-24	0 (0%)	6 (5.2%)	27 (25.2%)	18.3%	8,665 (17%)
25-29	41 (33.6%)	40 (35.1%)	37 (34.6%)	34.6%	19,843 (39%)
30-34	51 (41.8%)	50 (43.9%)	20 (18.7%)	26.2%	14,584 (28.7%)
35-39	28 (23%)	12 (10.5%)	16 (15%)	15.3%	4,962 (9.7%)
40-44	2 (1.6%)	5 (4.4%)	2 (1.9%)	2.3%	1,009 (2%)
45-49	0 (0%)	0 (0%)	1 (0.9%)	0.6%	52 (0.1%)
>50	0 (%)	0 (0%)	0 (0%)	0 %	0 (0%)
	N=122	N=114	N=107	N=343	N=50,911

2.2.4 Collection of information

Development of the data collection sheet. In selecting a dietary assessment technique for studies in childhood populations, all methods must be judged upon their own merits. Studies of food habits, food frequencies or meal patterns may demand other methods than energy and nutrient intake estimations (Persson and Carlgren, 1984a). The aim of the study was to get insight into the feeding patterns of infants and young children between birth and the age of one and a half years. A data collection sheet was designed to register personal data, anthropometric measurements and food habits, see appendix A. The mother was requested to answer all the questions. The mother was absent in only three cases: twice was it the father, once the grandmother who answered.

The data collection sheet was tested on its practical use in a pilot study in July 1988 with ten mothers who did not belong to the final sample. Only minor changes were made, e.g. a question was included on the mother's pre-pregnancy weight. This was because a mother was not pleased to see a higher weight recorded if she had not yet recuperated her pre-pregnancy weight. The extra question on her ordinary weight made her relax again.

Personal data. Figure 2.1 shows the first part of the data collection sheet, in which personal data of the baby and its family were registered. Name, address, sex, gestational age and date of birth of the child were recorded, as well as name and date of birth of the mother and the occupation of both parents.

Figure 2.1 Data collection sheet for personal data (translated into English)

CHILD: Christian name		surnames
address		
postal district		telephone
MOTHER: Christian name		surnames
date of birth	age	profession
FATHER: profession		

Anthropometric data. The mother was asked to recall weight and length of the infant at birth and her own normal weight before pregnancy. The vast majority of mothers in this study answered the questions on birth weight and length without any hesitation.

Anthropometric measurements were carried out by the investigator after training at the University of Surrey. Figure 2.2 shows the part of the data collection sheet where anthropometric data were recorded. Crying or agitation of some of the babies made certain measurements difficult. Equipment was provided by the University of Surrey and by Nutricia.

Figure 2.2 Data collection sheet for anthropometric data (translated into English)

sex male/female	gestational age (weeks)	date of birth	
birth weight (g)	birth length (cm)	age (months)	
code of the child		code of the mother	
length cm		length cm	
weight g		pre-pregnancy weight kg	
		actual weight kg	
		weight/(height)^2	
head circumference cm			
arm circumference cm			
triceps skinfold mm			
subscapular skinfold mm			

In eleven cases, anthropometric measurements of the mother were not carried out. One child was adopted and the anthropometric measurements of the adoptive mother were not relevant to those of the child. In three cases, the mother was not present and pregnancy of the mother made measurements useless in the other seven cases.

The following anthropometric measurements were made:

Weight

All children were weighed wearing their nappy and a minimum of clothes. Children under 10 kg were weighed using a pediatric electronic balance ("baby weigher" by CMS Weighing Equipment Ltd., London); weight was measured and recorded to the nearest 2 g. This instrument was checked by the author and found to be reliable. For children over 10 kg, body weight was calculated by subtracting the weight of the mother alone from that of the mother and child together. Both were weighed on portable electronic weighing scales and weight was measured to the nearest 0.5 kg. Mothers were weighed without shoes and outdoor clothing.

Three hundred grams were subtracted from the measured weight of every child for nappy and clothes.

Length

The length of the baby was measured using a Harpenden infantometer. The child was measured lying down. The mother held the head of the child against the fixed end of the infantometer, whilst the investigator adjusted the sliding side to the feet of the baby and read the result; length was measured to the nearest millimeter.

The mother's height was measured on a portable stadiometer in centimeters.

Head circumference

Head circumference was measured to the nearest millimeter using a fibre-glass measuring tape as described by Jelliffe (1966). The greatest circumference was measured by placing the tape firmly round the frontal bones just superior to the supra-orbital ridges, passing it round the head at the same level at each side, and laying it over the maximum occipital prominence at the back.

Skinfold thickness

Triceps and subscapular skinfold thickness of the left side of the body were measured using a Holtain skin-fold caliper; skinfold was measured to the nearest 0.2 mm. The technique used is described by Jelliffe (1966). The midpoint of the upperarm was assessed, halfway between the acromial process

of the scapula and the olecranon process of the ulna. The arm was hanging relaxed at the side. The skinfold was picked up between finger and thumb of the left hand, the calipers applied one centimeter below the hand about equal to the skinfold, while the skinfold was held gently throughout the measurement. The reading was taken as soon as the measurement had stabilized. Three measurements were made and averaged.
The subscapular skinfold was taken just below and laterally to the angle of the scapula, the fold running at approximately 45° to the spine, in the natural line of skin cleavage.

Arm circumference
Left upperarm circumference was measured to the nearest millimeter using a fibre-glass measuring tape as described by Jelliffe (1966). While the arm was hanging freely, the tape was placed gently but firmly round the arm at its midpoint, as determined for the measurement of the triceps skinfold.

Quetelet Index
The mother's Quetelet Index, defined as weight/(height)^2 (Weigley, 1989), and also called Body Mass Index, was calculated.

Food habits. The data collection sheet to record food habits was divided into three parts. Figure 2.3 shows the first part, which functioned as an introduction to part two and three of the data collection sheet on food habits, relaxed the mother as she noticed that no difficult questions were asked and provided information that could be cross-checked with data from the second and third parts to improve reliability of the records.

Figure 2.3 First part on food habits of the data collection sheet (translated into English)

```
Does your child have any illness?
Has he/she been ill before?
Did you breast-feed your child? yes/no        For how long?      weeks / months
Did you give any infant formula to your baby?  yes/no   Brand name?
When did you start with cow's milk?                  months
When did you feed your child for the first time something other than breast milk?
   or infant formula?                                months
```

The next part of the data collection sheet follows the dietary history technique. This technique was originally described by B. Burke (1947). It is a time-consuming interview which should be preferably carried out by a trained dietician (Burke 1947; Persson and Carlgren, 1984a). It provides insight into the usual food consumption of a subject. The method is based on the assumption that the subject has a certain regularity in his daily eating pattern. Young children do show this regularity. The investigator inquires what the subject usually eats in the course of a day, starting with any food item eaten before breakfast, passing through all daily meals until a bed-time snack, see figure 2.4. This method is commonly used by dieticians to obtain information on the feeding habits of a patient to be able to provide an individual diet prescription. Data obtained with this method are not sufficiently accurate to calculate nutrient intake for scientific purposes, but it is the ideal method to acquire information on feeding patterns and the use of certain foods (van Staveren et. al, 1981; de Vet, 1984).

The investigator had three years experience administering the method, thus ensuring the accuracy of the data obtained.

Figure 2.4 shows the part of the data collection sheet where the dietary history was recorded.

Figure 2.4 Part of the data collection sheet for recording the dietary history (translated into English)

breast milk/infant formula		number of feeds per day
before breakfast:		
breakfast: milk: human infant formula follow-on cow's milk other	cereals: without / with gluten without / with milk	other:
during the morning hours:		
lunch: meat yes / no egg yes / no potatoes yes / no pasta yes / no baby jars yes / no	fish yes / no vegetables yes / no rice yes / no with salt yes /no dessert yes / no	
afternoon snack: fruit cereals with fruit / jars / juices yoghurt / cream cheese	sugar addition?	
dinner: milk: human infant formula follow-on cow's milk other	cereals: without / with gluten without / with milk	other:
comments:		

In addition, the following questions were asked: Does the feeding pattern of your child differ much from one day to another? If so, what are the differences. Does your child take any vitamins? If so, which? Finally, any other comments were noted down.

The third part on food habits recorded the moment when the infant had started the use of specified foods, see figure 2.5. The time of introduction of formula-feeding, both infant and follow-on formulas, as well as cow's milk was asked again, and cross-checked with the answers given in the first part on feeding habits. Afterwards the moment of introducing infant cereals was inquired, as well as the types used. Then followed questions on fruit and fruit products, vegetables and other foods. The earliest moment of introduction to any non-formula food was checked with the answer in part one to the question about the introduction of the first food other than human milk or infant formula. This verified the exact moment of introduction of complementary feeding into the infant's diet.

Where possible, the answers of the mothers were checked, particularly those of infants above one year of age or if the mother hesitated in giving an answer to one of the questions. In those cases, the mother was asked to remember if her child was taking a certain food on a special occasion, e.g. "When did you go on holiday last year? Was your son taking cereals at that time?" or "Do you remember if your daughter was still being breast-fed at Christmas or was she having infant formula?". These questions were very helpful.

On several occasions, the mother's answers could be checked with the data written down in booklets provided to the mother through the health care system. It usually contained pregnancy, birth and anthropometric data, and many paediatricians used it to document their recommendations regarding the feeding of the infant. Many times it was possible to check the precise moment of introducing a certain food into the baby's diet.

If the mother had difficulties in remembering the exact timing of introduction, then the record of that food was left blank.

Figure 2.5 Part of the data collection sheet where the timing of introduction of specified foods was recorded (translated into English)

Introduction of foods		
months	food	type / brand name/ comments
	MILK infant formula follow-on formula cow's milk other	
	CEREALS no gluten, no milk no gluten, with milk with gluten, no milk with gluten, with milk other	
	yoghurt cream cheese other	
	FRUIT fresh jar cereals JUICE natural commercial other	with sugar yes / no
	BREAD biscuits other	
	VEGETABLES POTATOES PULSES PASTA	with salt yes / no
	MEAT FISH EGG white yolk CHEESE	
	JARS	
	DRINKS coffee / tea / herbal drinks soft drinks other	sugar added yes / no

2.3 Study on meal composition and daily nutrient intake

2.3.1 Population under study

Recruitment of the second set of children took place between April and June 1994. Mothers of infants of 7 and 8 months old, who visited the vaccination centres of Núñez de Balboa and Vicente Muzas were invited by the health personnel to participate in a study on infant feeding. No further details were provided. A telephone number and the name of the mother or baby was written down when the answer was positive. These data were provided to the investigator who tried to contact all mothers by phone. In this conversation, the purpose of the study was explained and an appointment made to visit the mother at home.

In total, 83 mothers expressed their willingness to collaborate with this study, but only 28 of them finally participated. Excluded were infants with severe illness in the neonatal or research period, with a birth weight below 2,500 g, being breast-fed or having a non-Spanish parent. Furthermore, the baby should be taking home-prepared meals, and the family should have a deepfreezer. Reasons for not entering the study were mainly not complying with the study criteria, as such breast-feeding the baby, the non-Spanish nationality of one of the parents, using only commercially prepared baby meals or not having started to use meat-based meals. In a few cases, it was impossible to contact the mother or the mother thought collaboration too time-consuming once she heard the details of the study. One mother of the 28 finally dropped out because her baby fell ill during the research period.

2.3.2 Meal sample and diary collection

The objective was to collect 50 samples of home-prepared baby meals containing meat. In Spain, the most common types of meat used in home-prepared meals for babies about seven months old are veal and chicken. Also in Italy these two meat types are popular in infant meals (Bellú, 1991). Because of the restricted number of meals that could be analysed, fifty in total, the type of meat to be used in the meal was limited to one variety, i.e. veal. Two samples were collected per mother.

The mothers were visited at home by either the investigator herself or another trained dietician. The visits were very time-consuming especially when the mothers found out that the investigator herself had a young child and wanted to exchange experiences. Of course, this exchange resulted in supplementary information that could not have been got otherwise.

During the home-visit, the study procedures were explained to the mother and left in writing. On a specially designed data collection sheet personal data, as well as additional information on the baby's birth weight and birth length as well as initial feeding habits were recorded, see figure 2.6. Appendix B shows both the study procedures and data collection sheet.

Figure 2.6 Data collection sheet for recording personal data and additional information (translated into English)

CHILD: Christian name	surnames		
address			
postal district	telephone		
MOTHER: Christian name	surnames		
date of birth	age	profession	
FATHER: profession			
sex male / female	gestational age (weeks)	date of birth	
birthweight (g)	birthlength (cm)		age (months)
Does your child have any illness?			
Has he/she been ill before?			
Did you breast-feed your child? yes / no For how long?			weeks / months
Did you give any infant formula to your baby? yes / no Which one?			
When did you feed your child for the first time something other than breast milk or infant formula?			months

Two containers were left with the mother. She, or the person who used to prepare the infant's meals, prepared on two different occasions a duplicate sample of the home-prepared meal based on vegetables and veal. The samples were put into the containers, cooled and immediately frozen.

The mother also completed a 24-hour food diary of her baby for both days when the duplicate sample was prepared on a specially designed form, see figure 2.7. The time when a food was taken by the baby was recorded as well as an accurate description of the food. If a meal was prepared, then the detailed recipe was asked for. If a food had a brand name, then this name was written down. Quantities offered to the baby as well as left-overs were recorded as precisely as possible in household measures.

Telephone contact was maintained with the mother during the research period. The frozen meals and diaries were collected, once the two days were completed. If possible, household measures used in the diaries were converted into grammes by weighing specific foods, e.g. infant cereals, on portable dietary scales (Soehnle). The diaries were checked and additional information obtained where necessary. Garrahie et. al (1991) emphasized that a debriefing session in which the records of children's food diaries were reviewed and additional information was filled in, leads to more accurate results.

Figure 2.7 Form for recording the 24-hour food intake (translated into English)

FORM TO BE FILLED IN BY THE MOTHER

(See instructions on the reverse)

On the .. of ..... 1994 I gave my child:

Hour	Description of the food	Brand name	Quantity	Quantity left over	Leave blank
(the form continues)					

The collection of the samples took more time than anticipated as many mothers prepared meals for more than one day and deep-froze them. As samples were required from two different preparations, it took in some cases up to a month before the mother had the two samples available.

Mothers were offered an incentive of one thousand pesetas (about £5,-), but about half of them rejected the offer.

2.3.3 Chemical analysis of the meal samples

Four of the 54 samples of the collected meals were not adequate, two contained liver or chicken instead of veal, and the quantity of two other samples was insufficient to make any chemical analysis. One mother repeated the procedures when she understood that the first samples she provided were not correct because of their composition.

The frozen meal samples were sent to the Netherlands to the Chemical and Physical Research Laboratory of Nutricia Research in Zoetermeer. Finally, 51 samples were analysed, 50 based on veal and one based on chicken. Samples were analysed for total solids, protein, fat, ash, sodium, potassium, calcium, magnesium, iron and zinc using the following methods.

Sample preparation: After thawing, the whole sample was homogenized by mixing with an Ultra Turrax. Subsamples were used in the determinations.

Total solids: The total solid content was obtained heating the sample at 100-105°C till constant weight was acquired.

Protein: After determination of Kjeldahl nitrogen, the protein level was obtained multiplying Kjeldahl nitrogen by 6.25.

Fat: After acid hydrolysis the fat was extracted with pentane. The mass of the fat was obtained by evaporation of the pentane.

Ash: The weight of the white residue obtained by destruction of the sample at 500-550°C.

Na, K, Ca, Mg, Fe and Zn: These minerals were determined in the ash solution by Atomic Absorption Spectrophotometry.

Fibre content was analysed in five samples, chosen at random by someone from the Chemical and Physical Research Laboratory. The samples were sent to TNO-Nutrition (Institute for techno-physical investigation) in Zeist, the Netherlands, for fibre determination. Fibre was analysed by enzymatic-gravimetric method following the procedures of analysis of the Association of Official Analytical Chemists (AOAC, 1990). Based on the results, and in relation to the total solid content of the samples, an average estimate was made for the fibre content of all samples.

Total carbohydrates were calculated by subtracting the protein, fat, ash and estimated fibre content of the total solid content.

The energy density was calculated multiplying the protein and total carbohydrate content by 4 kcal or 17 kJ, and the fat content by 9 kcal or 37 kJ.

2.3.4 Calculation of the nutrient content of the food diaries

In total, 54 food diaries of 27 children were collected. However, the nutrient content of only 46 diaries could be calculated. Table 2.7 gives an overview of the diaries used.

The diaries were calculated for energy, protein, fat, carbohydrates, Na, K, Ca, Mg, Fe and Zn. The quantities in household measures recorded by the mother were translated into grammes using the following methods:

Infant and follow-on formulas: The content in grammes of one level scoop of formula powder was provided by the manufacturers.

Table 2.7 Number of food diaries used for analysis of nutrient content

suitable for final analysis	46	accepted
meals not analysed	3	rejected
illness of the infant	1	rejected
incorrect data included	2	rejected
insufficient data	2	rejected
	=====	
total diaries collected	54	collected

Infant cereals: Many mothers used the scoop of the formula for measuring the amount of infant cereal. Whenever possible, this quantity was measured on portable weighing scales when collecting the diaries. In addition, manufacturers provided information on the weight of one tablespoon of cereals. This was helpful when the mother used tablespoons as a measuring unit.

Meals: Various mothers weighed the home-prepared meal on household scales before offering it to their child. Others gave the proportion of the meal in relation to the content of the container provided for the duplicate sample.

Desserts: In all but one case, yoghurt was given as a dessert, if a dessert was given at all. Custard was the other dessert given. All desserts were one portion commercial products of which the content was known.

Fruit purée: The fruit purée was either commercially manufactured or home-made. Commercial products came in jars or as cereals. When the product came in jars, the mother indicated jar-size and the proportion eaten by the child. In case of the cereals, procedures were followed as detailed above for infant cereals.

For the home-made fruit purées, precise descriptions of the ingredients were obtained in the diaries. Weight of the ingredients was estimated using information on typical weight and portion sizes of foods as described by Post (1990) and Thomas (1994).

Other foods: Only four foods mentioned in the food diaries, did not enter one of the previous categories, i.e. a piece of bread, a piece of cake, whiting and egg yolk. The exact weight of the fish was given and the weights of the other three foods were estimated by the investigator by weighing these foods in the measurements given by the mother on portable dietary scales (Soehnle).

Energy and nutrient intake were calculated using the results of the chemical analysis of the home-prepared meals, information on baby foods provided by the manufacturers together with data from *McCance and Widdowson's The composition of foods* (Holland et. al, 1991).

2.4 Data manipulation

At the end of each data collection period, all the data was introduced into a personal computer, using the following programmes: Polo V (Zefra, Madrid), a word processor and data base manager, and Symphony, a spreadsheet manager (Lotus Development Corporation, Cambridge). Both the investigator and competent persons, unrelated to the work, checked the correct input of the data. This was done in stages, because of the vast amount of information. Graphs were prepared with the programme Harvard Graphics (Software Publishing Corporation, Santa Clara).

2.5 Statistical methods

The data was analysed using the analysis of proportions, log-linear models, multiway contingency tables and censored survival data methods (Crowder et. al, 1991). The purpose of multiway contingency table methods is to model and analyse inter-relationships between two or more discrete variables. A particular feature of the data is the presence of censored observations. For example, if a baby at the time of the interview was aged three months and was still being breast-fed, then the age at which breast-feeding ceased is not known exactly but is known to exceed three months. Survival analysis methods allow such censoring to be handled correctly. Non-parametric methods based on the Kaplan-Meier estimator and parametric methods based on the Weibull distribution were used. Statistical analysis was carried out using the computer packages GLIM and S-Plus, and programmes written by Dr. A. Kimber, of the Department of Mathematical & Computing Sciences of the University of Surrey.
Where the distribution of the data was not normal, percentiles were used. Percentiles express what proportion of the population has values less than the one observed. For example, let 33 out of 332 infants receive a follow-on formula for the first time before the age of five months. Then, the 10th percentile, denoted by P10, is equal to, 5.0, i.e. 10% of the study population received follow-on formula by the age of 5.0 months. Sometimes, the percentile

cannot be estimated. To stay with the same example: follow-on formulas are not used by all mothers. If at no moment in time 75% of the mothers uses a follow-on formula, then the 75th percentile or P75 cannot be determined. In that case, an asterisk (*) indicates that neither that percentile, nor any higher percentile, can be estimated.

Feeding habits will be discussed in the following chapters. In chapter three the different types of milk feeding used by the children are detailed.

CHAPTER 3

MILK FEEDING

An account of the use of human milk,
infant formulas, follow-on formulas and cow's milk
in the first year and a half

3.1 Introduction

Milk is the basic food for all infants. After the decline in breast-feeding in the sixties and seventies, more mothers start breast-feeding their babies today (Martínez, 1981; Hitchcock 1981, 1988; Underwood, 1982; Florack, 1984; Persson, 1984c; Whitehead, 1984; Fomon, 1987; Vestermark, 1991).

From human milk most babies change at some time to an infant milk and finally to the "adult" type of milk, cow's milk. A follow-on formula can be used as an intermediate step between the infant formula and cow's milk.

In 1989, there were more than twenty different infant formulas available in Spain from eight companies. These milks were exclusively sold in pharmacies and could be classified into infant formulas and follow-on formulas. Except for some minor deviations, all formulas complied the ESPGAN recommendations for either type of formula (ESPGAN, 1977, 1981, 1990) and were fortified with iron.

The aim of this part of the research was to observe all changes taking place in the milk feeding of children in three different socioeconomic groups in Madrid and to compare current practices with actual infant feeding recommendations.

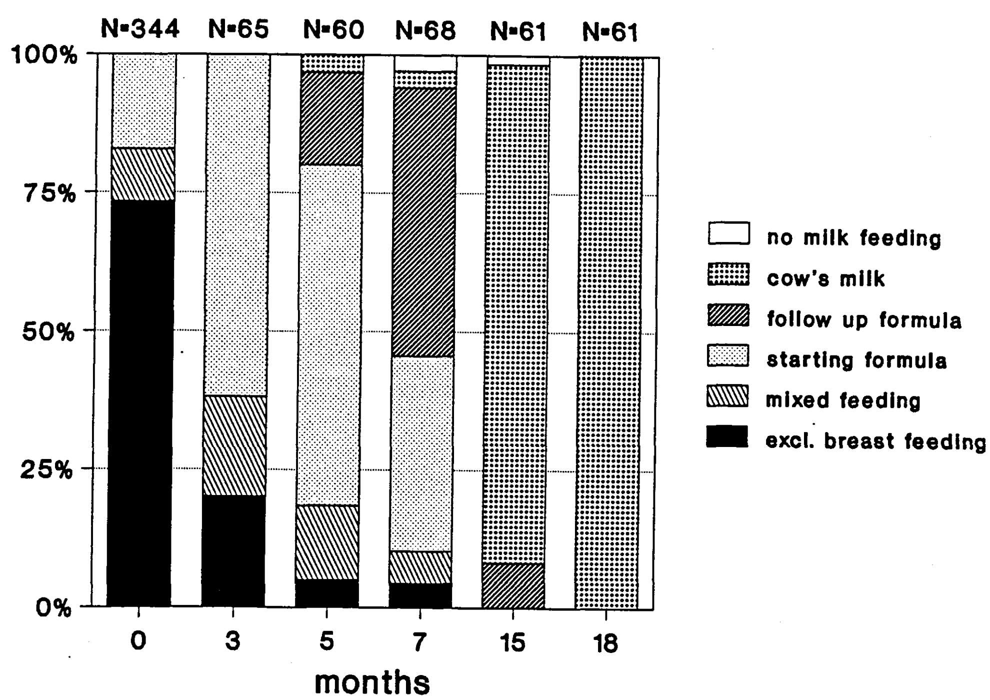
3.2 Methods

Methods are described in detail in chapter two, section 2.2.

3.3 Results

Figure 3.1 gives an overview of different types of milks used by the children. Results are shown for the whole sample at birth and the type of milk that was consumed at that moment for each age-group.

Figure 3.1 Types of milk being used at birth and by each age group.



3.3.1 Breast feeding

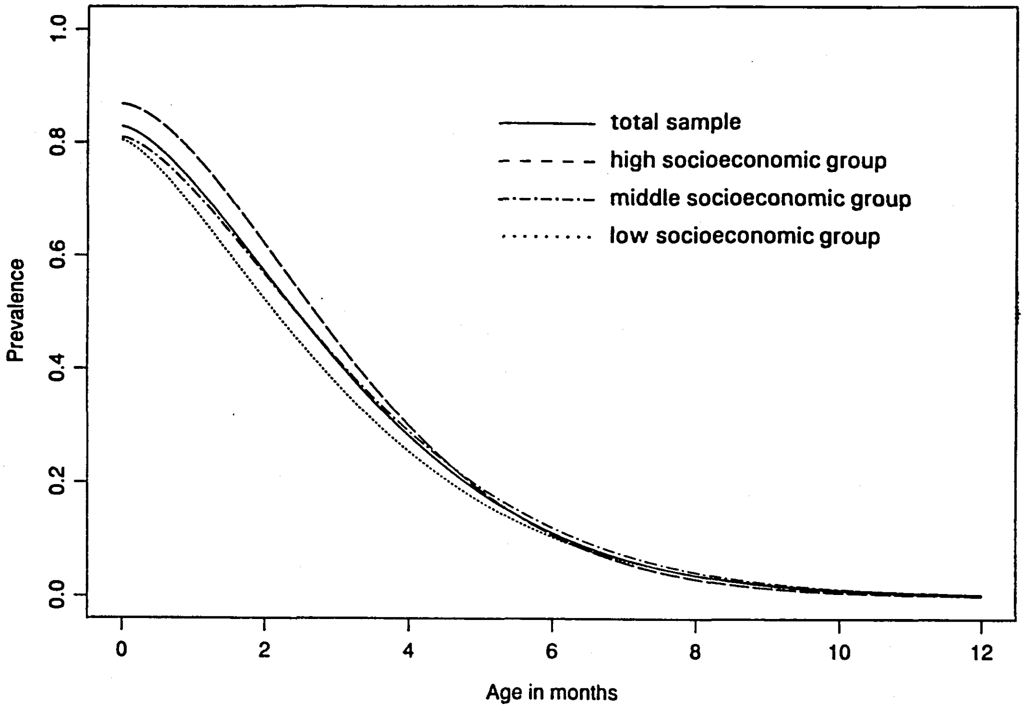
The incidence of breast-feeding was defined as the proportion of babies who were breast-fed initially. In this study in Madrid, 286 of 344 (83%) of the children received breast-feeding from birth (95% confidence limits 79-87%). In 38 cases (11%) breast-feeding was combined with the administration of an infant milk. The other 58 infants were given exclusively formula-feeding. A slightly higher rate of initial breast-feeding was found in the highest socioeconomic group, but the differences were not statistically significant. Prevalence of breast-feeding refers to the proportion of babies still breast-fed at specified ages, even if the infants were also receiving infant formula or solid food. Table 3.1 shows the prevalence of breast-feeding at different ages by socioeconomic group.

Table 3.1 Prevalence in percentages of breast-feeding at the ages of 0, 3, 5 and 7 months by socioeconomic group with the corresponding 95% confidence limits.

age in months	socioeconomic group			total sample
	low	middle	high	
0	80 (73-88)	81 (74-88)	87 (81-93)	83 (79-87)
3	37 (27-52)	42 (32-55)	45 (35-57)	41 (35-49)
5	17 (10-28)	19 (11-32)	19 (12-29)	18 (14-24)
7	6 (1-20)	7 (2-24)	6 (2-16)	7 (3-12)

Although the great majority of mothers started with breast-feeding, this proportion declined rapidly in the first months after birth. Differences were observed between the breast-feeding patterns in the socioeconomic groups, but they were not statistically significant. Figure 3.2 shows prevalence of breast-feeding over time for the whole sample and by socioeconomic group as modelled by the Weibull distribution.

Figure 3.2 Prevalence of breast-feeding over time for the whole sample and for the high, middle and low socioeconomic group as modelled by the Weibull distribution.



Statistical analysis using multiway contingency tables revealed that older mothers did not breast-feed more than younger mothers in the present study. Neither did the age of the mother influence the duration of breast-feeding.

The length of time the mother breast-fed her child, exclusively or not, did not appear to depend on the sex of the child.

3.3.2 Infant and follow-on formulas

The majority of infants changed in the first three months from breast-feeding to an infant formula. Of the three months old children already 77% received an infant milk, 18% in combination with breast-feeding. In the group of children of five months, 17% had already made the change to a follow-on formula. In the seven months group, 48.5% took a follow-on formula. However, other mothers were clearly recommended by their paediatrician to continue using the infant formula.

The lowest observed age for the introduction of a follow-on formula was two and a half months, the highest 12 months. Differences seen between socioeconomic groups for the use of follow-on milks were small and just borderline statistically significant (p=0.05; see table 3.2).

Table 3.2 Age in months at introduction of follow-on formula by socioeconomic group

socioeconomic group	number of babies	percentiles (in months) 10	25	50
all	332	5.0	5.9	8.1
low	103	5.3	6.0	9.1
middle	111	5.0	6.1	*
high	118	4.8	5.8	6.2

* could not be estimated

Looking only at babies of 12 months and older, 74 of 129 infants used or had used a follow-on formula, i.e. 57.4% (95% confidence limits 48.9 - 65.9), suggesting that between about a half and two thirds of the babies received follow-on formula at some stage. In the 15 months age-group still 8% continued taking the follow-on formula.

3.3.3 Cow's milk

The age of 12 months was the moment when cow's milk was most likely to be introduced. About half of the children received cow's milk for the first time in their lives at that moment. At 18 months, all infants had switched to cow's milk, mostly whole cow's milk.

Table 3.3 Proportion in percentages of children in each socioeconomic group, based on the Kaplan-Meier estimator, receiving cow's milk at the ages between six and 15 months with the corresponding 95% confidence limits.

age in months	socioeconomic group: high	middle	low	combined
6	2 (0- 5)	3 (1- 6)	4 (1- 6)	4 (1- 6)
7	7 (1-12)	5 (1- 8)	8 (3-10)	7 (3-10)
8	11 (3-19)	7 (1- 12)	9 (5-13)	9 (5-13)
9	16 (5-25)	9 (2-15)	17 (7-26)	14 (8-19)
10	23 (10-34)	11 (3-19)	24 (11-34)	19 (13-25)
11	32 (17-44)	16 (5-25)	31 (16-42)	26 (18-33)
12	81 (64-90)	78 (62-87)	75 (58-85)	78 (69-84)
13	85 (70-93)	80 (64-89)	84 (75-88)	83 (75-88)
14	88 (72-95)	89 (75-95)	88 (74-95)	88 (81-93)
15	90 (75-96)	93 (80-98)	92 (86-96)	92 (86-96)

Table 3.3 shows the proportion of children in each socioeconomic group, ba-

sed on the Kaplan-Meier estimator, that were receiving cow's milk at the ages between six and 15 months. No statistically significant differences could be observed between socioeconomic groups.

3.3.4 Milk-cereals

Two infants of seven months and one of 15 months did not receive any milk feeding as such. These infants received milk-cereals, that can be defined as mixtures of milk powder, cereals and possibly other ingredients (sugar, dried fruit) to be prepared with water to form a homogenous pap. Milk-cereals should provide the essential nutrients, normally provided by the equivalent amount of milk as water is used for its preparation. Two of the three children received also yoghurt and cream cheese.

3.4 Discussion

3.4.1 Breast-feeding

After the general decline in breast-feeding in the Western world in the sixties and seventies, overall incidence is increasing. In this study, figures coincide with those from the end of the fifties, when about the same number of mothers in Madrid started breast-feeding (Casado de Frías, 1983). However, mothers breast-feed for a shorter period now than before, see figure 3.3. This observation could also be made when comparing the results with recent reports from other European countries. Figure 3.4 shows the prevalence of breast-feeding between birth and nine months in Great Britain (White et al., 1992), Italy (Francescato et al., 1990) and the present study.

Figure 3.3 Proportion of mothers in Madrid breast-feeding their babies in the first two months of life between 1959 and 1989. Data from Casado de Frías (1983) and this study.

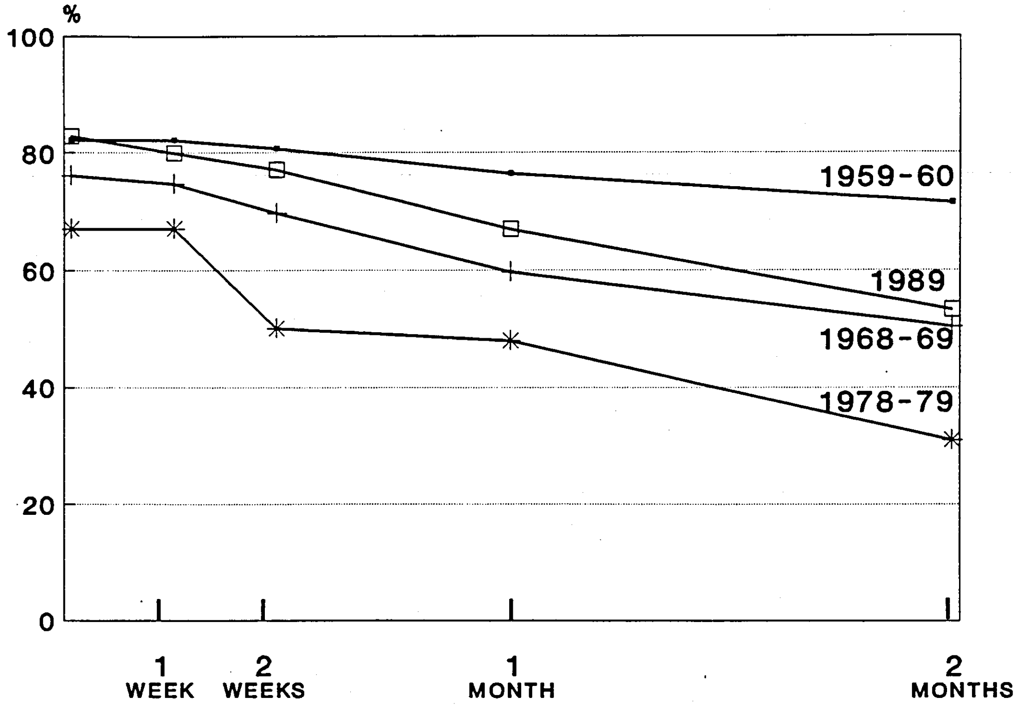
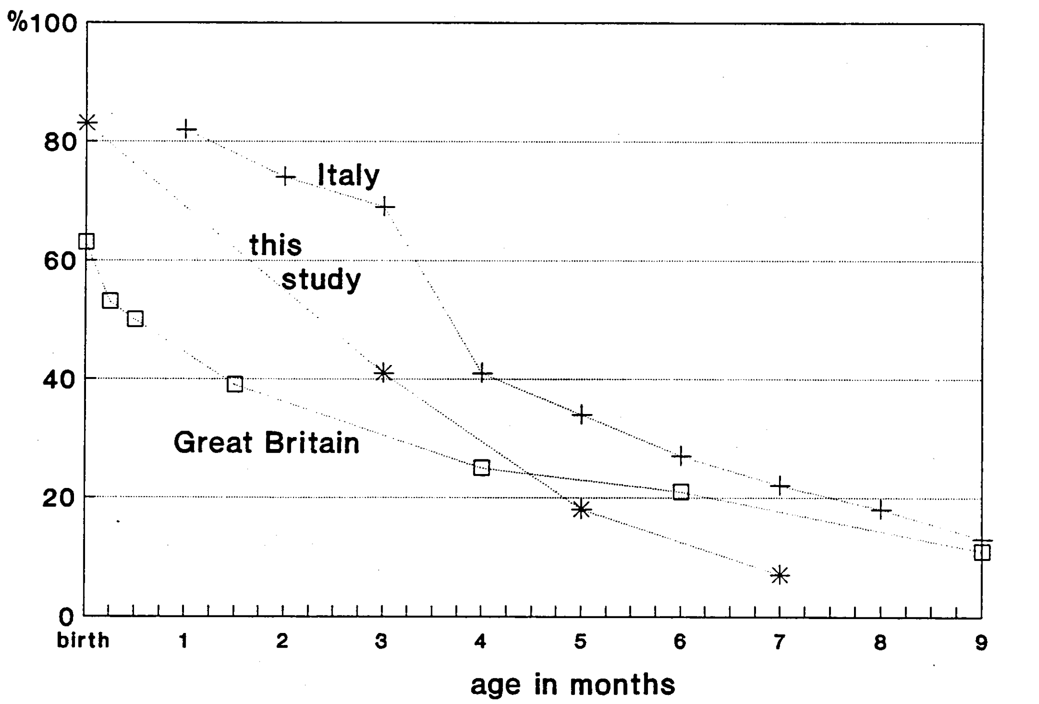
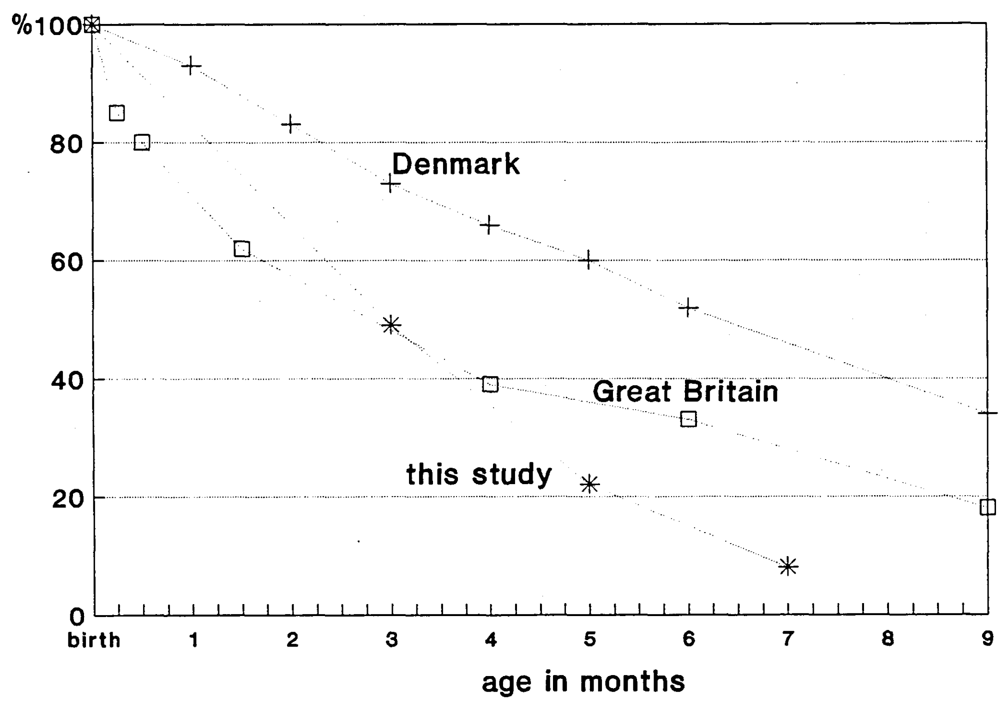


Figure 3.4 Prevalence of breast-feeding in Great Britain (White et al., 1992), Italy (Francescato et al., 1990) and Madrid (the present study).



To visualize better the rate with which breast-feeding declined between birth and nine months, the proportion of infants who were initially breast-fed was set out over time in comparison with data from Great Britain (White et al., 1992) and Denmark (Vestermark et al., 1991), see figure 3.5. The Italian study could not be included in the graph, as Francescato did not provide any information on the incidence of breast-feeding at birth.

Figure 3.5 Prevalence of breast-feeding in Great Britain (White et al., 1992), Denmark (Vestermark et al., 1991) and Madrid (the present study).



Our remarkable finding is the small differences in milk feeding behaviour among the three socioeconomic groups. As described in chapter 1, section 1.2.1, the influence of socioeconomic level on breast-feeding has been investigated in other European countries as well. Generally, fewer subjects of low socioeconomic level have been found to breast-feed and they do so for shorter periods than those of high socioeconomic level.

In the U.K., the social gradient in breast-feeding was apparent as reported by White et al. (1992) in the last British report of the Department of Health "Infant feeding 1990". Considerably less initial breast-feeding could be found in the socioeconomic groups with manual occupation in Great Britain. Comparing the Madrid data with the figures for the region of London and the South

East to diminish the influence of rural areas, the differences are less striking but still important, see table 3.4. Jones (1987) had already observed the same behaviour in the U.K. in a survey of 1,525 mothers.

Table 3.4 Percentage of mothers nursing the first days after birth. In Great Britain, 1990 (White et al., 1992); in London and the South East region, 1990 (calculated from White et al., 1992); in Madrid, 1989 (this study).

socioeconomic group		G.Brit.	London	Madrid
high	I	86	87	87
	II	79	83	
middle	III non-manual	73	80	81
	III manual	59	72	
low	IV and V	52	68	80
all (weighted)		63	74	81

In the Netherlands, in the Leiden Preschool Children Study, breast-feeding was more frequent in mothers with higher education than in mothers with lower education (Florack et al., 1984; Horst et al., 1986). Data were collected in 1980 and in 1982. In 1980 93% and in 1982 96% of the mothers with university education started breast-feeding after birth compared to 60% and 43% respectively of the mothers with primary school education only.

In Sweden, Persson & Samuelson (1984) studied infant feeding patterns in three different towns. They found a higher prevalence of breast-feeding in the university town where parents had a higher education compared with breast-feeding in the other two towns where the socioeconomic level was lower.

In Denmark, Vestermark et al. (1991) noticed in a longitudinal prospective study on the duration of breast-feeding, that duration was longer in well-educated mothers and in mothers from higher social classes.

Also outside Europe, the tendency for mothers of a high socioeconomic level to breast-feed more and longer than mothers of a low socioeconomic level has been noted (Martínez, 1981; Hitchcock, 1988).

The fact that Madrid is different in this respect was also confirmed by Tembouri et al. (1990). They recorded the duration of breast-feeding in a group of 233 infants from a town on the outskirts of Madrid. They found small differences in the duration of breast-feeding between socioeconomic groups that were not statistically significant.

In agreement with studies elsewhere, see chapter 1, section 1.2.1, in the present study the sex of the infant did not make any difference to the mother's initial decision to breast-feed, nor to its duration.

As described in chapter 1, section 1.2.1, many other studies on breast-feeding found an influence of the mother's age on the incidence and duration of breast-feeding. This observation was not made in the present research and reinforces the idea of homogeneity of the sample studied.

3.4.2 Mixed feeding

Mixed feeding was defined as giving a baby both breast-feeding and other foods within 24 hours. Generally the other food was a milk formula, with few exceptions only in the older infant. Mixed feeding was a practice used by 9.4% of the mothers after birth and in the age groups of three, five and seven months, 18%, 13.4% and 5.9% of the children were fed this way respectively. A mixed feeding regime was adopted for several reasons. Firstly, when the mother could not provide sufficient milk for her baby and the formula was used as a supplement to human milk. Furthermore in case the mother was absent at the time of one or more feedings; infant formula substituted her milk at those times. Also mixed feeding was used in the transition period when switching from exclusively breast-feeding to exclusively formula-feeding. Finally, the introduction of weaning foods was necessary in the older infant and solid foods were given besides human milk.

3.4.3 Infant formulas and cow's milk

As commented in chapter 1, section 1.2.5, results of various studies have indicated that unmodified whole cow's milk is unsuitable for children under one year of age (Montalto, 1985; Horst, 1987a; Tunnessen, 1987; Lönnerdal, 1990; Oski, 1990; Lozoff, 1991). Authorities in the area of infant nutrition have expressed the recommendation that breast- or iron-fortified formula-feeding be continued until at least the end of the first year, thus delaying the introduction of cow's milk (DHSS, 1988; ESPGAN, 1990; Fomon, 1990; Wharton, 1990; Study Group Infant Nutrition, 1991; AAP, 1992).

Leading Spanish paediatricians recommended already in the eighties that the introduction of cow's milk should be delayed until the baby's first birthday (Tormo, 1983; Herrero, 1983) and continue to do so (Polanco, 1990; Hernández, 1993). The results found in this survey reflect theseguidelines, although still more than a quarter of the mothers started giving cow's milk to their child before the end of the first year.

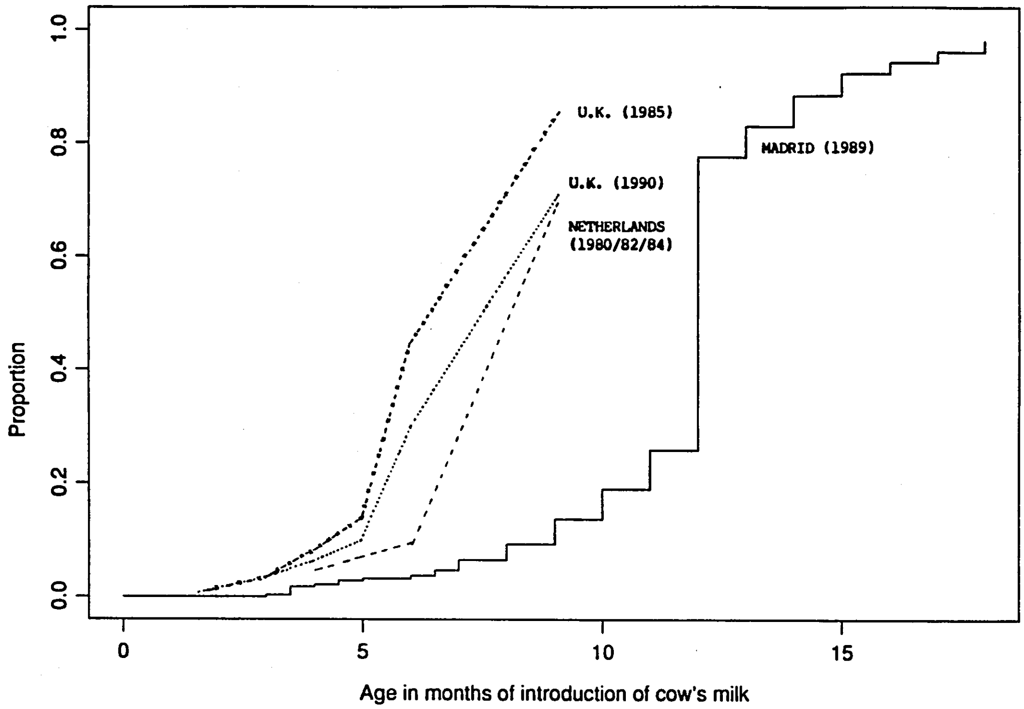
In other European countries, cow's milk is still introduced earlier than desired into the infant's diet, although a delay in the introduction can be observed. White et al. (1992) noticed in Great Britain that mothers started later with cow's milk in 1990 compared to 1985, see table 3.5.

Table 3.5 Proportion of mothers who had introduced liquid cow's milk into their baby's diet in 1985 and in 1990, according to the age of the baby.

Age of the baby	1985	1990
before 6 weeks	1	1
before 3 months	3	3
before 4 months	9	7
before 5 months	16	11
before 6 months	45	30
before 9 months	84	71

Figure 3.6 shows the age of introduction of cow's milk into the infant's diet in Madrid compared with observations from Great Britain from 1985 (Martin & White, 1988) and 1990 (White et al., 1992) as well as from the Netherlands (Horst et al., 1987). It is possible, though, that today's introduction of cow's milk in the Netherlands takes place at a later date than shown, as the data were collected at an earlier time than the Madrid data. No follow-on formula was available at the time of the Leiden Preschool Children Study. In 1987 the first follow-on formula appeared on the Dutch market. In the latest revision of the official Dutch guidelines for infant feeding (Study Group Infant Nutrition, 1991), follow-on formulas are mentioned for the first time and are given preference over the use of cow's milk in children between six and 12 months of age.

Figure 3.6 Age of the children at introduction of cow's milk into their diet in Great Britain in 1985 (Martin & White, 1988) and 1990 (White et al., 1992), the Netherlands (Horst et al., 1987) and the present study.



The Committee on Nutrition of ESPGAN (ESPGAN, 1990) stressed that starting infant formulas can satisfactorily be used between 6 and 12 months of age, provided that the formula is fortified with iron. However, since cow's milk is cheaper than such formula, it is often introduced early into the infant's diet. A follow-on formula may be a good alternative. Wharton (1990) extends his recommendation for the use of follow-on formulas to the age of two years while ESPGAN mentions the age of three years. Afterwards semi-skimmed or whole cow's milk can satisfactorily substitute these formulas. The ESPGAN Committee mentioned in its report of 1990 that in European countries 40% of the babies by 6 months and 75% by 9 months of age were being fed cow's milk. The latest figures of Great Britain showed already a small decrease in this number of infants, as shown before (White et al., 1992). Kjaernes et al. (1988) commented that in Norway in a longitudinal, prospective study on infant feeding, cow's milk was introduced from the age of six months onwards and that by the age of ten months all infants received cow's milk and no formula. The Madrid sample complied in this aspect better with actual recommendations.

3.4.4 Other observations

Three special observations were made. First of all, several mothers commented that they had applied the following scheme to introduce cow's milk to their babies. They started with skimmed milk. Once the baby showed good tolerance to skimmed milk, they passed on to the semi-skimmed milk. Once tolerance to semi-skimmed milk was established, they made the final change to whole milk. Mothers assumed that skimmed milk was the easiest tolerated type of milk because of its low fat content. They were apparently unaware of the fact that infant formulas generally contain even more fat than whole cow's milk and that skimmed and semi-skimmed milk are unsuitable for infants and young children. Paediatricians should provide this information to the mother.

Secondly, about half of the children younger than one year who were taking cow's milk at the time of the interview, did not receive any vitamin supplementation. Of all infants under twelve months of age, 83% received some vitamin supplementation. It was remarkable that half of the infants who most needed it, those taking cow's milk before the age of 1 year, were not supplemented with vitamins.

Thirdly, several children of the 15 and 18 months group drank large quantities of milk. Although no quantification was done in the study, in some cases the mother affirmed that the child took about one and a half litres of milk per day.

3.5 Conclusions

More than 80% of the mothers in Madrid breast-fed their child from birth, but the rate of breast-feeding declined rapidly over time. Although the incidence of breast-feeding compared favourable to figures from other European countries, duration of breast-feeding was shorter in the present study than observed elsewhere. Any promotional activity for breast-feeding in Madrid should thus not be focussed on the initiation of breast-feeding but on the continuation of breast-feeding for a longer period.

After cessation of breast-feeding, infant formulas were used in the first months of life. From about four months onwards follow-on formulas were introduced. Between a half and two thirds of the children took a follow-on milk at some stage.

Finally the step to cow's milk was made. More than a quarter of the children received cow's milk earlier than recommended, i.e. before the end of the first year. Notwithstanding, these figures compared favourable to practices elsewhere in Europe. By the age of 18 months, all children drank cow's milk. Introduction of cow's milk may be further delayed as suggested in recent years by authorities in the area of infant feeding.

Our most remarkable observation was the homogeneity of the sample in feeding behaviour. Although differences were seen between socioeconomic groups with respect to breast-feeding, the use of follow-on formulas and the introduction of cow's milk, none of them were statistically significant.

Milk feeding will at some time be complemented with other foods. In chapter four, feeding practices will be discussed in relation to the introduction and use of the complementary foods.

CHAPTER 4

WEANING PRACTICES

A report on when, how, and with which foods,
mothers accustom their babies to sundry and solid nourishment

4.1 Introduction

The introduction of complementary foods is an important phase in the infant's life for both the child and the mother. For the infant, as he has to make the transition from liquid to solid foods, and from suckling to eating with a spoon. For the mother, as her baby makes his very first steps to independency.

In chapter 1, section 1.2.3, ten guidelines for the introduction of weaning foods have been formulated based on the recommendations from various national and international paediatric advisory groups.

The aim of the present study was to observe how mothers in three different socioeconomic groups in Madrid carried out the process of introducing complementary foods into their baby's diet and to compare thesepractices with theseten guidelines.

4.2 Methods

Methods have been described in detail in chapter two, section 2.2.

4.3 Results

4.3.1 Age at introduction of the first weaning food

The age at which complementary food was introduced into the infant's diet ranged from a minimum of one month to a maximum of eight months. The two infants who received solids at the age of one month, were both taking formula after having had two three weeks of breast-feeding respectively. The one infant who did not receive weaning foods until the age of eight months, was exclusively breast-fed until that age. Half of the mothers had already introduced a complementary food at the age of 4,2 months. A few mothers who had started giving solid foods to their infants at an early time on their own initiative, were convinced by their paediatrician to delay the introduction.

Table 4.1 presents the age of introduction of weaning foods by socioeconomic group. Although mothers in the high socioeconomic group started somewhat later with the administration of complementary foods to their babies, this difference was not statistically significant. Five mothers could not remember when they started for the first time with weaning foods.

Table 4.1 Age in months at introduction of weaning foods by socioeconomic group

socioeconomic	number of			percentiles (in months)		
group	babies	10	25	50	75	90
all	339	2.9	3.3	4.2	5.1	6.0
low	105	2.4	3.1	4.1	5.0	5.9
middle	114	2.9	3.2	4.2	5.1	6.0
high	120	2.9	3.8	4.6	5.2	6.0

No relationship could be found between the moment of introduction of weaning foods and the sex of the child; no statistically significant relationship between birth weight of the baby and the time of introducing complementary foods was apparent.

Mothers were classified into four age-groups, which had approximately one quarter of the mothers in each category, i.e. those with ages up to 27 years, from 28 to 30 years, from 31 to 34 years and over 34 years. As the final two age-groups seemed to behave similarly, they were combined. Statistically, the mother's age was highly significantly related to the time of introducing complementary foods ($p=0.007$), as younger mothers were more likely to start with solids earlier than older mothers, see table 4.2.

Table 4.2 Age in months at introduction of weaning foods by mother's age

mother's age	number of babies	percentiles (in months) 10	25	50	75	90
≤ 27 years	98	2.7	3.1	3.9	4.9	5.7
28 to 30 years	81	3.0	3.3	4.2	5.5	6.1
≥ 31 years	158	2.9	3.8	4.4	5.2	6.0

Finally, a possible relationship between the method of feeding, breast or bottle, and the moment of starting weaning was examined. At three months, the proportion of babies given solids was significantly less ($p=0.002$) for mothers still breast-feeding than those not breast-feeding. In this subdivision no influence of socioeconomic group was observed, see table 4.3.

Table 4.3 Proportion of babies who had started weaning at three months of age, classified by method of feeding and socioeconomic group

socioeconomic group	type of feeding	number of babies	started weaning
low	breast	32	6 (19%)
	formula	73	24 (33%)
middle	breast	40	6 (15%)
	formula	74	24 (32%)
high	breast	48	6 (13%)
	formula	71	17 (24%)

Table 4.4 Median age in months for the introduction of certain foods

food	age in months
gluten-free milk-free cereals	5.2
fresh fruit	5.8
vegetables	6.1
meat	6.2
biscuits	7.4
bread	7.8
fish	7.9
fruit juice	7.9
gluten-containing milk-free cereals	8.2
yoghurt	8.2
cream cheese	9.3
pulses	12.1
pasta	>18.5

4.3.2 Order of introduction of complementary foods

The order in which the various foods were introduced into the infant's diet was similar in all socioeconomic groups. Table 4.4 shows the median age in months at which certain foods were introduced. Some foods are not mentioned as at no moment in time 50% of the children were given that food.

All types of foods will be now discussed one by one.

Cereals. In Spain, infant cereals can be classified into four categories: cereals based on gluten-free or gluten-containing varieties, and cereals with or without milk powder added. The cereals without milk powder are recommended to be prepared with infant formula, follow-on formula or cow's milk depending on the age of the child, whilst those with milk powder included are to be prepared with water. Almost all infant cereals in Spain had sugar added at the time of the study and still have, although the quantity has been reduced in some varieties.

The most popular complementary food to be introduced first into the baby's diet were infant cereals. The vast majority of mothers started with cereals based on gluten-free varieties such as corn and rice. At a later stage gluten-containing cereals like wheat were introduced. Mothers showed preference for the milk-free cereals.

Gluten-free milk-free cereals. The lowest observed age of introduction was one and a half months, and the highest nine months. Not all infants received gluten-free milk-free cereals. Some received the milk-containing variety, others started immediately with gluten-containing cereals. The 90th percentile was therefore never reached and has not been included in table 4.5. Eight mothers could not remember whether or when they introduced gluten-free milk-free cereals.

Table 4.5 Age in months at introduction of gluten-free, milk-free cereals by socioeconomic group

socioeconomic group	number of babies	percentiles (in months) 10	25	50	75
all	337	3.2	4.1	5.2	> 9.5
low	104	3.1	4.0	5.1	> 7.5
middle	113	3.1	4.0	5.5	> 7.5
high	120	3.8	4.2	5.2	6.2

Gluten-free milk-containing cereals. The lowest observed age of introduction was three months, the highest eight months. This type of cereals was prepared with water. Some breast-feeding mothers mentioned this as an advantage, but use among breast-feeding mothers was not higher than among formula-feeding mothers. Only a minority of children received this type of cereals. Mothers from the high socioeconomic group used this type of cereals less frequently than the rest but the difference was not statistically significant. Only the P10 can be given, as the P25 was never reached, see table 4.6.

Table 4.6 Age in months at introduction of gluten-free milk-containing cereals by socioeconomic group

socioeconomic group	number of babies	percentile (in months) 10
all	341	5.2
low	105	4.1
middle	115	4.7
high	121	> 8.5

Gluten-containing milk-free cereals. Mothers informed that they prepared this type of cereals correctly with milk, which could be an infant formula, follow-on formula or cow's milk depending on the age of the child. Most mothers who started with a gluten-free milk-free variety continued later with this type of cereals. Again not all children received these cereals and the P90 could therefore not be estimated, see table 4.7. The lowest observed age of introduction was one month, the highest 12 months. There were 15 missing values, i.e. mothers who did not remember whether or when they introduced gluten-containing, milk-free cereals.

Table 4.7 Age in months at introduction of gluten-containing, milk-free cereals by socioeconomic group

socioeconomic	number of	percentiles (in months)				
group	babies	10	25	50	75	90
all	329	5.2	6.8	8.2	>15.5	>18.5*
low	104	5.2	6.8	8.1	>15.5	>15.5*
middle	109	5.0	6.2	8.7	>15.5	>18.5*
high	116	5.8	6.9	8.5	12.0	>18.5*

* could not be estimated

Gluten-containing milk-containing cereals. This type of cereals was reported to be prepared correctly by the majority of mothers with water. Some mothers, however, said they prepared these cereals with formula or milk, doubling in that way the protein content of the dish. The lowest observed age of introduction was one month, the highest 14 months. Again, only a minority of mothers used this type of cereals, although more than the milk-containing gluten-free variety. Only the P10 and P25 could be estimated, see table 4.8.

Table 4.8 Age in months at introduction of gluten-containing, milk-containing cereals by socioeconomic group

socioeconomic group	number of babies	percentiles (in months) 10	25
all	334	5.9	8.0
low	104	6.1	>7.5
middle	110	5.8	7.0
high	120	6.0	9.4

Fruit cereals. Fruit-cereals are a mixture of cereals with fruit flakes and flavours added. Their use was not very extensive, but still the P10 could be estimated, see table 4.9. The lowest observed age of introduction was three and a half months, the highest eight months. Fruit-cereals were generally taken instead of fresh fruit.

Table 4.9 Age in months at introduction of fruit-cereals by socioeconomic group

socioeconomic group	number of babies	percentile (in months) 10
all	343	6.9
low	106	5.9
middle	115	6.1
high	122	*

* could not be estimated

Fruit juice. Fruit juice refers mainly to fresh orange juice, as in Spain the use of commercial baby fruit juices is very limited and no concentrated drinks or herbal baby drinks based on fruit juice were available at the time of the research. Chapter five describes in detail the use of herbal drinks for the infants in the study. The use of fruit juice was mainly reported in the younger infant, where fresh orange juice diluted with water was commonly given for its laxative effect. In the older infant, mothers did not mention the use of fruit juice separately, but included it in the use of "fresh fruit". A statistically significant difference in introduction of fruit juice could be observed, where the lowest socioeconomic group introduced later than the other two groups ($p=0.01$). The lowest observed age of introduction was before the age of one month and the highest seven months. There were five missing values, see table 4.10.

Table 4.10 Age in months at introduction of fruit juice by socioeconomic group

socioeconomic	number of	percentiles (in months)	
groups	babies	10	25
all	339	2.8	6.1
low	106	3.9	*
middle	113	2.0	4.0
high	120	2.8	*

* could not be estimated

Fresh fruit. The lowest observed age of introduction of fresh fruit was three months, the highest ten months. Three babies had not had fresh fruit by the age of 15 months, and one by 18 months. There were seven missing values, see table 4.11.

Table 4.11 Age in months at introduction of fresh fruit by socioeconomic group

socioeconomic	number of	percentiles (in months)				
group	babies	10	25	50	75	90
all	337	3.9	4.8	5.8	6.2	7.5
low	104	3.5	4.8	5.8	6.2	8.3
middle	113	3.6	4.5	5.5	6.3	7.2
high	120	3.9	4.9	5.8	6.1	7.1

Fresh fruit was used in the younger infant to prepare fruit purées. Mothers used different additions to diminish the acidity of the purée and to improve its acceptance by the baby. The use of biscuits, cereals, sweetened condensed milk, infant formula, cow's milk, sugar, saccharine and honey in the preparation of home-made fruit purées was recorded. Table 4.12 shows the number of infants who were taking home-made fruit purées at the time of the interview and the additions used in the purées. Some mothers used more than one addition at one time. The use of sugar will be discussed separately in section 4.3.2.

Table 4.12 Additions used to improve the taste of 170 home-made fruit purées

▪ biscuits	89	(52%)
▪ infant cereals	18	(11%)
▪ condensed milk	19	(11%)
▪ infant or follow-on formula	10	(6%)
▪ cow's milk	3	(2%)
▪ honey	21	(12%)
▪ saccharine	2	(1%)

Biscuits. The use of biscuits was very common. Although at the time of the present study commercial baby biscuits were available in Spain, their use was not very extensive. No baby rusks were sold in Spain. The most popular type of biscuit given to the babies was the so-called "María"-biscuit, an ordinary dry biscuit. This biscuit was often added to the home-made fruit purée. The lowest observed age of introduction was two months, the highest 18 months. Three babies had not had biscuits by the age of 18 months. Although mothers in the low socioeconomic group started with biscuits earlier than mothers of the other two socioeconomic groups, the difference was not statistically significant. There were 16 missing values, see table 4.13.

Table 4.13 Age in months at introduction of biscuits by socioeconomic group

socioeconomic group	number of babies	percentiles (in months) 10	25	50	75	90
all	328	4.8	5.9	7.4	10.1	12.0
low	103	4.0	5.5	6.6	8.8	11.1
middle	110	4.8	6.0	7.5	11.2	11.9
high	115	5.0	6.0	7.5	10.9	12.5

Bread. Bread was introduced somewhat later than biscuits. The lowest observed age of introduction was two months, the highest 14 months. Eleven babies had not had bread by the age of 15 months. There were 19 missing values. The introduction of bread was statistically significantly earlier in the low socioeconomic group ($p=0.01$) than in the middle and high socioeconomic groups, see table 4.14.

Yoghurt. Yoghurt and cream cheese were favourite foods for the baby's afternoon snack in the second half of the first year. The lowest observed age of introduction of yoghurt was three months, the highest 17 months. One baby had not had yoghurt by the age of 18 months. There were eight missing values, see table 4.15.

Table 4.14 Age in months at introduction of bread by socioeconomic group

socioeconomic group	number of babies	percentiles (in months) 10	25	50	75	90
all	325	5.3	6.0	7.8	11.3	>14.5*
low	103	4.4	5.9	6.8	8.6	10.9
middle	108	5.8	6.1	8.8	11.4	12.1
high	114	5.8	6.2	7.9	11.9	>14.5*

* could not be estimated

Table 4.15 Age in months at introduction of yoghurt by socioeconomic group

socioeconomic group	number of babies	percentiles (in months) 10	25	50	75	90
all	336	5.8	6.9	8.2	10.2	12.2
low	105	5.2	6.7	7.8	9.4	12.1
middle	114	5.2	6.4	8.1	10.3	12.0
high	117	6.1	7.3	8.9	10.6	12.3

Cream cheese. Most cream cheese given to the babies was fruit-flavoured cream cheese. The lowest observed age of introduction was three months, the highest 17 months. There were seven infants aged 15 months and five aged 18 months who had not had cream cheese at that time. There were nine missing values. The mothers of the high socioeconomic group introduced cream cheese significantly later ($p=0.04$) than mothers of the other two socioeconomic groups, see table 4.16.

Table 4.16 Age in months at introduction of cream cheese by socioeconomic group

socioeconomic group	number of babies	percentiles (in months) 10	25	50	75	90
all	335	6.0	7.8	9.3	12.0	17.3
low	105	5.2	7.0	8.9	12.0	16.9
middle	113	6.1	7.3	9.3	11.4	12.4
high	117	6.5	8.0	9.8	12.4	>14.5*

* could not be estimated

Vegetables. At the age of nine months, all infants received puréed vegetables. Chapter 7 describes in more detail the types of vegetables that are used in home-prepared meals. The lowest observed age of introduction was three months, the highest nine months. The majority started to take vegetables between the ages of five and a half and seven months, see table 4.17.

Table 4.17 Age in months at introduction of vegetables by socioeconomic group

socioeconomic group	number of babies	percentiles (in months) 10	25	50	75	90
all	336	4.9	5.6	6.1	6.9	7.9
low	103	4.8	5.3	6.0	6.5	7.9
middle	113	4.9	5.5	6.0	6.9	8.0
high	120	4.9	5.8	6.2	6.9	7.8

Pulses. Pulses were started with very late by the mothers in Madrid, or were not even introduced by the age of 18 months. The lowest observed age of introduction was four and a half months, see table 4.18.

Table 4.18 Age in months at introduction of pulses by socioeconomic group

socioeconomic group	number of babies	percentiles (in months) 10	25	50	75	90
all	335	9.4	11.6	12.1	13.3	>18.5*
low	103	9.6	11.6	12.0	12.5	16.6
middle	113	9.5	11.7	12.1	12.4	>18.5*
high	120	9.1	11.5	12.3	14.9	>18.5*

* could not be estimated

Pasta. Pasta was generally introduced very late into the infant's diet, i.e. after the age of one year. The lowest observed age of introduction was seven and a half months. At the age of 18 months, there were still a number of infants who had never had this food. The figures for the P50 and higher could therefore not be estimated, see table 4.19.

Table 4.19 Age in months at introduction of pastas by socioeconomic group

socioeconomic group	number of babies	percentiles (in months) 10	25	50
all	342	11.7	14.3	>18.5*
low	106	9.9	12.0	>18.5*
middle	115	12.2	17.8	>18.5*
high	121	11.8	14.6	>18.5*

* could not be estimated

Meat. At the age of ten months, all infants took meat. Veal and chicken were mostly used as the first meat varieties, other types of meat followed later. The lowest observed age of introduction was three months, the highest ten months. Most infants started to eat meat for the first time between the ages of six and seven months, see table 4.20.

Table 4.20 Age in months at introduction of meat by socioeconomic group

socioeconomic group	number of babies	percentiles (in months) 10	25	50	75	90
all	334	5.1	5.8	6.2	7.1	8.2
low	103	5.0	5.8	6.1	7.1	8.3
middle	112	5.0	5.8	6.2	7.1	8.1
high	119	5.2	5.9	6.4	7.1	8.2

Fish. The lowest observed age of introduction was three months, the highest twelve months. There were 10 missing values, see table 4.21.

Table 4.21 Age in months at introduction of fish by socioeconomic group

socioeconomic group	number of babies	percentiles (in months) 10	25	50	75	90
all	334	5.8	6.8	7.9	9.1	10.2
low	103	5.8	6.1	7.8	9.5	11.6
middle	112	5.9	6.9	7.9	8.8	10.0
high	119	5.8	6.8	7.8	9.1	10.5

Egg. Egg was introduced in two phases by 24% of the mothers: first the yolk and one or more months later the white. The lowest observed age of introduction for egg yolk was four months, the highest 13. Table 4.22 gives an overview of the moment of introduction of the egg yolk. For those mothers who introduced the whole egg at one time, the moment of introducing the yolk was the same as introducing whole egg. There were eleven missing values.

Table 4.22 Age in months at introduction of egg yolk by socioeconomic group

socioeconomic group	number of babies	percentiles (in months) 10	25	50	75	90
all	333	6.9	8.0	9.8	11.7	12.6
low	103	7.8	8.1	11.0	12.1	12.7
middle	113	6.8	7.9	9.0	10.7	12.0
high	117	6.8	7.8	9.8	11.8	13.4

The lowest observed age of introduction for whole egg was four months, the highest 16 months. Table 4.23 gives an overview of the moment of introduction of whole egg. There were eleven missing values.

Table 4.23 Age in months at introduction of whole egg by socioeconomic group

socioeconomic group	number of babies	10	25	50	75	90
		percentiles (in months)				
all	333	8.0	10.1	11.8	12.4	14.2
low	103	7.9	9.2	11.8	12.4	14.0
middle	113	8.6	10.9	11.9	12.4	14.4
high	117	8.3	10.7	11.7	12.4	14.0

4.3.3 Cultural practices related to the introduction of complementary foods

Salt. The majority of the mothers added salt to the meals they prepared for their babies. Table 4.24 gives an overview of the number of mothers in each socioeconomic group adding salt to the meals. Data from all mothers who had introduced any food item to which salt could be added were analysed.

Table 4.24 Addition of salt to foods consumed

socioeconomic group	basis*	% of total group	mothers adding salt	% of mothers adding salt
low	68	64%	50	74%
middle	74	64%	51	69%
high	77	63%	48	62%
total	219	64%	149	68%

* all babies receiving foods to which salt could be added

Although a decrease in the use of salt could be noted along the socioeconomic groups from the lower to the higher group, the differences were not statistically significant.

Sugar. Only a minority of the mothers added sugar to their baby's meals. The use of sweetened baby foods was, however, more common. Table 4.25 gives an overview of the number of mothers in each socioeconomic group adding sugar to the meals, using sweetened foods or adding honey to the meals. Data from all mothers who had introduced any food item to which sugar could be added were analysed.

Table 4.25 Use of sugar and honey in foods consumed

socioeconomic group	basis*	% of total group	mothers adding sugar		mothers using sweetened foods		mothers adding honey	
low	91	85%	25	28%	64	70%	12	13%
middle	98	85%	16	16%	59	60%	13	13%
high	102	84%	14	14%	84	82%	8	8%
total	291	85%	55	19%	207	71%	33	11%

* all babies receiving foods to which sugar could be added

Significantly more mothers in the low socioeconomic group added sugar to their baby's food than mothers from the middle and high socioeconomic group ($p<0.04$). There was a significant difference between the groups ($p<0.003$) in the use of sweetened foods, their use being highest in the high socioeconomic group and lowest in the middle socioeconomic group. No difference could be observed for the addition of honey to the infant's foods.

Artificial sweeteners. At the time of the interview ten of the 344 mothers (3%) used artificial sweeteners, most of the time saccharine, in the infant's diet. Table 4.26 shows by whom artificial sweeteners were used and to which foods they were added.

Table 4.26 Use of artificial sweeteners by age of the child, socioeconomic group and type of food to which they were added

Age in months	socioeconomic group	type of food
5	middle	herbal drink
8	high	herbal drink
10	high	yoghurt
15	low	herbal drink
15	low	water
15	middle	fruit purée
15	high	yoghurt
18	high	yoghurt
18	high	yoghurt
19	high	fruit purée

Simultaneous use of gluten-free and gluten-containing foods. In this study 186 mothers gave gluten-free cereals to their child before the age of six months. At the same time, 54 of them (29%) gave gluten-containing bread or biscuits. Mothers in the low socioeconomic group made this mistake significantly more ($P<0.01$) than mothers in the middle and high socioeconomic group, see table 4.27.

Baby jars. In Spain, basically two types of commercial baby jars were available at the time of the study: whole meals and fruit varieties. The use of the products was mostly limited to the weekends and holidays. Only a minority of mothers gave jars on a daily basis to their babies. Table 4.28 shows the use of baby jars by the different age-groups.

Table 4.27 Simultaneous use of gluten-free cereals and bread or biscuits by infants under six months of age.

socioeconomic group	gluten-free cereals < 6 months	gluten-free cereals plus bread or biscuits < 6 months	
low	57	24	42%
middle	61	14	23%
high	68	16	24%
TOTAL	186	54	29%

Table 4.28 Use of baby jars by age-group

Age in months	Number of babies	Used baby jars
3	64	1 (2%)
5	60	6 (10%)
7	68	26 (38%)
15	60	36 (60%)
18	61	36 (59%)

Usage of baby jars increased steadily with age until it reached a plateau sometime between eight and 15 months. Looking at all babies of 15 months and older, then 80 out of 131, 61.1% (95% confidence limits 52.8 - 69.4) had received baby jars at some time. There was no difference between socioeconomic groups.

4.4 Discussion

The results of the present research will be compared with the guidelines formulated by international and national paediatric advisory groups, and by leading Spanish paediatricians as summarized in chapter 1, section 1.2.3, and where possible, with other studies on the introduction of weaning foods, particularly the surveys carried out in the U.K. in 1986 by the Ministry of Agriculture, Fisheries and Food (Mills and Tyler, 1992) and in 1990 by the Social Survey Division of the Office of Population Censuses and Surveys on behalf of the Department of Health and the Scottish Home and Health Department (White et al., 1992).

Introduction of weaning foods

Complementary feeding was generally started earlier than is thought desirable. Half of the mothers in this study had already introduced one or more weaning foods at the age of 4.2 months. The situation in the U.K., however, looks even more unsatisfactory, as in the 1990 survey 94% of the babies had been given solid foods by 4 months of age (White et al., 1992).

The feeding method in the first months, i.e. breast-feeding or formula-feeding appeared to be an influencing factor in the timing of the introduction of solid foods with breast-feeding mothers starting complementary feeding later than formula-feeding mothers. These findings are in agreement with those from Yeung et al. (1979) in Canada, from Hitchcock and Coy (1988) in Australia and White et al. (1992) in the U.K.

Contrary to the observation of Hoffmans et al. (1986) in the Netherlands, who saw that children of less well-educated mothers appeared to derive less energy from solids at the age of 4 months than children from educated mothers, and to the findings of White et al. (1992) in the U.K., where the age at introduction of solid foods was strongly related to social class as defined by the current or most recent occupation of the husband or partner, only a trend was noticed in the Madrid sample that was not statistically significant for mothers from the high socioeconomic group to start somewhat later with complementary foods than mothers from the middle and low socioeconomic group.

White et al. (1992) in the U.K. looked at a possible influence of birth weight and noticed that, before the age of four months, mothers of higher birth weight babies tended to introduce solid foods earlier than mothers from lower birth weight babies. Beyond the age of four months, birth weight had little effect on the introduction of complementary foods. No relationship could be found in this study. Neither was any influence observed of the sex of the child; nor did Mills and Tyler (1992) in the U.K.

None of the other studies on weaning practices described in this thesis have reported the observation that the mother's age is significant for the timing of the first weaning food. Only Quandt (1984) mentioned that she observed no relation between the timing of the introduction of solids and the age of the mother.

Foods should be introduced as single ingredient foods

The objective of the recommendation to introduce foods as single ingredient foods is to be able to establish possible intolerances to certain foods by the infant. In practice, however, this guideline is hardly followed. Single ingredient baby cereals, such as instant rice flour, or single ingredient baby jars, such as carrot purée, are not available in Spain. Commercial infant foods, both cereals and jars, are mainly multi-ingredient products. Gluten-free milk-free infant cereals, for instance, intended for the initial phase of weaning may contain up to ten different ingredients. Manufacturers of Spanish baby foods could contribute their part by reducing the number of ingredients used in their products, particularly in those advised for the initial phase of weaning.

Foods should be introduced one by one

The guideline to introduce foods one by one was also neglected. Particularly when starting with the first savoury meals, different vegetables and often also meat, were introduced at the same time. The same held true for the introduction of fruit purée, where different fruits were used at the time.

Sequence of food introduction

There is no need to specify the order in which foods should be introduced into the infant's diet. ESPGAN (1982) added that national habits and economic factors should be taken into consideration. In Madrid, as in Canada and the U.K, cereals were the first solids given to most babies (Yeung et al., 1979; Mills and Tyler, 1992). It was remarkable to notice that some foods, particularly pulses and pasta were introduced very late by the mothers in Madrid, or were not even started with by the age of 18 months. Nutritionally, no reason can justify this attitude, although the Spanish paediatrician Polanco (1990) does not recommend the introduction of pulses until the age of 18 to 24 months. Probably, tradition dictates the late introduction of thesefoods.

No gluten in the first months

Most mothers in Madrid were aware that gluten is an undesirable component in the young baby's diet. The majority started therefore with gluten-free varieties when starting with cereals. Mothers, however, ignore the nature of gluten. It happened that, while using special infant cereals without gluten, they simultaneously gave bread and biscuits to their babies. Mothers from the middle and high socioeconomic group made this mistake significantly less. In Sweden, Persson and Samuelson (1984c) observed, that mothers characterized by high socioeconomic group or by higher education were more prone to avoid gluten-containing foods before the age of five months than less well-educated mothers. The study from White et al. (1992) in the U.K. did not specify the use of gluten-containing foods in the first half year. They reported, however, that in 1990 only 9% of the mothers of babies aged four and five months took the gluten content into account when deciding what solid to give to their baby.

Avoidance of nitrate-rich vegetables

Nitrate-rich vegetables should specially be avoided in the first months. Nitrate-rich vegetables were probably not a problem in Madrid, as most children did not receive vegetables until the age of five or six months and mothers in Madrid generally used a mixture of vegetables to prepare their infant's meal, thus attenuating any potential problem.

No salt should be added

Although infant feeding guidelines recommend not to add salt to the baby's meals, the majority of the mothers in this sample did so. Salt was mostly added to the main meal taken at midday and, in the older infant, to the warm dish taken in the evening. The higher the socioeconomic group the less frequent the addition of salt, but differences were not statistically significant. In the U.K. Mills and Tyler (1992) found far fewer mothers adding salt. Potatoes and vegetables showed the highest rate of salt addition in the U.K., 39% and 36% respectively, whereas an average of 68% of the mothers in Madrid added salt to their baby's meal.

No sugar should be added

Influence of the socioeconomic group was clear with respect to the addition of sugar to the baby's food in the present study. The higher the socioeconomic group, the less frequently sugar was added. Mills and Tyler (1992) in the

U.K. did not comment on a possible influence of socioeconomic group, as they only looked at the addition of sugar to selected foods, i.e. breakfast cereals, fruit and milk-based desserts. They found that 33%, 22% and 45% of the mothers added sugar to the dishes respectively. In the present study a far lower average for the addition of sugar to all foods was found, only 19%. Persson and Samuelson (1984c) in Sweden noticed that high socioeconomic group or higher education was linked to lower consumption of sucrose-rich foods. Hoffmans et al. (1986) in the Netherlands, also saw that children of 16 months of highly educated mothers consumed significantly less sweets and snacks than children from less educated mothers. It was therefore noteworthy, that with regard to the use of sugar-containing products, this trend was not observed. Mothers of the high socioeconomic group used sugar-containing foods more frequently than mothers of the low socioeconomic group, and the middle socioeconomic group used this type of foods least. This may be explained by the fact that most mothers were unaware of the sugar content of the product. Particularly in the case of special baby foods, mothers would not expect those products to contain sugar. As commented before, at the time of the research, almost all infant cereals and all fruit varieties of baby jars commercialized in Spain did contain sugar. The use of sugar-containing products reflected therefore to a great extent the use of cereals and jars among mothers. Only a minority of mothers added honey to their infant's food. Because feeding honey to a baby increases the risk of acquiring type B infant botulism, several major agencies and organizations including the AAP and the U.S. Food and Drug Administration have joined in the recommendation that honey should not be fed to infants, especially those under six months (Arnon, 1985).

Introduction of potentially allergenic foods

Foods frequently mentioned as potentially allergenic are fish, egg and cow's milk (ESPGAN, 1982). Cow's milk will be discussed under point 10. Although most mothers started with fish between seven and nine months, 10% of the babies had already received fish at the age of 5.8 months which is earlier than considered desirable. It was interesting to observe that almost a quarter of the mothers first started with egg yolk before giving whole egg to the baby. If the objective of the procedure was to postpone the introduction of the more allergenic egg white, then the aim may be missed, first because of the possibility of proteins in the yolk cross-reacting with allergens in egg white and secondly because it will be difficult to avoid contamination of egg yolk by some egg white proteins when preparing food (Langeland and Aas, 1987).

Continued use of breast milk or iron-fortified infant formula throughout the first year

The use of different types of milk in the first year of life is already discussed in detail in chapter three.

Other observations

Finally a few observations are described that are considered worth reporting, although they only apply to a few isolated cases.

Several mothers considered fruit cereals a type of "instant fruit" and did not realize that the major component of the product were cereals. Fruit cereals substituted completely fresh fruit in the diets of those children.

The actual use of artificial sweeteners among mothers in Madrid may be higher than the three percent observed in this study, as they were mainly given to children of 15 months and older and only 38% of the sample was that old.

Six mothers, four of them in the low socioeconomic group, prepared milk cereals with infant formula or cow's milk, thus doubling the protein content of the meal. As no quantitative study on nutrient intake was done, the influence of this extra load of proteins on total protein intake could not be estimated.

Only two children in the whole sample, one of 15 and one of 18 months and both from the low socioeconomic group, used soft drinks. This is very low compared to the observation of Mills and Tyler (1992) that 47% of the British children of nine to 12 months were taking squash and soft drinks.

4.5 Conclusions

The introduction of complementary foods in Madrid did follow in general the recommendations formulated by international and national paediatric advisory groups, but some guidelines should be adhered to more closely.

The introduction of the first weaning food could be further delayed till the age of four months or later. More attention should be given to the introduction of foods one by one and to delaying the introduction of potentially allergenic foods like egg and fish as well as foods that may contain them. Differences in feeding behaviour were observed among socioeconomic groups, but only some of them had statistical significance. From a nutritional point of view the low socioeconomic group needs to be given more information on gluten and gluten-containing foods, as this group made most often the mistake of giving at the same time gluten-free cereals and bread or biscuits. The introduction of bread was also earlier in this group than desired. Particularly as in the sample the low socioeconomic group was less represented than in the actual population of Madrid, this error may be more common than the results of this study indicate. The importance of not adding sugar and salt to the meals should receive more attention. Producers of baby foods for Spain could have a closer look at the number of ingredients in complementary foods that are indicated in the initial phase of weaning, and at the necessity of adding salt and sugar to those products.

As commented in the text, the observation that almost 20% of the mothers used herbal drinks in their children's diet will be discussed in detail in chapter five.

CHAPTER 5

HERBAL DRINK USAGE

Observations on herbal tea usage in infancy

5.1 Introduction

Review of dietary habits of the present study revealed the administration of adult type herbal drinks to young infants by a number of mothers. In Spain, herbal teas are widely used by adults and children because of their supposed pharmacological effects. The teas can be purchased at any general food outlet and in pharmacies.

Lipsitz (1984) stated that the use of herbal teas in home remedies for common childhood illnesses is a frequent practice in the Mexican American population in southern Colorado, United States. The uses of chamomile and peppermint tea were mentioned. He related the case of a young child with water intoxication, resulting from the prolonged use of these teas as only oral intake.

Talalaj and Czechowics (1990) advised caution in the use of herbal remedies that contain pyrrolizidine alkaloids, substances that, in small quantities, may have toxic effects on the young infant. A list of plants that should be avoided was provided, including coltsfoot *Tussilago farfara*, butterbur *Petasites hybrides* and hound's-tongue *Cynoglossum officinalis*, but none of the herbs used by the mothers in Madrid were included.

Rosti et al. (1994) in Italy described the cases of two breast-fed neonates with signs and symptoms as lethargy, hypotonia, emesis, weak cry and poor suckling, suggesting the involvement of the central nervous system. One of the mothers showed unspecific symptoms that could have been attributable to common conditions like the flu. The mothers said not to be taking any medications, but were drinking more than two litres per day of herbal tea mixtures, containing extracts of liquorice, fennel, anise and *Galega officinalis* to stimulate lactation. Based on the clinical suspicion of ingestion of toxic substances through their own mother's milk, both breast-feeding and the consumption of teas were discontinued. The clinical conditions of both the infants and mothers improved rapidly within 24-36 hours and breast-feeding could be reintroduced. Symptoms did not reappear and the infants were doing well at six months follow-up.

In the Netherlands it is a tradition, when a baby is born, to give to each visitor *beschuit met muisjes*, this is Dutch toast with aniseed covered with a white and pink sugarcoat. The aniseed in the *muisjes* was the traditional remedy against colic in the young baby. As the new mother had an ample share in the *muisjes*, the baby would receive his portion via the breast milk (Stam-Dresselhuys, 1966/1980).

Little has been done to investigate scientifically the possible beneficial effects of herbal teas. Only Weizman et al. (1993) in Israel conducted a double-blind study to test the effect of a herbal tea preparation in infantile colic. The herbal tea preparation contained extracts of chamomile, vervain, licorice, fennel and balm-mint. Furthermore, it contained natural flavours and glucose. The placebo preparation only contained the last two ingredients. Weizman found that the use of this tea eliminated the colic in 19 (57%) of 33 infants, whereas the placebo was helpful in only 9 (26%) of 35 infants ($p<0.01$). The mean colic score, as recorded by the parents in a diary, was significantly improved in the tea-treated children.

The Dutch "Pharmaceutisch weekblad" addressed the question of how much fennel water an infant safely can take. A maximum recommended intake of such a drink was given based on the amount of trans-ethanol present in the volatile oil of the tea (van Ham, 1985). The recommended maximum daily dosage of trans-ethanol is 2.5 mg per kg weight (Martindale, 1989). Assuming that fennel oil contains 70% ethanol, and that fennel water contains 0.1% fennel oil, van Ham reached the guideline that an infant younger than three months can take four times a day 12 ml of fennel water. Fennel water usually contains more ethanol than ordinary fennel tea.

5.2 Methods

Methods have been described in detail in chapter two, section 2.2.

5.3 Results

Sixty four of 344 infants (18.6%) received herbal drinks, most of them in the first few months of life. The varieties of teas administered were anise, chamomile, lime-flower and mint. Table 5.1 provides information on the number of infants receiving each tea variety. Except for the star-anise, that was sold as such, all other herbs came in bags, like ordinary tea. In all cases the drink was prepared at home.

Table 5.1 Number of infants that received each tea variety. Some infants received more than one variety.

variety	frequency
anise	32
chamomile	27
lime-flower	7
mint	1
total	67

The use of herbal teas differed from one socioeconomic group to the other. Table 5.2 shows the number of infants that received herbal teas classified by socioeconomic group.

Table 5.2 Number of infants that received herbal teas classified by socioeconomic group

socioeconomic group	used herbal tea	
	yes	no
low	27 (25.2%)	80 (74.8%)
middle	18 (15.6%)	97 (84.4%)
high	19 (15.6%)	103 (84.4%)
total	64 (18.6%)	280 (81.4%)

Log-linear analysis of the data confirmed the impression that herbal teas were statistically significantly more used in the lower than in the combined middle and higher class ($P \leq 0.04$). No evidence was found that herbal tea usage was related to the sex of the child ($P > 0.05$).

5.4 Discussion

In official guidelines for infant feeding as given by ESPGAN (1982), the DHSS (1988) and the Dutch Study Group Infant Nutrition (1991), no recommendation is made on the use of herbal drinks, although both in the U.K. and in the Netherlands herbal drinks are used in infancy (van Ham, 1985; Mills and Tyler, 1992; White et al., 1992). Mills and Tyler (1992) reported, that one fifth of their sample (N=488) of infants between six and 12 months drank concentrated powder drinks flavoured with, for example, fennel, hibiscus and rosehip, which were made up with water. White et al. (1992) observed an increase in the use of herbal drinks in Great Britain in 1990 compared to 1985, but did not comment on the socioeconomic groups in which the drinks were used.

In practice quite a number of mothers give herbal teas to their babies to remedy minor digestive problems. The lack of an official recommendation for the use of herbal drinks in infancy results in incongruent information to the mother on the subject, if any at all. Advice from family, friends and neighbours will therefore become more influential, particularly in the low socioeconomic group where family and neighbours live closer to each other. This may explain why herbal teas were more frequently given in the low than in the middle and high socioeconomic groups.

Several herbal tea varieties contain essential oils. Essential oils are volatile odorous mixtures of esters, aldehydes, alcohols, ketones, and terpenes. Taken internally, the volatile oils exert a mild irritant action on the mucous membranes of the mouth and digestive tract, which induces a feeling of warmth and increases salivation, hence their use as carminatives (Martindale, 1989). A carminative is a drug causing expulsion of gas from the stomach or bowel. Essential oils are widely used in folk medicine (Martindale, 1989).

Thirty two mothers in this study used anise-based teas. Aniseed is the ripe dried fruit of *Pimpinella anisum* containing not less than 2% v/w of volatile oil (Martindale, 1989; Farmacopea Europea, 1988). Star anise is the dried ripe fruit of *Illicium verum* (Martindale, 1989). Both aniseed and star anise contain anise oil and have a carminative effect (Martindale, 1989). Star anise was used more often than aniseed. The main reason for giving this tea to the infant was because of digestive problems, particularly gases.

Twenty seven mothers reported that they gave chamomile tea to their infants in case of upset bowels. Chamomile flowers are the dried flowerheads of *Matricaria recutita (=Chamomilla recutita) (Compositae)* containing not less than 0.4% v/w of volatile oil (Martindale, 1989; Farmacopea Oficial Española, 1954) or of the dried flowerheads of the cultivated double variety *Anthemis nobilis (Compositae)*, containing not less than 0.7% v/w of volatile oil. It has a carminative effect (The Merck Index, 1989). An infusion of chamomile flowers, "chamomile tea" is a domestic remedy for indigestion, both in children and adults.

A small number of mothers (N=7) mentioned the use of lime-blossom tea. They mainly used it for its sedative (pacifying) effect. Lime-blossom is the dried inflorescences, with their attached bracts, of the common lime, *Tilia europea*, and other species of the genus *Tilia* (Martindale, 1989; Farmacopea Oficial Española, 1954). *Tilia* is mildly astringent and is reputed to have antispasmodic and diaphoretic (producing perspiration) properties (Martindale, 1989). Lime-blossom tea is a traditional domestic remedy.

One mother gave mint tea to her baby. Mint tea is prepared from the dried leaves of *Mentha piperita (Labiatae)*, which contain not less than 1.2% v/w of volatile oil (Martindale, 1989; Farmacopea Oficial Española, 1954). Peppermint oil is an aromatic carminative (Martindale, 1989; The Merck Index, 1989), acts as a gastric sedative (The Merck Index, 1989) and relieves flatulence (Martindale, 1989). Commercialized mint teas in Spain are mostly a mixture of *Mentha piperita* and *Mentha pulegium*. The latter, although present in smaller quantities, gives the tea in Spain its popular name *poleo*.

5.5 Conclusions

As the objective of the study was to make a qualitative observation of infant feeding practices and not a quantitative one, the design of the study did not include any estimation of the amount of volatile oil consumed by the infants. To that extent, a measure should have been made of both the exact intake of tea per day and its concentration, which not only depends on the amount of water used in relation to the amount of herb, but also on the time the tea has drawn. Neither did the design of the study permit us to make any conclusions on the possible pharmacological and nutritional effects of the use of herbal drinks. Although no data were collected on the frequency with which herbal drinks were given, the impression was that herbal tea use was limited to short term intakes to relieve minor digestive problems, particularly gases.

Most mothers sweetened the teas to improve acceptance of the drink by the child, a practice discouraged in the current guidelines for infant feeding. Sweeteners used were sugar, honey and artificial sweeteners, usually saccharine.

To be able to make recommendations that might be useful in formulating official guidelines for infant feeding, a more detailed study on the subject looking at the effects of the use of herbal teas by young children, both from a nutritional and a pharmacological point of view, is necessary.

In chapter six growth performance of the 344 children in this study will be discussed.

CHAPTER 6

GROWTH PERFORMANCE

A comparison of anthropometric results with various relevant growth references

6.1 Introduction

Growth in infancy is a complex process that depends on many interacting influences including genetic and environmental factors. Such influences include the prenatal and postnatal nutritional status of the mother, as well as infant factors like birth weight, diet and infections. These in turn are determined by socioeconomic, cultural and biological conditions (Seward and Serdula, 1984).

The aim of this part of the study was to evaluate growth performance of the children in this study by comparing the results of anthropometric measurements of the children to different growth references. The references used were: (a) the growth references of the *Instituto de Investigación sobre Crecimiento y Desarrollo* (Institute for the investigation on growth and development) of the Fundación F. Orbegozo in Spain published in 1988 (Hernández et al., 1988), further referred to as the Bilbao references, (b) the WHO and American NCHS references and (c) the U.K. growth standards and results from the Cambridge Growth Study.

6.2 Methods

Methods are described in detail in chapter two, section 2.2.

6.3 Results and discussion

For this particular chapter, results and discussion are combined, because anthropometric measurements only become meaningful by comparison to a reference as commented in chapter one, section 1.4.1. Results will thus immediately be discussed in relation to one or more references.

6.3.1 Bilbao growth references

The Bilbao growth references are the most frequently used references in Spain to plot a child's growth and assess its nutritional status. However, the sample for these growth references was not representative for the whole of Spain as all children came from the Basque country in the Northern part of Spain. The curves for infants between birth and two years were based on longitudinal data of 577 children, 285 male and 292 female. Only 405 children completed the study at 24 months, 202 male and 203 female. Children were measured at birth, three, six, nine, 12, 18 and 24 months (Sobradillo Ruiz, 1984). Data were collected from infants born in 1978 and 1979 (Sobradillo Ruiz, personal communication).

The type of milk feeding used in the first three months was recorded for the Bilbao sample. No information is available on the moment of introduction of complementary food. Table 6.1 compares the type of milk feeding in the first three months of the Bilbao and this study.

Table 6.1 Type of milk-feeding during the first three months of the Bilbao and the present study

type of feeding	Bilbao	Madrid
exclusive breast-feeding for 2 weeks	17.0%	5.8%
exclusive breast-feeding for 1 month	18.4%	10.2%
exclusive breast-feeding for 2 months	11.8%	13.7%
excl. breast-feeding for 3 months or more	18.4%	43.7%
mixed feeding at birth	7.1%	9.4%
formula feeding at birth	27.3%	17.2%

Analysis using the chi-squared test showed that a statistically significantly higher number of infants were exclusively breast-fed in the present study ($p=0.02$). Total breast-feeding at birth was also statistically significantly higher in the Madrid sample ($p<0.001$). Mothers in the Madrid sample breast-fed on average statistically significantly longer than mothers in the Bilbao sample ($p<0.0005$).

6.3.2 WHO and NCHS growth references

In 1978 the WHO presented a growth chart for international use in maternal and child health care with the objective that the chart would promote healthy growth by increasing the level of awareness and knowledge of the family and the health worker through the graphic presentation of simple body measurements (WHO, 1978).

The data used were taken from the United States National Child Health Examination Survey (NCHS) as they met best the criteria set for selecting the reference values. However, the reference values for children from birth to 23 months of age, which were not available from the US national survey, derive from longitudinal studies by the Fels Research Institute of Yellow Springs, Ohio. Whereas the NCHS data are representative for the entire US population, as the cross-sectional sample included various ethnic groups from all socioeconomic strata and from both urban and rural areas, the Fels data were collected between 1929 and 1975 from white middle-class children followed longitudinally. Infants were predominantly formula-fed in the early months (WHO, 1978; Seward and Serdula 1984; Gorstein et al., 1994).

Stature measurement of the children in the Fels survey was recumbent and in the NCHS survey standing, due to the age of the children studied. Recumbent lengths are, on the average, greater than standing heights. Tanner (1966) described that the average difference is a little under a centimetre, but that differences from zero to 2.5 cm may occur when passing from one measurement to the other. In this study, all data will be compared to the results of the Fels survey, as all children were under two years of age. In both studies, infant's length was measured recumbent.

6.3.3 U.K. growth references and Cambridge Growth Study

As commented in chapter one, section 1.3, the Cambridge study was designed to measure growth, and energy and nutrient intake longitudinally throughout infancy in Cambridge, U.K. As results of this study indicated that the growth references used at that moment in the U.K. were no longer appropriate for the present generation of infants, new growth standards have been developed, which include the results of the Cambridge study. These new U.K. growth references were published in chart form in 1994 by the Child Growth Foundation. Weight and length of the Madrid sample will be compared to the numerical bases of these growth charts, as prepared by Dr. T. Cole of the Dunn Nutrition Centre in Cambridge (A. Paul, personal communication).

Head circumference, arm circumference as well as triceps and subscapular skinfolds will be compared to the actual results of the Cambridge study as published in the literature.

6.3.4 Weight at birth

Average birth weight was 3394 g (SD 389) for boys and 3271 g (SD 392) for girls. The lowest reported birth weight was 2500 g, the minimum birth weight to be included in this study, and the highest was 4420 g. There were two missing values. Table 6.2 shows the birth weight for boys and girls in the three socioeconomic groups. Analysis of variance showed that there was no statistically significant difference in birth weight between socioeconomic group for either boys or girls.

Table 6.2 Average birth weight by socioeconomic group and sex in grammes

sex	socioeconomic group		
	high	middle	low
boys	3433 (SD 407) N=55	3377 (SD 384) N=63	3373 (SD 372) N=53
girls	3285 (SD 386) N=66	3335 (SD 419) N=52	3191 (SD 358) N=53

No relation could be found between birth weight and mother's weight, mother's Quetelet Index and mother's age. Morgan (1978) did not find any relationship either between birth weight and mother's weight in 94 children living within a 100 miles radius of London in the seventies.

The reported birth weights of the Madrid sample were compared with the Bilbao and WHO references. No statistically significant differences were observed between the Madrid and WHO data using the two-sample t-test, but statistically significant differences were found, using the same test, between the Madrid and Bilbao birth weights, which was very significant for boys ($p<0.001$) and almost significant for girls ($p=0.07$), see table 6.3.

6.3.5 Length at birth

Only 240 out of 344 (70%) mothers knew and remembered their baby's birth length. Table 6.4 gives an overview of these birth lengths by sex and socioeconomic group. Data may be biased as it is unknown if the lengths of the babies whose mothers did not know or did not remember differed from those who did. Analysis of variance showed no statistically significant difference between socioeconomic groups.

Table 6.3 Average and standard deviation of birth weight of the children of this study compared to the Bilbao and WHO references

sex	Madrid	Bilbao	WHO
boys	3.39 kg (SD 0.39) N=171	3.53 kg (SD 0.45) N=285	3.3 kg (SD 0.4-0.5) N>700
girls	3.27 kg (SD 0.39) N=171	3.34 kg (SD 0.41) N=292	3.2 kg (SD 0.4-0.5) N>700

Table 6.4 Reported birth length, by socioeconomic group and sex, in cm. The percentages between brackets express the fraction of mothers who could recall the baby's length

sex	socioeconomic group			total sample
	high	middle	low	
boys	50.7 (SD 1.7) N=36 (64%)	50.9 (SD 1.8) N=42 (67%)	50.6 (SD 2.1) N=36 (68%)	50.8 (SD 1.9) N=114 (67%)
girls	50.2 (SD 1.9) N=51 (77%)	50.1 (SD 1.9) N=37 (71%)	49.5 (SD 2.2) N=38 (70%)	50.0 (SD 2.0) N=126 (74%)

6.3.6 Height and weight

Height measurements of the Madrid children were plotted for boys and girls against the Bilbao, WHO and new U.K. references for height by age, see figures 6.1 and 6.2. Children in this study were on average longer than the children of any of the references, as the lengths of most of the Madrid children fell above the 50th percentile of any of the three references. No child had a length below the 3rd percentile, but several had a length above the 97th centile of the Bilbao and WHO references.

Figure 6.1 Length by age of the boys compared to standard references

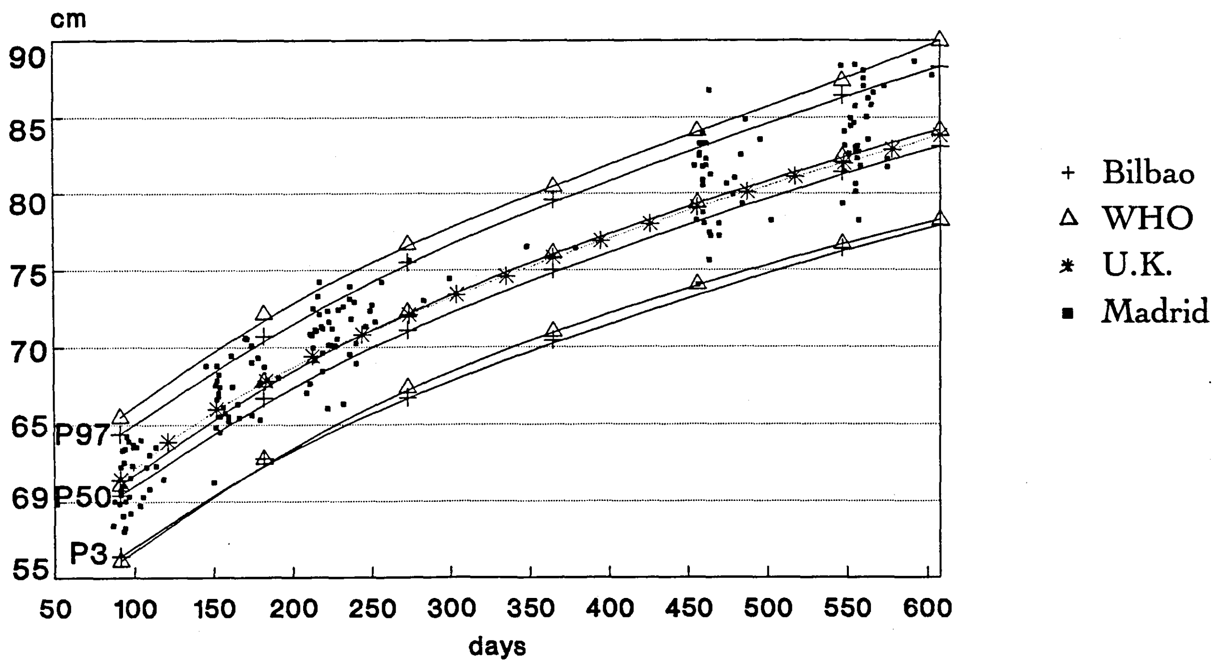
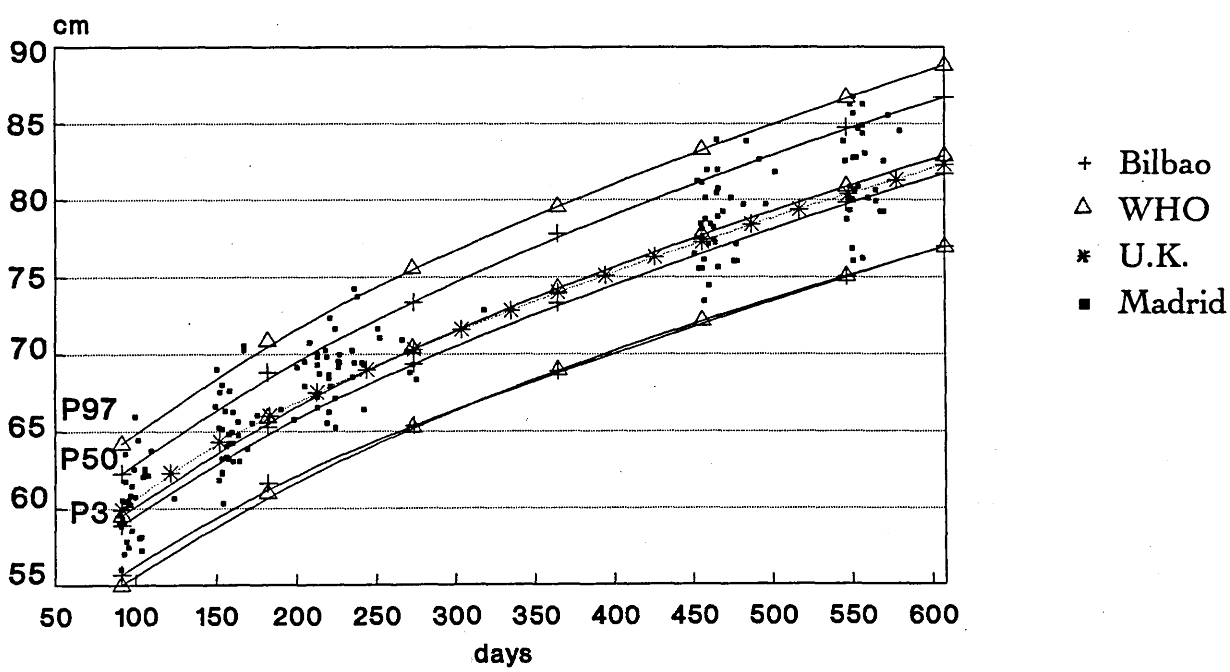
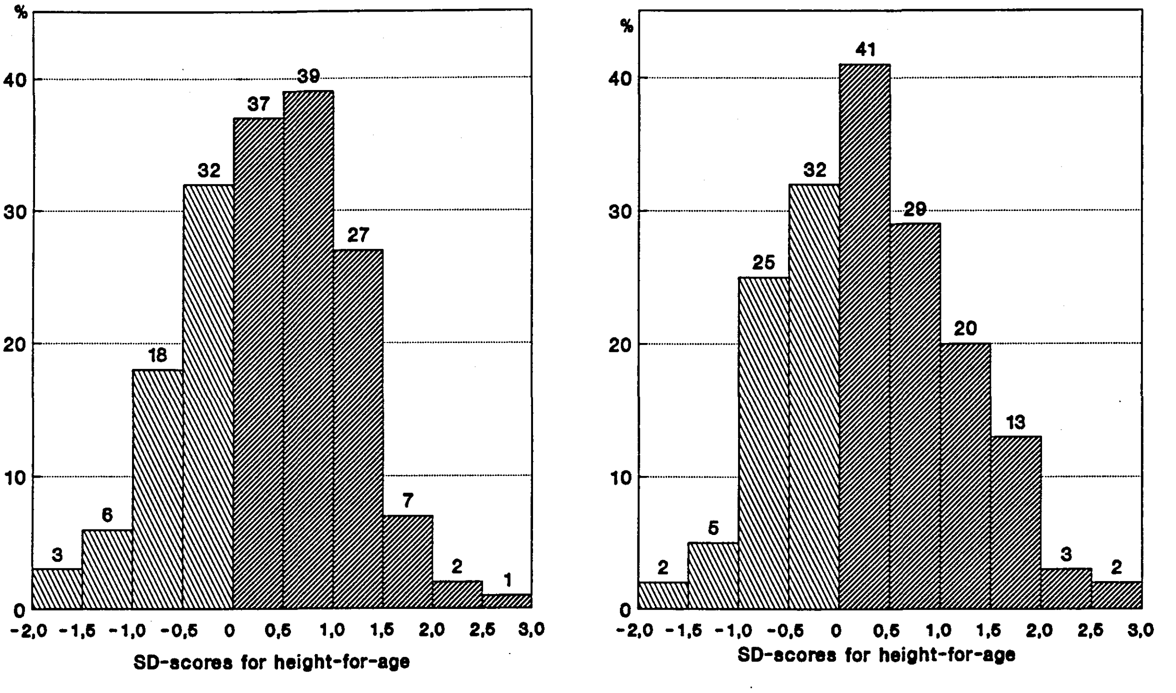


Figure 6.2 Length by age of the girls compared to standard references



To be able to examine the attained heights of the infants in more detail, the SD-scores for height-for-age were calculated on the basis of the WHO data. The frequency distribution of the SD-scores showed a slight skewness to the right for both sexes, confirming that the children in this study were on average taller than the reference population, see figures 6.3 and 6.4. Looking at the extremes of the distribution, the observations were made that no child had a length of less than two standard deviations from the median, but that three boys and five girls were longer than two standard deviations from the median.

Figures 6.3 and 6.4 Frequency distribution of the SD-scores for height-for-age for boys (left) and girls (right)



Corrected weight measurements, i.e. weight measurements minus 300 grammes for nappy and light clothes, were also plotted against the Bilbao, WHO and U.K. references. Figure 6.5 shows the weights by age for boys and figure 6.6 the weights by age for girls. The population in the present research was, on average, heavier than the reference populations.

Figure 6.5 Weight by age of the boys compared to standard references

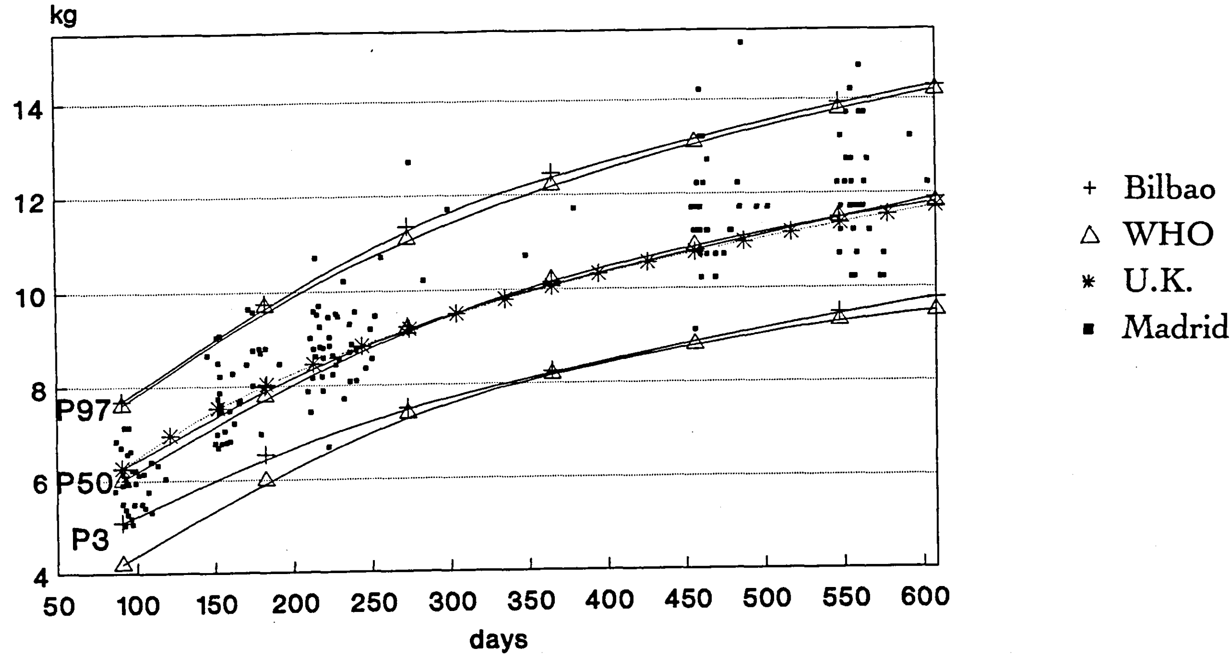
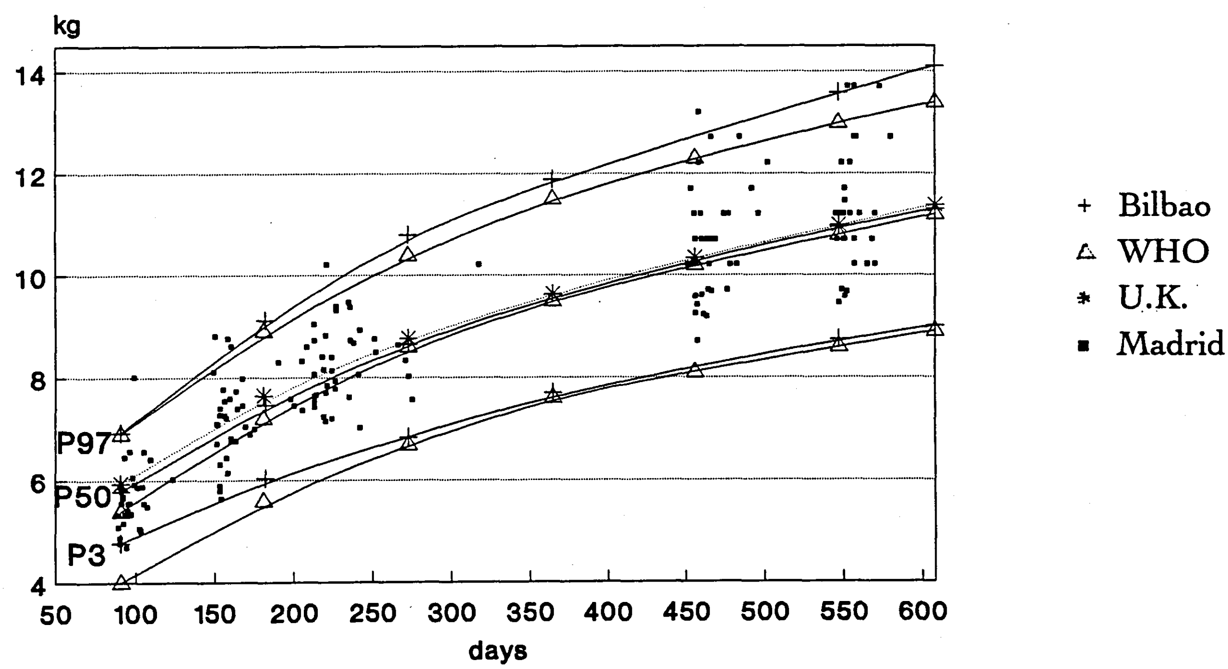


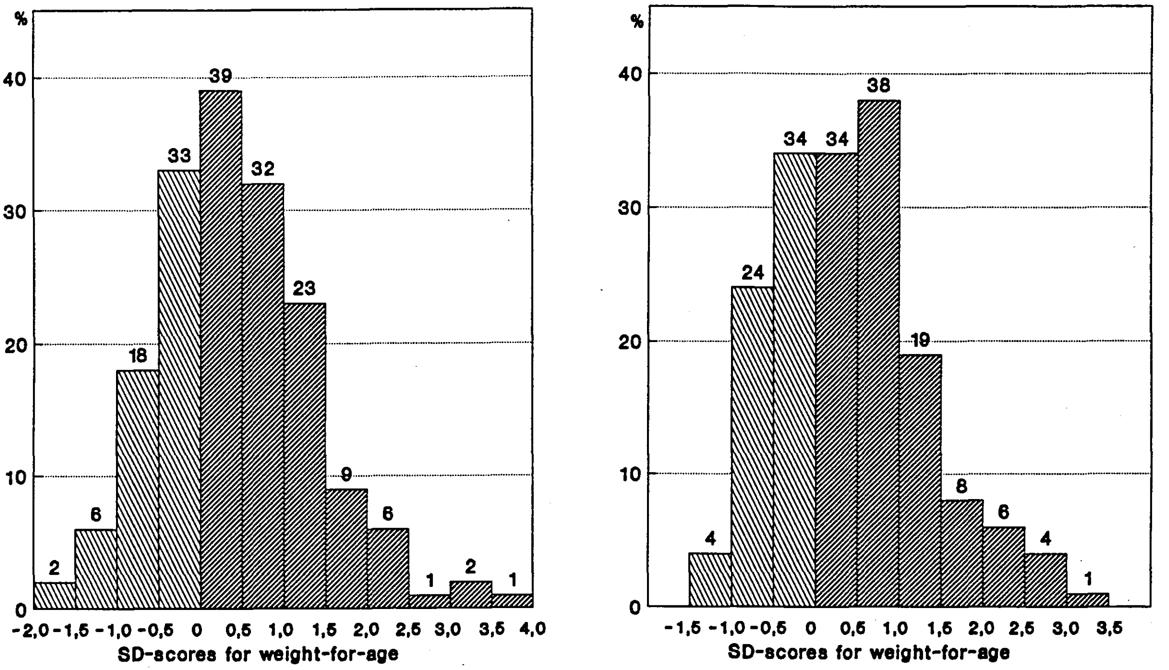
Figure 6.6 Weight by age of the girls compared to standard references



SD-scores, based on the WHO reference, for weight-for-age were also examined, see figures 6.7 and 6.8. The frequency distribution of these SD-scores showed a clear skewness to the right, confirming that the children in this study had on average a greater weight-for-age than the reference population.

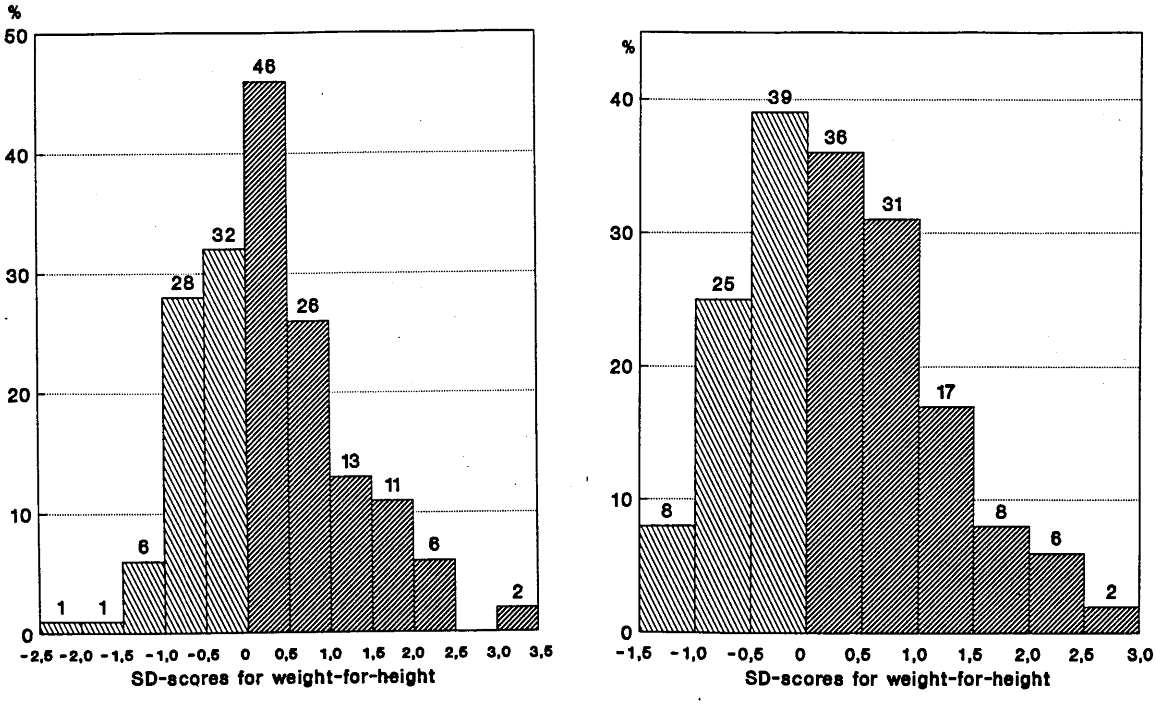
Looking again at the extremes of the distribution, it was noticed that no boy had a weight below two standard deviations of the median, and no girl had a weight of less than one and a half standard deviations below the median. On the other extreme, however, ten boys and eleven girls had a weight of more than two standard deviations above the median.

Figures 6.7 and 6.8 Frequency distribution of the SD-scores for weight-for-age for boys (left) and girls (right)



To distinguish between children with a higher weight-for-age because of greater length and because of obesity, the weight-for-height SD-scores were checked. Figures 6.9 and 6.10 show the frequency distributions of the SD-scores for weight-for-height based on the WHO reference, for boys and girls respectively. Only one boy had a weight-for-height of less than 2 SD below the median and no girl had a weight-for-height less than 1.5 SD below the median. The upper side showed that eight boys and eight girls were too heavy for their length as their SD-score for weight-for-height was more than 2 SD above the median. As this sample was, on average, taller than the reference population, the effect of moving the lower cutt-off point for the height-for-age SD-scores from -2 to -1.5 was also looked at. In that case, five children would fall into the category "short", but all of them had a normal weight for their length. So this would have no influence on the number of under- and overweight children.

Figures 6.9 and 6.10 Frequency distribution of the SD-scores for weight-for-height for boys (left) and girls (right)



To estimate the prevalence of under- and overweight children in this population, the SD-scores for height-for-age and weight-for-height were cross-tabulated as proposed by Waterlow and described in chapter 1, section 1.4.1, see table 6.5. This table also indicates in which cell the 21 children with a weight-for-age (w-f-a) SD-score of over two can be found. As can be seen, nine of these 21 infants (43%) fall into the "normal weight" category, whereas four children with an adequate weight-for-age were in fact overweight once their length was taken into account. Only one child should be classified as underweight.

Table 6.5 Cross-tabulation of SD-scores for weight-for-height and height-for age for the children in this study

		SD-scores height-for-age		
		≤-2	-1.9 to 1.9	≥2
SD-scores weight-for-heigth	≤-2	0	1 (0.3%)	0
	-1.9 to 1.9	0	319 (92.7%) *7 w-f-a >2*	8 (2.3%) *2 w-f-a >2*
	2.0 to 2.9	0	14 (4.1%) *10 w-f-a >2*	0
	≥ 3	0	2 (0.6%) *2 w-f-a >2*	0

Socioeconomic group. To see the distribution of the indices for weight and height per socioeconomic group, the SD-scores for all indices were tabulated per socioeconomic group, see table 6.6 for boys and 6.7 for girls. No statistically significant difference between socioeconomic groups could be found, using the chi-squared test, for any of the indices for either boys or girls or the two sexes combined.

Table 6.6 SD-score distribution for weight-for-height, height-for-age and weight-for-age for boys by socioeconomic group

Index	Socioeconomic group					
	low		middle		high	
weight-for-height	N=53		N=63		N=56	
<2	0	0.0%	1	1.6%	0	0.0%
-2.0 to -1.1	1	1.9%	3	4.8%	3	5.3%
-1.0 to -0.1	21	39.6%	22	34.9%	17	30.4%
0 to +0.9	20	37.7%	27	42.8%	25	44.6%
+1.0 to +1.9	8	15.1%	7	11.1%	9	16.1%
+2.0 to +2.9	1	1.9%	3	4.8%	2	3.6%
≥3	2	3.8%	0	0.0%	0	0.0%
height-for-age	N=53		N=63		N=56	
-2.0 to -1.1	1	1.9 %	5	7.9%	3	5.3%
-1.0 to -0.1	22	41.5%	15	23.8%	13	23.2%
0 to +0.9	19	35.8%	26	41.3%	31	55.4%
+1.0 to +1.9	10	18.9%	15	23.8%	9	16.1%
≥2.0	1	1.9 %	2	3.2 %	0	0.0%
weight-for-age	N=53		N=63		N=56	
-2.0 to -1.1	1	1.9%	4	6.3%	3	5.3%
-1.0 to -0.1	23	43.4%	15	23.8%	13	23.2%
0 to +0.9	16	30.2%	27	42.9%	28	50.0%
+1.0 to +1.9	8	15.1%	15	23.8%	9	16.1%
+2.0 to +2.9	3	5.6%	2	3.2%	2	3.6%
≥3	2	3.8%	0	0.0%	1	1.8%

Table 6.7 SD-score distribution for weight-for-height, height-for-age and weight-for-age for girls by socioeconomic group

Index	Socioeconomic group					
	low		middle		high	
weight-for-height	N=54		N=52		N=66	
<2	0	0.0%	0	0.0%	0	0.0%
-2.0 to -1.1	2	3.7%	4	7.7 %	2	3.0%
-1.0 to -0.1	24	44.5%	16	30.8%	24	36.4%
0 to +0.9	18	33.3%	20	38.5%	29	44.0%
+1.0 to +1.9	6	11.1%	10	19.2%	9	13.6%
+2.0 to +2.9	4	7.4%	2	3.8%	2	3.0%
≥3	0	0.0%	0	0.0%	0	0.0%
height-for-age	N=54		N=52		N=66	
-2.0 to -1.1	3	5.6%	2	3.8%	2	3.0%
-1.0 to -0.1	20	37.0%	15	28.9%	22	33.3%
0 to +0.9	23	42.6%	23	44.2%	24	36.4%
+1.0 to +1.9	6	11.1%	11	21.2%	16	24.3%
≥2.0	2	3.7 %	1	1.9%	2	3.0%
weight-for-age	N=54		N=52		N=66	
-2.0 to -1.1	2	3.7%	1	1.9%	1	1.5%
-1.0 to -0.1	20	37.0%	20	38.5%	18	27.3%
0 to +0.9	24	44.5%	17	32.7%	31	47.0%
+1.0 to +1.9	6	11.1%	8	15.4%	13	19.7%
+2.0 to +2.9	2	3.7 %	5	9.6%	3	4.5%
≥3	0	0.0%	1	1.9%	0	0.0%

Feeding methods. As commented in chapter 1, section 1.3, many studies have shown different growth patterns between breast-fed and formula-fed infants. A possible relationship between breast-feeding and the SD-scores for weight-for-height was examined. No statistically significant difference in weight-for-height SD-scores could be found using the two sample t-test between children who were breast-fed and those who were not, or between those breast-fed for less than three months and those breast-fed for more than three months. This does not necessarily mean that this difference did not exist, as the cross-sectional design of the present study may not have been sufficiently sensitive to detect such differences. Neither was a correlation found between the age at introduction of weaning and the weight-for-height SD-scores using linear regression.

6.3.7 Head circumference

Ounsted (1985) reported that head circumference of children in the U.K. has shown an upward trend in this century. Paul et al. (1986) published in the journal Archives of Disease in Childhood a table for head circumference for infants from two weeks to one year derived from the Cambridge Growth Study. They had also found that during the first year of life, mean head circumference was about one centimetre greater than that presented in standard growth charts at that moment, referring to those of the U.K. and the United States. Both Ounsted and Paul stressed the need for new charts to be prepared for the present generation of babies.

Head circumference measurements of the present study were plotted both for boys and girls against the Bilbao, the NCHS (Hamill et al., 1979) which are the basis for the WHO reference, and the Cambridge references as published by Paul et al. (1986), see figure 6.11 and 6.12. Head circumferences of the children in this study were situated on average well above the 50th percentile of the Bilbao and NCHS references for both sexes. The Bilbao data are from a far more recent data (1978-1981) than the NCHS ones, but still the Cambridge 50th percentile is situated above the 50th percentile of Bilbao for both sexes.

Figure 6.11. Head circumference by age of the boys compared to the Bilbao, NCHS and Cambridge references

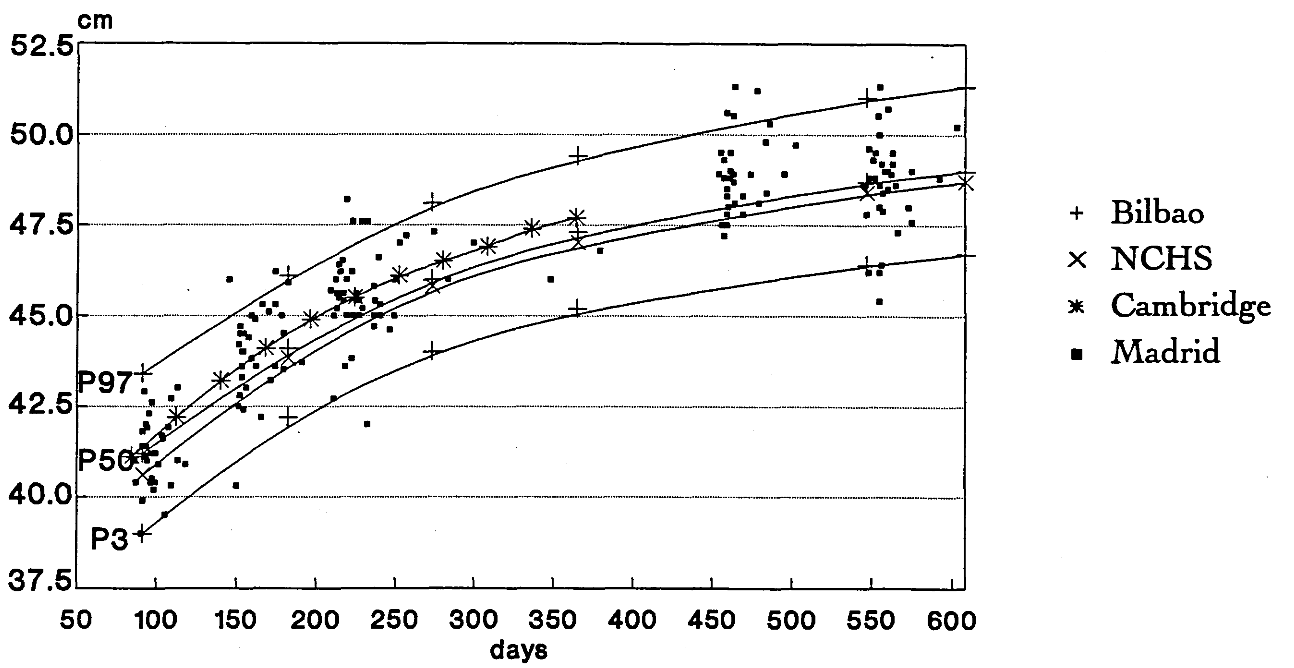
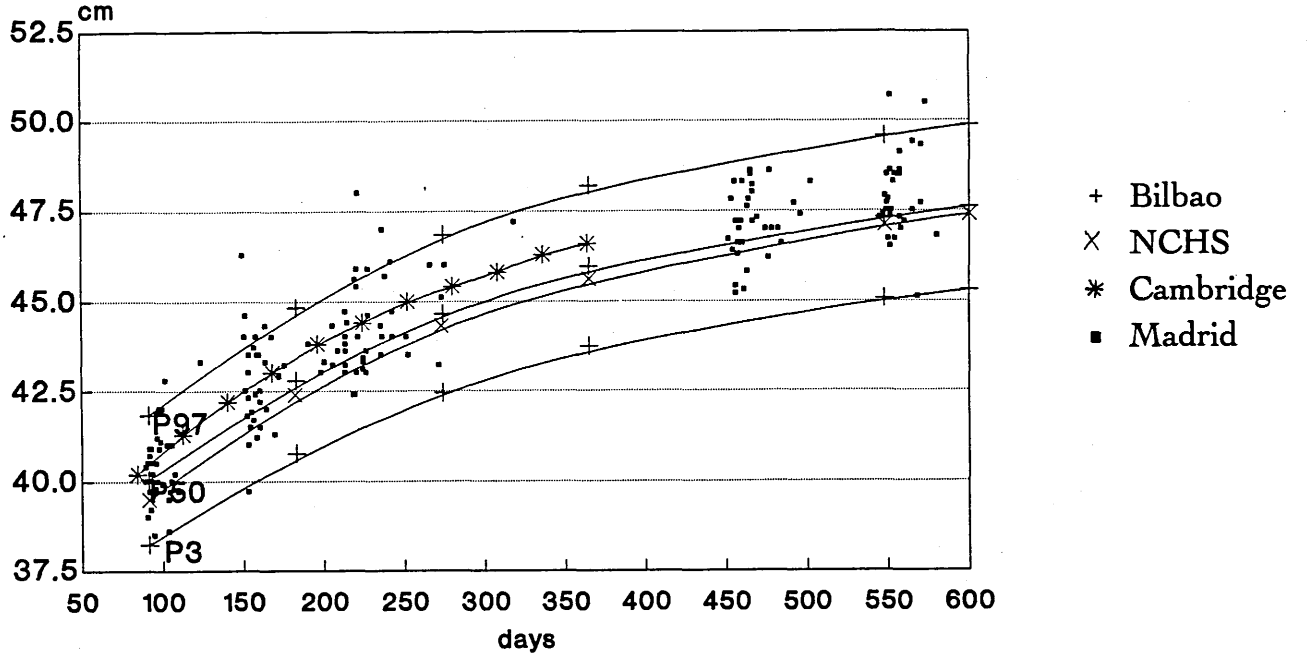


Figure 6.12. Head circumference by age of the girls compared to the Bilbao, NCHS and Cambridge references



To study in more detail the head circumferences of the present research with the finding of Paul et al., SD-scores were calculated on the basis of the Cambridge data for all infants up to one year. The mean and standard deviation as given in the publication were used. Since head circumference was normally distributed, mean and median were the same (A. Paul, personal communication, 1994). The mean SD-score for boys was 0.0 with a standard deviation of 1.02 and for girls -0.08 with a standard deviation of 1.08, confirming the impression that the head circumference in the children in Madrid was similar to those observed in Cambridge. Table 6.8 gives the frequency distribution of these SD-scores.

Table 6.8 Frequency distribution of SD-scores for head circumference of 214 children in Madrid based on data of Paul et al. (1986)

SD-score	boys	girls
3.0 to 3.4	0	2
2.5 to 2.9	0	0
2.0 to 2.4	2	2
1.5 to 1.9	6	3
1.0 to 1.4	8	9
0.5 to 0.9	19	15
0.0 to 0.4	18	15
-0.5 to -0.1	24	20
-1.0 to -0.6	14	19
-1.5 to -1.1	7	15
-2.0 to -1.6	5	5
-2.5 to -2.1	3	2
-3.0 to -2.6	1	0
totals	107	107

Correlation analysis showed statistically significant relationships between the SD-scores for head circumferences and both birth weight and actual weight. The correlation between birth weight and head circumference SD-score was 0.38 ($p<0.001$). Head size is an important indicator of fetal growth. Ultrasonic fetal growth measurements show that fetuses who demonstrate intrauterine growth failure are of two basic kinds: proportionally small and disproportionally small. The former are small for every body component, including head size, whereas the latter appear to have "normal" head size (Falkner, 1991). A correlation between head circumference and birth weight could therefore be expected, especially as no infants with a birth weight of less than two and a half kilogrammes were included in this study.

The correlation between the SD-scores for weight-for-age and head circumference was 0.46 ($p<0.001$). Head circumference is considered to be relatively unaffected by malnutrition (Sutphen, 1989; Fomon and Nelson, 1993). This is contradictory to the observed correlation between head circumference and weight-for-age.

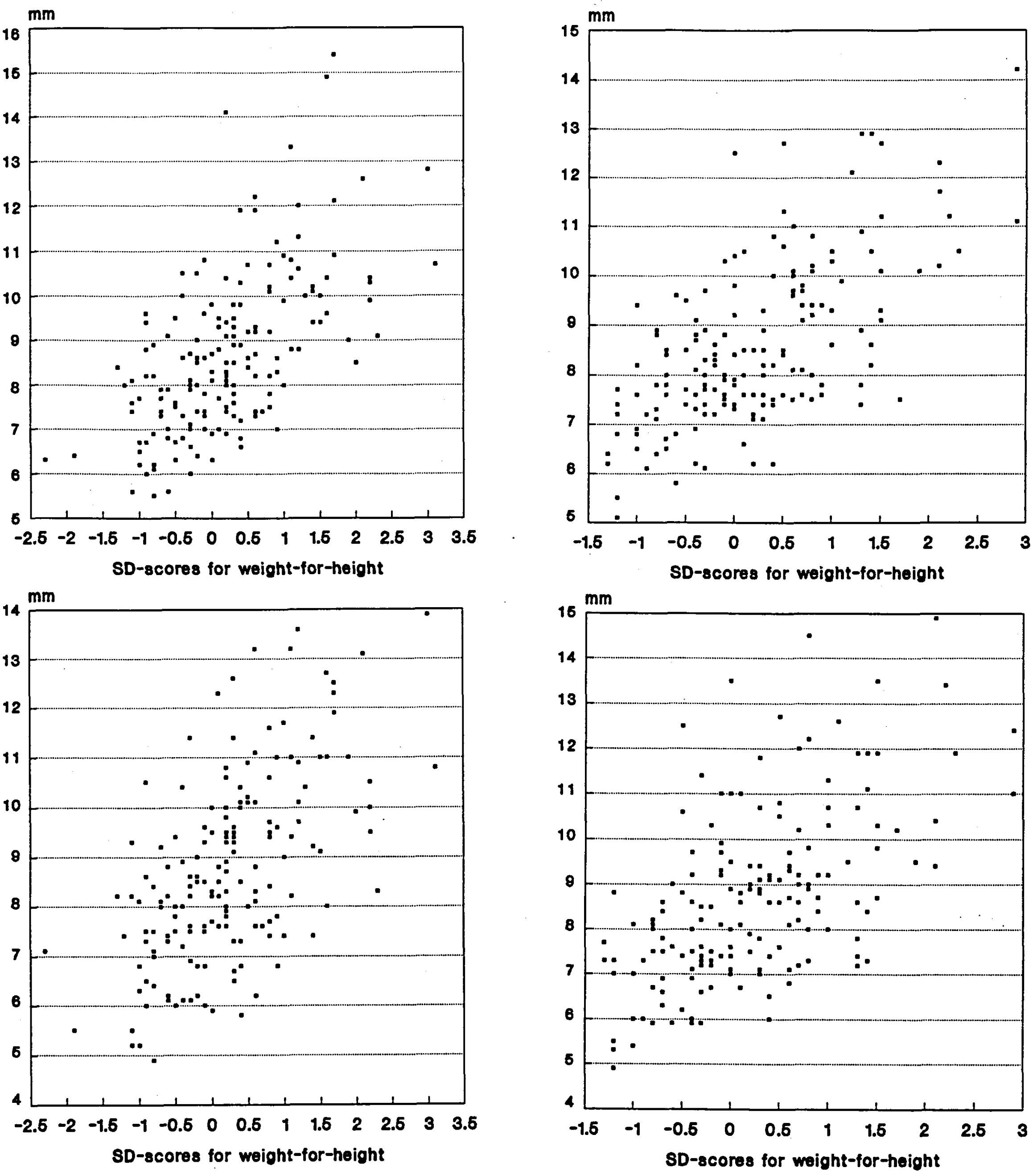
6.3.8 Skinfold measurements

Skinfold measurements are used to estimate the thickness of subcutaneous fat, which in turn is considered an indicator of over- and underweight. The use of skinfold measurements has several drawbacks. First of all, accurate determinations of skinfold thicknesses of infants is difficult to obtain. Fomon and Nelson (1993) remark that the difference between the 10th and 50th centile values for the triceps or subscapular skinfold during infancy is approximately two millimetres. The difficulty in obtaining satisfactory measurements is therefore apparent. Secondly, the use of skinfold measurements as an indicator for total body fat in infants is still not justified, as already remarked by Morgan in 1980 (Morgan, 1980). Davies and Lucas (1990) investigated the relationship between percentage fat mass and skinfold thickness in a group of male and female infants at five, 11 and 26 weeks of age, using $H_2{}^{18}O$ dilution technique to determine fat-free mass and hence fat mass. They found that in all cases skinfold thickness was poorly predictive of percentage body fat and suggested that this might be caused by the variation in the distribution of internal and external stores of body fat in young infants.

As a consequence, skinfold measurements are only recommended to be taken in certain cases. Owen (1982) concluded in a report of a meeting of specialists who assisted the American Department of Health and Human Services regarding the publication of the NCHS skinfold thickness reference data, that in practice, it is operationally reasonable to limit measurements of skinfold during infancy and childhood to individuals whose weight-for-height is greater than the 90th percentile or less than the 10th percentile. Scott et al. (1992) suggested similarly to take skinfold measurements only when information on body fat and body composition changes is necessary or if the common nutritional problems expected in a population, such as high prevalence of obesity or failure to thrive, indicate that these measurements are useful.

In spite of its limitations, skinfold thickness correlates roughly with total body fat as measured by potassium-40 counting, body density, or isotope dilution techniques. The published correlation coefficients vary between 0.4 and 0.9, with pre-school children demonstrating relatively poorer correlations (Sutphen, 1989). In this study, correlation analysis revealed a correlation between the triceps skinfold and the weight-for-height SD-score of 0.62 ($p<0.001$) and a correlation of 0.58 ($p<0.001$) between the subscapular skinfold and the weight-for-height SD-score, see figure 6.13.

Figure 6.13. Triceps (upper figures) and subscapular (lower figures) skinfold measurements by weight-for-height SD-scores for boys (left) and girls (right).



The triceps skinfold was plotted against the Bilbao curves and the median values found in the Cambridge study (Paul et al., 1988; Paul et al., 1990), see figures 6.14 and 6.15. The Cambridge values are considerably lower than the Bilbao median values. The triceps values of the children in this study correspond better with the Cambridge values than those for Bilbao. Already in 1984, Whitehead and Paul (1984) described that the average values for boys in the Cambridge sample were close to the 10th centile of the British growth references used at that time. Both he and Paul (1988) insisted on the need for new growth standards for infants. Warrington and Storey (1988a) also observed skinfold thicknesses below the U.K. standards in both Asian and Caucasian children living in the U.K.

Figure 6.14. Triceps skinfold by age of the boys compared to the Bilbao and Cambridge references

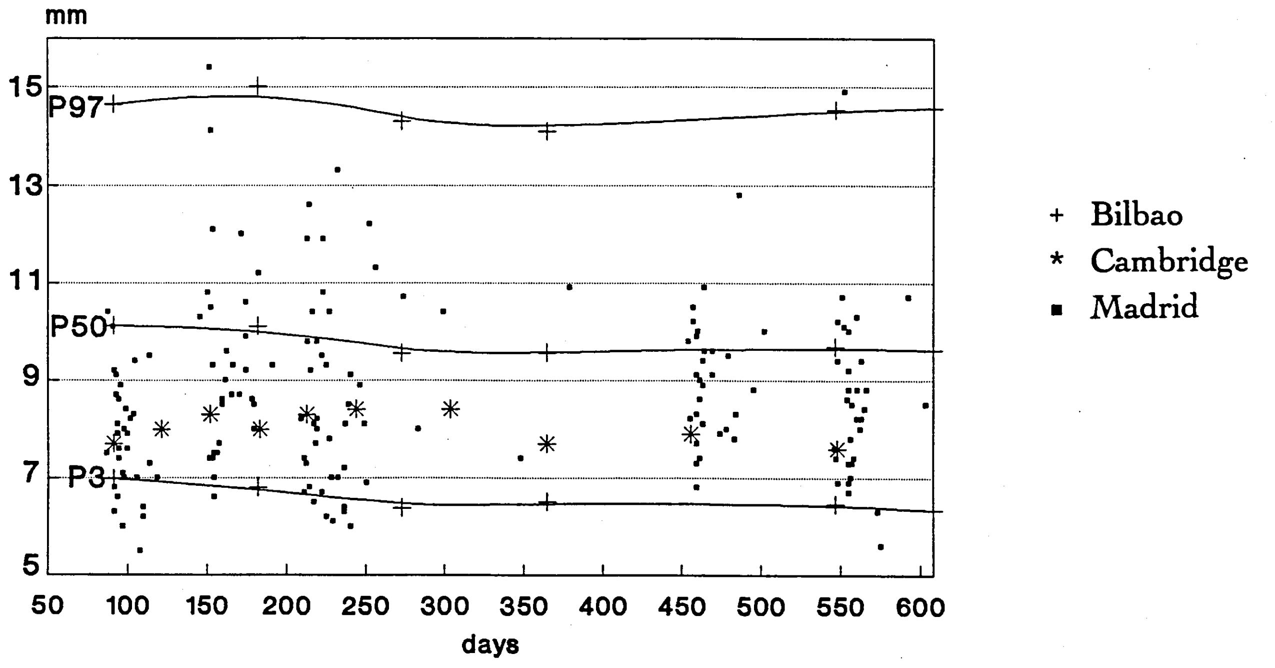
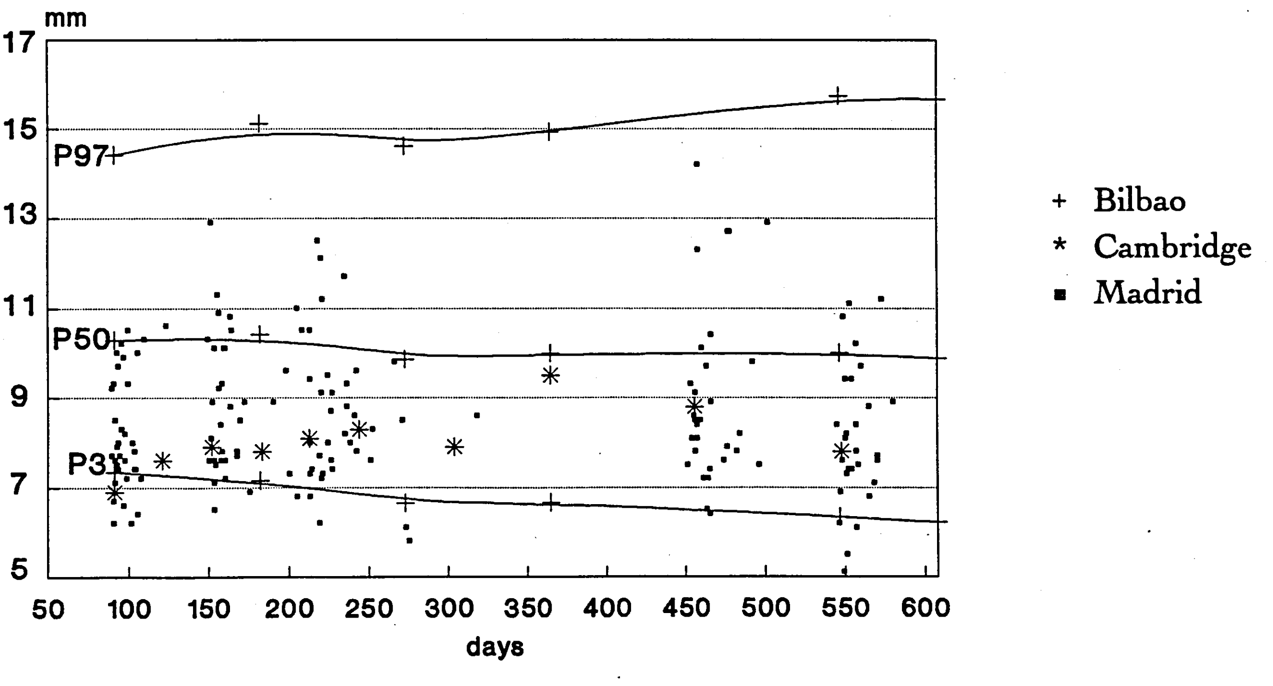


Figure 6.15. Triceps skinfold by age of the girls compared to two references



Subscapular skinfolds were also plotted against the Bilbao reference. Whereas the majority of the triceps skinfold measurements of the Madrid children were situated between the P3 and P50 of the Bilbao curves, the subscapular skinfold measurements for both sexes were mainly found between the P50 and P97, see figures 6.16 and 6.17.

Figure 6.16. Subscapular skinfold by age of the boys compared to the Bilbao reference

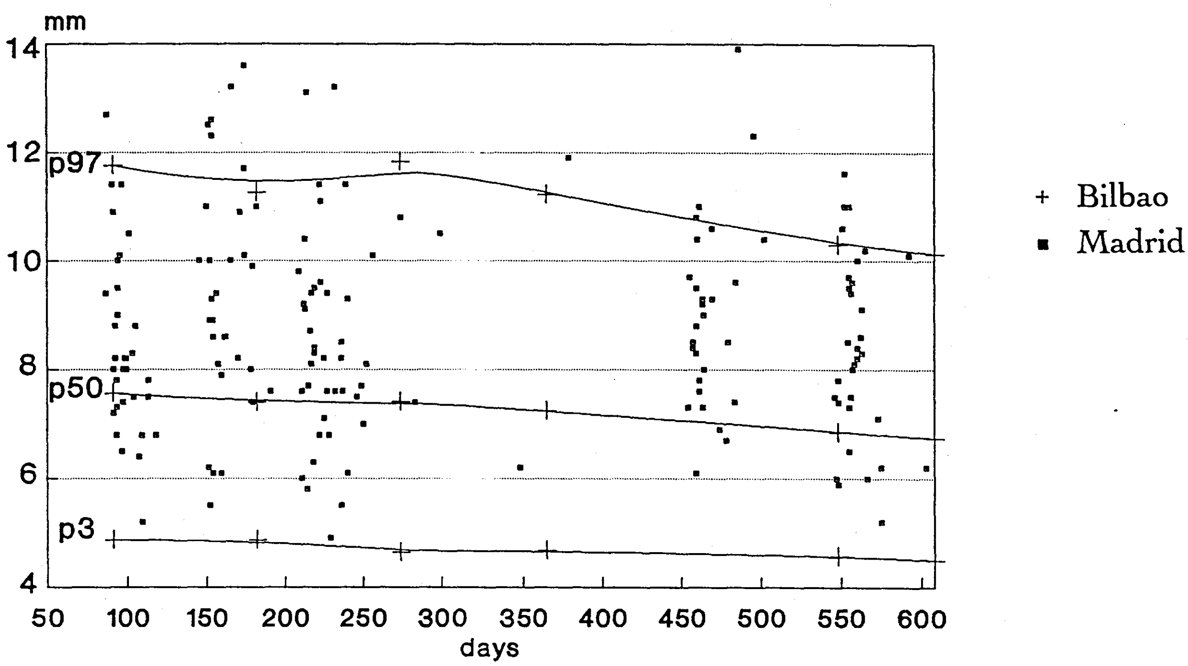
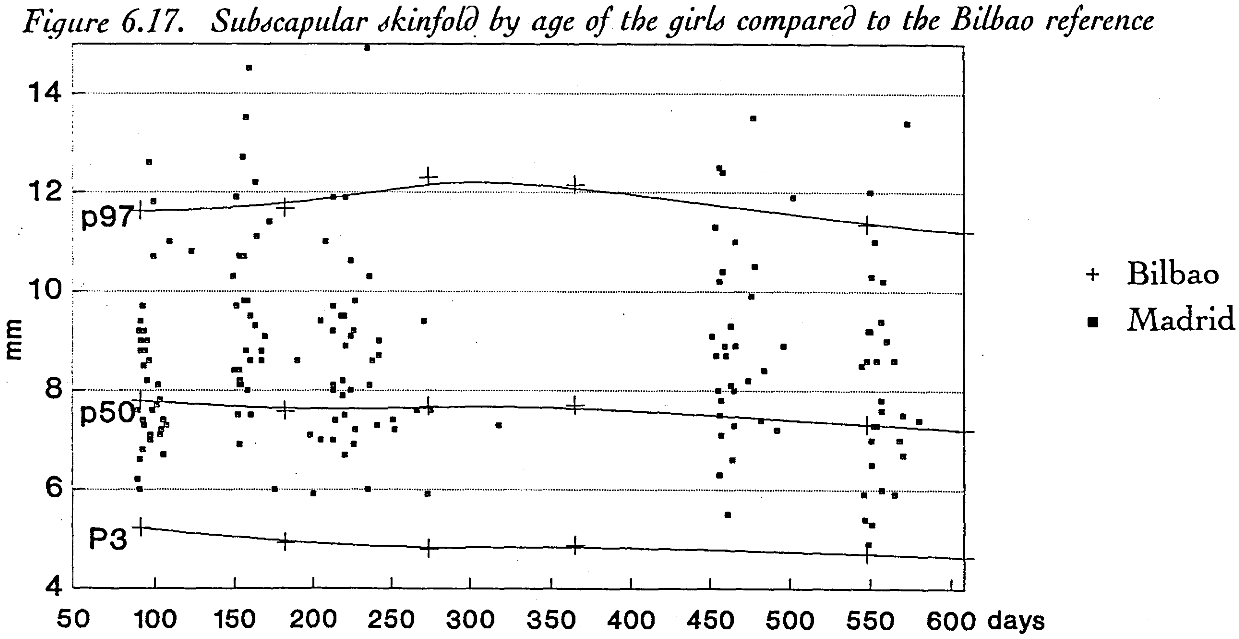


Figure 6.17. Subscapular skinfold by age of the girls compared to the Bilbao reference



6.3.9 Mid-upper arm circumference

The mid-upper arm circumference (MUAC) is not a widely used anthropometric measure in Western countries, but it is a popular and useful measurement in the Third World, especially where weighing scales are not available (Whitehead, 1989). The arm circumference can be related to height as an age-independent ratio of nutritional status similar to weight-for-height (Jelliffe, 1966). In 1969, Jelliffe and Jelliffe (1969) even declared the arm circumference a Public Health Index of Protein-Calorie Malnutrition in early childhood. Their monograph on this subject has become renowned and the mean values for the mid-upper arm circumference given by them a standard. In 1990, Voorhoeve published in the Journal of Tropical Pediatrics the results of mid-upper arm circumference measurements carried out by Gerver on more than 2.500 Dutch children and observed that at all ages the results of the Dutch children were greater than those published by Jelliffe and Jelliffe, whose figures were based on a large sample of healthy Polish children. Voorhoeve assumed that the greater arm circumference reflected the better nutritional status of the Dutch children. However, he commented that he saw no need to change Jelliffe's standard in measuring under- or malnutrition, but considered Gerver's results of essential importance for the detection of overnutrition. He indicated that in children under four years of age, a MUAC of more than 18 cm suggests that the child is fat and a MUAC of over 19 cm that the child is obese.

The mid-upper arm circumference values of this study were plotted against the Bilbao references, the values published by Voorhoeve and the median values found in the Cambridge study (Paul et al., 1988; Paul et al., 1990), see figures 6.18 and 6.19. More results of this study could be found under the P50 than over the P50 of both the Bilbao reference and the values published by Voorhoeve, but they were clearly situated over the P50 of the Cambridge study.

Figure 6.18. Mid-upper arm circumference by age of the boys compared to three references

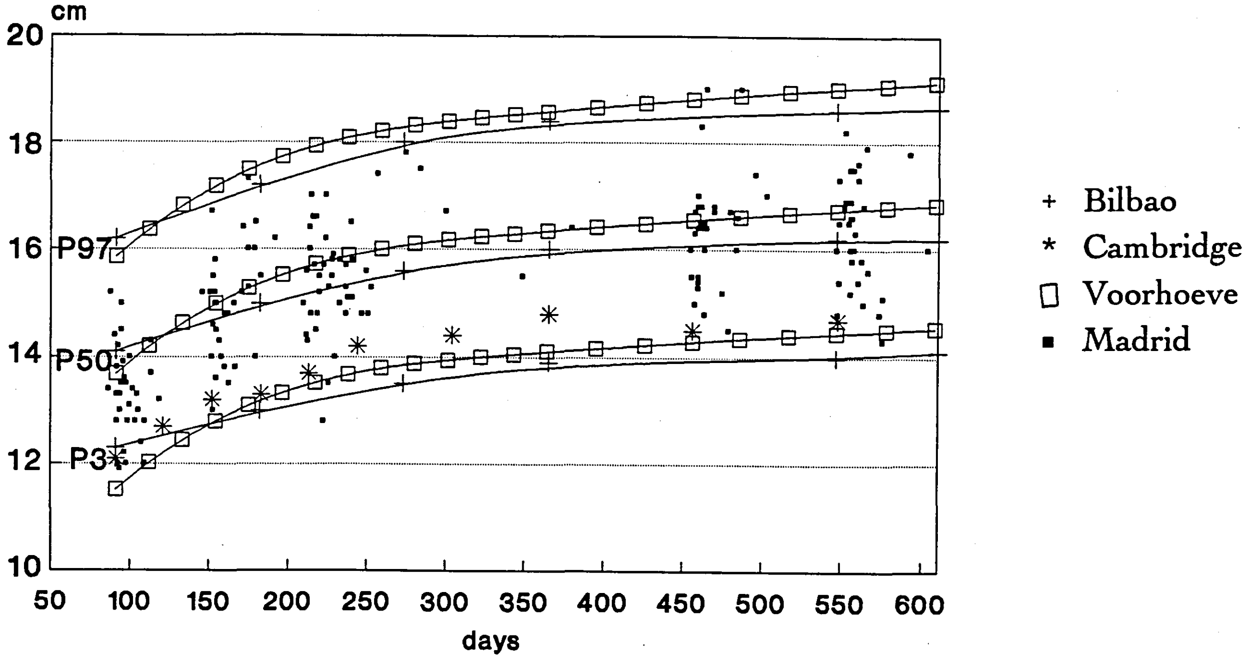
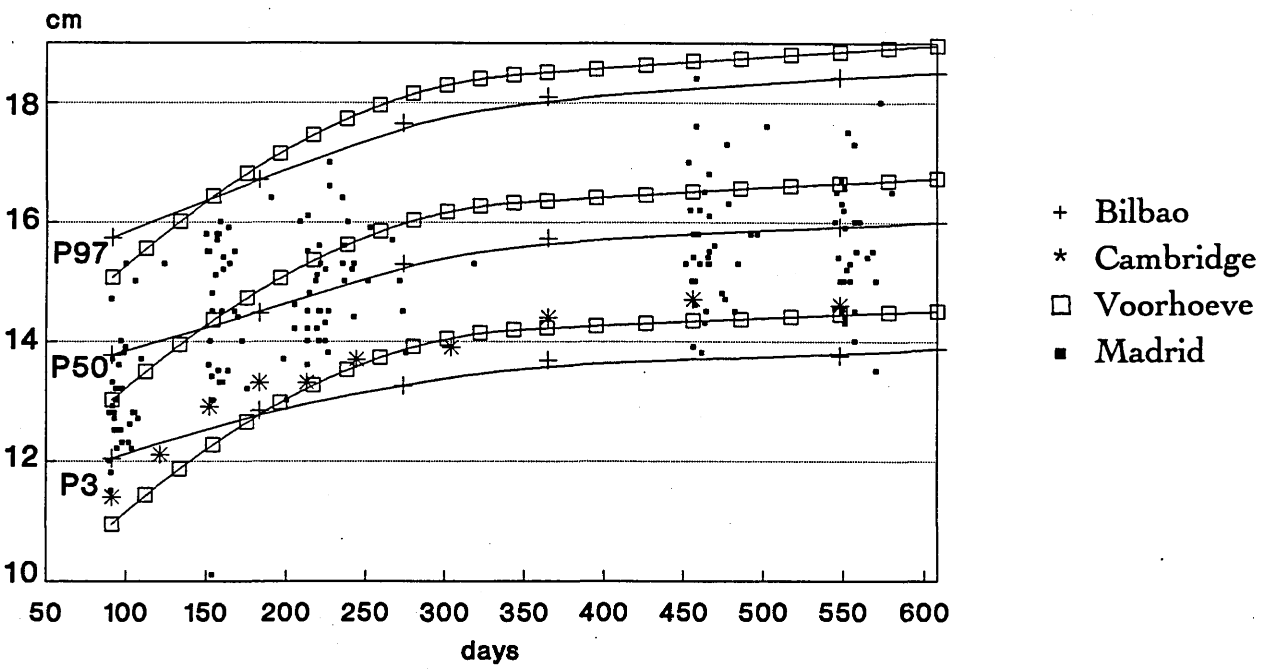


Figure 6.19. Mid-upper arm circumference by age of the girls compared to three references



Four boys and two girls had a MUAC of more than 18 cm. Both girls and only one of the boys had also a weight-for-height SD-score over 2. Two boys would be classified by the mid-upper arm circumference as fat and one as obese while their weight-for-height SD-score was lower than two. Other children with a weight-for-height SD-score higher than two would not be classified as overweight by the MUAC, see table 6.9. The mid-upper arm circumference may be useful as an additional measurement to detect overweight children, but the cut-off point of 18 cm does appear to be too high to be able to detect all cases of overweight, as defined by the weight-for-height SD-score, in children up to one year and a half.

Table 6.9. MUACs and weight-for-height SD-scores of presumably overweight children

Age months	sex	MUAC cm	weight-for-height SD-score
15	female	18.4	2.9
18	female	18.0	2.2
15	male	18.3	1.9
15	male	19.0	1.6
15	male	19.0	3.0
18	male	18.2	1.6
7	female	16.4	2.1
7	female	16.1	2.3
15	female	16.8	2.2
15	female	17.6	2.1
18	female	17.3	2.1
18	female	17.5	2.9
5	male	16.5	2.0
7	male	17.0	2.1
9	male	17.8	3.1
10	male	16.7	2.2
15	male	17.0	2.3
15	male	16.8	2.2
18	male	17.3	2.2

6.4 Conclusions

Children in this study were on average taller and heavier than those of the Bilbao, WHO and new U.K. references. Only one (0.3%) child would be classified as underweight, as defined by a weight-for-height SD-score of less than -2, whereas 16 (4.7%) would be classified as overweight, as defined by a weight-for-height SD-score of more than two, based on the WHO reference. No statistically significant differences were observed between socioeconomic groups for either birth weight, height-for-age, weight-for-age or weight-for-height. Feeding method in the first months, i.e. breast- or formula-feeding, and timing of complementary feeding did not result in any statistically significant differences in the children's weight-for-height. This does not necessarily mean that no relationship existed as the research was not designed to study these influences in detail.

Head circumferences of the children were, on average, greater than those of the Bilbao and NCHS references and corresponded better with those of the Cambridge Growth Study. Statistically significant correlations were found between the SD-scores for head circumference based on the Cambridge data, and both birth weight and weight-for-age.

Also the skinfold measurements were more in line with the Cambridge data than with the Bilbao reference. Although taller and heavier, the children in this study appeared to be leaner than the children in the Bilbao sample. Statistically significant correlations were found between skinfold measurements, both triceps and subscapular, and the weight-for-height SD-scores.

The mid-upper arm circumference, another possible indicator of under- and overnutrition, confirmed that the children in this study were leaner than those of the Bilbao sample, as their average mid-upper arm circumference was smaller. The children had greater arm circumferences, however, than those of the Cambridge Growth Study.

Literature review revealed that many authors felt a need for new growth references for the present generation of infants, now that infant feeding practices have changed. The results of the present research seem to confirm this need.

The following chapters deal with the second line of research of the thesis.

CHAPTER 7

HOME-PREPARED BABY MEALS

The chemical composition of meals prepared at home
for children of seven and eight months
and their nutritional evaluation

7.1 Introduction

One of the nutritional aims of introducing complementary foods into the infant's diet is to provide that part of the child's energy and nutrient requirements that cannot be met by human milk or infant formula alone. Complete dishes, i.e. meals based on a high protein source (meat, fish, cheese, egg), together with vegetables and a starch component, are an important weaning food. In Spain, complete dishes for infants are available ready-to-use in jars, but their use is limited as commented in chapter 4, section 4.3.2. Recently, also complete meals in dehydrated form have become available, but their use is still infrequent. Most complete dishes for infants are prepared at home. Many mothers and paediatricians consider home-made baby meals superior in quality to their commercial equivalents, but little information is available to confirm this opinion. Rincón et al. (1990) analysed 260 samples of five types of commercial baby meals produced in Spain for ten minerals. They found that potassium, calcium, phosphorus, magnesium, iron and zinc content differed according to the meal variety, but that sodium, chloride, manganese and copper did not. In a follow-up study (Abellán et al., 1994) the calcium, phosphorus and magnesium contents were further studied in meat-based commercial baby meals and to what extent these contents were determined by the manufacturing process and ingredient composition. It was concluded that the levels of these three elements did not depend on the type of meat used in their preparation but rather on the recipe.

The aim of this study was to evaluate the nutritional composition of a series of meat-based home-prepared meals for children of seven and eight months old with respect to energy, macronutrients and six minerals, sodium, potassium, calcium, magnesium, iron and zinc.

7.2 Methods

Methods are discussed in detail in chapter 2, section 2.3

7.3 Results

7.3.1 Recipes

The recipes provided by the mothers showed great similarity. All meals were based on a mixture of vegetables, to which potatoes, meat, oil and other ingredients were added. The number of ingredients per meal varied from four to twelve. Table 7.1 gives an overview of the total number of ingredients used per meal.

Table 7.1. Total number of ingredients per meal

Number of ingredients	Number of samples
<4	0
4	2
5	9
6	8
7	9
8	7
9	11
10	3
11	0
12	2

The number of different vegetables in one meal varied from three to eight.

Table 7.2 shows the number of vegetables used per sample. Potatoes are included in this table as being a vegetable; pulses are not included. Garlic and parsley, that are used as condiments, are not classified as vegetables for this purpose.

Table 7.2. Number of vegetables per meal

Number of vegetables	Number of samples
3	5
4	13
5	22
6	5
7	5
8	1

All 51 samples had carrots in their composition and all but one potatoes. Most mothers prepared the meals for their babies for more than one day. The portions that were not used that same day, were deep frozen. Every day a meal was thawed to give to the baby. A consequence of this system was that the child received the same meal for a certain period. This period varied from three days to one month. Table 7.3 shows the recipe for the preparation of the meals for one month as given by one of the mothers.

Table 7.3. Recipe given by one mother for the preparation of one batch of 30 meals

water	2½ liter
Swiss chard	1 kg
slicing beans	1 kg
leek	4 normal sized
potatoes	9 big sized
carrots	1 kg
olive oil	2 tablespoons

After cooking and homogenizing the ingredients, the purée is divided into 30 portions which are deep frozen. Every day a portion of about 100 ml is thawed and 50 g of previously cooked and mincemeat is added.

A source of fat was added to 38 of the 51 meals (75%). Olive oil was the most frequently used fat source (31 meals, 61%); two meals had butter added, and eight meals were prepared with (marrow) bones or a piece of cured Spanish ham. Three of these last meals also contained olive oil. Both the bones and the ham were only used for preparing stock to flavour the meals. The ham was not included in the actual meal of the child.

The amount of oil added was minor. Particularly when the mother prepared meals for more than one day, this quantity had no proportion to the number of meals that were made. One mother, for instance, added two tablespoons of olive oil in a recipe for six meals, and the mother who prepared the meals for one month at a time did not add more than two tablespoons of oil either, as shown in table 7.3.

Potato was included in all but one recipe as the principal starch component. Like olive oil, the quantity of potato used was small and varied in most cases from a half to a whole small potato per meal.

Only 14 of the 51 meals (27%) had salt added and two meals derived salt from the cured Spanish ham that was added during cooking.

7.3.2 Chemical analysis

A summary of the results of the chemical analysis and the calculation of carbohydrates and energy are given in table 7.4; the complete data can be found in Appendix C.

Table 7.4. Composition per 100 g of 50 home-prepared baby meals based on veal

	unit	lowest value	mean	(SD)	highest value
total solids	g	8.3	12.4	(2.2)	17.4
protein	g	2.2	4.4	(1.3)	9.6
fat	g	0.1	1.4	(0.9)	4.1
carbohydrates	g	2.5	5.0	(1.3)	8.9
fibre	g	0.7	1.0		1.5
ash	g	0.2	0.7	(0.2)	1.1
Na	mg	11	67	(64)	257
K	mg	112	192	(45)	289
Ca	mg	6	15	(5.8)	29
Mg	mg	7	13	(2.8)	19
Fe	mg	0.2	0.5	(0.2)	0.9
Zn	mg	0.3	0.7	(0.3)	1.5
energy (kcal)	kcal	31	50	(11)	74
energy (kJ)	kJ	131	209	(47)	311

Fibre was analysed in five samples and varied between 0.7 and 1.5 g per 100 g product. Based on these samples a mean fibre value has been calculated of 8.3% (95% confidence limits 6.3-10.3) of the total solid content, which has been used for all samples that were not analysed for fibre. Table 7.5 gives the results of the fibre analysis.

Table 7.5. Dietary fibre content of five meal samples and its relation to total solids

sample	fibre g/100g	total solids g/100g	% fibre of total solids
1	0.7	10.7	6.6
2	0.9	11.6	7.7
3	1.5	14.4	10.4
4	0.9	12.4	7.2
5	1.0	10.6	9.4

7.4 Discussion

7.4.1 Recipes

It was interesting to find that mothers used such a variety of vegetables for one meal. In the Netherlands, for instance, one type of vegetable is generally used in baby meals. Geuns (1985) described in a study on the weaning patterns of 76 infants between six and 12 months of age, that most of the children received a complete cooked meal based on a high protein source with rice or potatoes and *one* vegetable only. Variety in the diet was obtained by choosing a different vegetable each day. The habit of using only one vegetable per day was also found in the Leiden Preschool Study in the Netherlands, in 65 home-prepared meals for children of six months in 1982 (Prof. Dr. D. Kromhout, personal communication). An important difference between the Leiden and Madrid study could be observed in the type of vegetables used and their frequency, see table 7.6. The choice of vegetables will mainly be based on cultural habits and availability of the product. Potatoes are not included as they are not considered a vegetable in the Netherlands.

Table 7.6. Types of vegetables used in 65 Dutch and 51 Spanish baby meals. Vegetable names partly from Buishand et al., 1986

Vegetable	Span. meals	Dutch meals	Spanish name	Dutch name	Botanical name
Carrots	51	13	zanahoria	wortel	*Daucus carota*
Leek	39	1	puerro	prei	*Allium porrum*
Slicing beans	35	11	judía verde	snijboon	*Phaseolus vulgaris*
Swiss chard	21	0	acelga	snijbietrib	*Beta vulgaris* var. *flavescens*
Turnip	14	0	nabo	koolraap	*Brassica napus* var. *napobrassica*
Courgette	13	0	calabacín	courgette	*Cucurbita pepo*
Cauliflower	1	10	coliflor	bloemkool	*Brassica oleracea* var. *botrytis*
Endive	0	11	escarola	andijvie	*Cichorium endivia*
Onion	9	0	cebolla	ui	*Allium cepa*
Spinach	2	7	espinacas	spinazie	*Spinacia oleracea*
Tomato	7	5	tomate	tomaat	*Lycopersicum lycopersicum*
Chicory	0	7	endivias	witlof	*Cichorium intybus* var. *foliosum*
Peas	3	0	guisante	doperwt	*Pisum sativum*
Sweet pepper	2	0	pimiento	paprika	*Capsicum annuum*
Lettuce	2	0	lechuga	sla	*Lactuca sativa*
Beet root	0	2	remolacha	rode biet	*Beta vulgaris* var. *conditiva*
Celery	1	0	apio	bleekselderij	*Apium graveolens* var. *dulce*
Celeriac	1	0	apio	knolselderij	*Apium graveolens* var. *rapaceum*
Pumpkin	1	0	calabaza	pompoen	*Cucurbita maxima*
Aubergine	1	0	berenjena	aubergine	*Solanum macrocarpum*
Kohlrabi	0	1	nabicol	koolrabi	*Brassica oleracea* var. *gongulodes*
Purslane	0	1	verdolaga	postelein	*Postulaca oleracea* ssp. *sativa*
Total used	203	69			
Meals	51	65			
Mean per meal	4.0	1.1			

7.4.2 Nutritional composition of the meals

Differences between meals prepared by the same and by different mothers
Highly significant differences were observed for all nutrients between the meals prepared by different mothers. A random-effect one-way analysis of variance was performed. By using the F distribution, the ratio of standard deviations (τ/σ) could be estimated where τ is the between-mother standard deviation and σ the within-mother standard deviation (Wetherill, 1972). Ta-

ble 7.7 gives both the p-value and the estimated ratio with its 95% confidence interval for each nutrient.

Table 7.7. p-value and estimated ratio of standard deviations with its 95% confidence interval for energy and each nutrient

	p-value	estimated ratio	95% confidence interval
energy	<0.0001	1.5	0.8-2.3
protein	0.0001	1.4	0.8-2.3
fat	0.0006	1.2	0.6-2.0
carbohydrates	0.0001	1.4	0.8-2.3
sodium	<0.0001	2.6	1.6-3.9
potassium	0.0016	1.1	0.5-1.8
calcium	0.0010	1.2	0.6-1.9
magnesium	0.0003	1.3	0.7-2.1
iron	<0.0001	1.6	0.9-2.5
zinc	<0.0001	1.5	0.8-2.4

The between-mother differences were bigger than the within-mother differences. The biggest differences were observed for sodium, as some mothers added salt to the meals and others did not.

Comparison with dietary guidelines for infants of 7 and 8 months of age

Various countries have dietary guidelines in which they give the estimated recommended intake for energy and nutrients. Table 7.8 compares an average size (200 g) of home-made baby meal, using the mean values for energy and nutrients obtained in this study, with the recommended intakes of energy and nutrients of the Panel on Dietary Reference Values of the Committee on Medical Aspects of Food Policy in the U.K. (DHSS, 1991), the National Research Council in the United States (1989), the *Voedingsraad* in the Netherlands (1992) and the reference values for nutritional labelling for foods intended for infants and young children from the EC (1994). Spain does not have any official dietary guidelines.

The U.K. recommendation for protein is based on the use of egg and milk protein, assuming total digestibility. In a diet which contains other types of protein, the reference value should be increased to adjust for the lower quality of other proteins. The Dutch guidelines are the only ones, that recommend a certain energy distribution between the macronutrients. Protein should be derived from about 11 percent of the energy intake, giving the figure of 22 g of protein per day. Baby meals provide between 10 and 15% of the daily estimated average energy requirements, and between 40 and 60% of the reference protein intake. Milk taken as breast milk or formula is still the basis of the diet of children of seven and eight months. The baby meals are taken as a complement to this milk basis. Hence, it is easily understood that the total protein intake per day will surpass the recommended amount for this nutrient.

Table 7.8. Recommended daily intakes and the amounts provided by an average portion of home-prepared meal; for recommendations given per kg weight, the weight of the child was taken to be 9 kg.

			UK	US	NL	EC	200 g of baby meal	% of daily recommendations
age range		months	7-9	6-12	6-12	6-12	7-8	
energy	kcal	boys	825	850	850		100	12%
	kcal	girls	765	850	850		100	12 to 13%
protein	g		13.7	14	22		8.8	40 - 64%
fat					35-40 En%		2.4	6 - 8%
carbohydrates					± 50 En%		10.0	9%
sodium	mg		320				134	42%
potassium	mg		700				384	55%
calcium	mg		525	600	400-600	400	30	5 - 8%
magnesium	mg		75	60	35-60		26	35 - 74%
iron	mg		7.8	10	7	6	1.0	10 - 17%
zinc	mg		5.0	5	4	4	1.4	28 - 35%

Fat should provide between 35 and 40% of the total energy, which means an intake of between 32 and 37 g per day. The average content of 2.4 g of fat in a baby meal contributes only a meagre seven percent to this amount. The meals supply about 10% of the daily recommendation for carbohydrates.

Only the U.K. gives a reference intake for sodium and potassium. About half of these values are covered by the average baby meal. The meals are a poor source of calcium. The principal calcium source for children in the second half of the first year is still breast milk or formula, which reduces the need for other calcium suppliers. Baby meals may provide a substantial part of the magnesium requirements of the infant, depending on the recipe of the meal and the portion the baby takes. Although meat-based baby meals may help to cover the iron requirements of the child, they are by no means such an important iron source as often thought. The meals contribute a significant amount of zinc.

Comparison with the composition of human milk

Although complementary foods, such as baby meals, are not intended to substitute human milk or infant formula, but rather provide additional energy and nutrients to cover the increased nutritional needs of the baby, a comparison between the two is useful to show where baby meals may supplement human milk. Table 7.9 shows the nutritional composition of mature human milk as given in McCance & Widdowson (Holland et al, 1991) and the mean values for the home-made meals of this study.

Table 7.9. Composition of mature human milk and 50 home-made meals per 100 g

		mature human milk	home-made meals mean values	index
protein	g	1.3*	4.4	3.4
fat	g	4.1	1.4	0.3
carbohydrates	g	7.2	5.0	0.7
energy, kcal	kcal	69	50	0.7
energy, kJ	kJ	289	209	
Na	mg	15	67	4.5
K	mg	58	192	3.3
Ca	mg	34	15	0.4
Mg	mg	3	13	4.3
Fe	mg	0.07	0.5	7.1
Zn	mg	0.3	0.7	2.3

* Calculated as Nx6.38. Excluding the non-protein nitrogen, true protein is 0.85%

Compared to human milk, the home-prepared meals provided per 100 g product more protein, sodium, potassium, magnesium, iron and, to a lesser extent, zinc. The contribution of the meals to the increased needs for energy in the form of fat and carbohydrates was low.

Comparison with guidelines for commercial baby meals

Both ESPGAN and the EC have developed recommendations for the composition of commercial baby-meals. ESPGAN published its guidelines in 1981

(ESPGAN, 1981). The EC draft directive on processed cereal-based foods and baby foods for infants and young children (EC, 1994) is still not accepted. The home-prepared meals of this study were checked for their compliance with these recommendation.

Both ESPGAN and the EC establish a minimum of protein for complete dishes, ESPGAN sets this minimum at 4.5 g per 100 kcal, the EC at 3 g per 100 kcal. All home-prepared meals complied with these guidelines. Neither of the two guidelines give a maximum for protein. The home-prepared meals showed values of up to 14.8 g of protein per 100 kcal, more than three times the minimum protein level set by ESPGAN and almost five times that set by the EC.

The EC has established a maximum value for fat in complete dishes of 4.5 g per 100 kcal. In the report of the Scientific Committee for Food (1989/1990), which is the basis of the draft directive, it is argued that throughout Europe recommendations have been made to reduce the overall consumption of fat, particularly saturated fat. A strict limitation of fat in the infant's diet, e.g. down to 30 En% as advised for adults, is thought inappropriate. The Committee suggests therefore that energy derived from fat should not exceed 40%, i.e. 4.5 g per 100 kcal. Four home-prepared meals had higher values than that, the highest being 5.5 g per 100 kcal. In three of the four cases, olive oil was used and in one case fat was derived from a bone used during the cooking of the meal. The mayority of the meals had a low fat content, on average 2.5 g per 100 kcal which is equivalent to 22.5 En% and thus lower than thought desirable by the EC.

ESPGAN did not establish a guideline for fat, but did so for the energy content of the meals. According to ESPGAN, one of the aims of these complete dishes is to supply more energy per volume than human milk. It seemed therefore reasonable that such a main course has an energy density of at least 70 kcal or 300 kJ per 100 g. Only three out of the 51 home-prepared meals had an energy content of 70 kcal or higher. All three of them had a fat content above the EC recommendation. The average energy content of all meals was 50 kcal per 100 g product, with the lowest energy density being only 31 kcal per 100 g.

Both ESPGAN and the EC give a maximum value for sodium, ESPGAN established this value at 230 mg per 100 kcal (10 mEq/100 kcal), the EC proposes 200 mg per 100 kcal. Ten meals had higher sodium levels than 230 mg per 100 kcal, and 12 higher than 200 mg per 100 kcal, thus about 20% of the samples had sodium contents higher than recommended.

Comparison with commercial baby meals in Spain

At least 25 varieties of commercial baby meals indicated for infants of seven to nine months were available in Spain from the three major manufacturers of baby jars (Nestlé, Alter and Hero). Five of them used veal as the main protein source. Table 7.10 gives the mean nutritional composition of the 25 commercial meals, the five meals based on veal and the results of this study.

Table 7.10. Nutrient content of commercial and home-made meals. Between parentheses, minimum and maximum values

		25 commercial meals based on meat	5 commercial meals based on veal	50 home-made meals based on veal
protein	g	4.5 (3.5-5.5)	4.4 (4.0-4.8)	4.4 (2.2-9.6)
fat	g	3.2 (2.2-4.4)	3.0 (2.6-3.5)	1.4 (0.1-4.1)
carbohydrates	g	7.3 (5.2-9.5)	7.5 (6.0-8.1)	5.0 (2.5-8.9)
energy	kcal	76 (70-90)	75 (72-77)	50 (31-74)
Na	mg	127 (60-183)	141 (113-164)	67 (11-257)
K	mg	166 (102-207)	170 (145-197)	192 (112 - 289)
Ca	mg	16 (7-46)	13 (8-21)	15 (6-29)
Mg	mg	12 (8-18)	12 (10-13)	13 (7-19)
Fe	mg	0.7 (0.4-1.2)	0.7 (0.6-0.8)	0.5 (0.2-0.9)
Zn	mg	0.5 (0.1-1.1)	0.4 (0.1-1.0)	0.7 (0.3-1.5)

The five commercial baby meals based on veal do not differ significantly in their nutritional composition from all meat-based commercial baby meals. However, there are differences between the commercial and home-made meals. These can be found in the fat, carbohydrate, energy and sodium content. The quantities of the other five minerals are quite similar in both types of meals. The range between maximum and minimum values is much wider for the home-made meals. Average sodium content was higher in the commercial meals, although well below the maximum recommended level by both ESPGAN and the EC. Energy density of the commercial meals was higher than in the home-made meals, because of both a higher fat and carbohydrate content. Table 7.11 gives the relation of macronutrients expressed as a percentage of energy for both types of meals.

Table 7.11. Percentage of energy derived from each macronutrient for commercial and home-made baby meals based on veal

	commercial meals	home-made meals
protein	24 En%	36 En%
fat	36 En%	23 En%
carbohydrates	40 En%	41 En%

The commercial meals have a far better balance between macronutrients than the home-made meals. This is mainly due to their higher energy content. Addition of fat to the home-made meals would increase their energy density as well as improve the relation between the three macronutrients.

Comparison with the composition of home-made baby meals in the U.K.
Between June and October 1992, a study on weaning was conducted in the U.K. among 1004 infants. Home-prepared meals of a subsample were collected and chemically analysed (J. Morgan et al., 1994). Out of 108 savoury meals, none was based on veal, but 27 had beef in their composition, the type of meat that comes closest to veal (A. Redfern, personal communication). The meals were prepared for infants between four and eleven months. To eliminate the possible influences of the younger and older infants, the 15 meals for children between 6 and 9 months have been looked at separately.

Table 7.12. Nutrient contents of British and Spanish baby meals made at home. Between parentheses are the minimum and maximum values

Country		U.K.	U.K.	Spain
Age range		4 to 11 months	6 to 9 months	7 to 8 months
Type of meat		beef	beef	veal
Number of meals analysed		27	15	50
protein	g/100 kcal	5.8 (1.7-11.8)	4.6 (1.7-11.8)	9.1 (5.0-14.8)
fat	g/100 kcal	2.4 (0.5- 6.4)	2.0 (0.5- 5.0)	2.5 (0.3- 5.5)
carbohydrates	g/100 kcal	13.8 (1.7-20.5)	14.4 (5.7-20.5)	10.3 (4.8-14.7)
Na	mg/100 g	187 (12-534)	124 (12-377)	67 (11-257)
K	mg/100 g	243 (149-423)	235 (149-423)	192 (112-289)
Ca	mg/100 g	29 (5-147)	29 (6-147)	15 (6- 29)
Mg	mg/100 g	not available	not available	13 (7- 19)
Fe	mg/100 g	0.8 (0.3-2.5)	0.7 (0.3-1.7)	0.5 (0.2-0.9)
Zn	mg/100 g	0.9 (0.1-2.5)	0.8 (0.1-2.5)	0.7 (0.3-1.5)
energy	kcal/100g	79 (36-192)	74 (36-192)	50 (31-74)

Table 7.12 shows the average nutritional composition of both the 27 and 15 beef-based British meals and of the 50 veal-based Spanish meals.

The range between the observed maximum and minimum values is in all cases smaller in the Spanish group. The British meals showed more diversity in their recipes than the Spanish ones which explains the wider range of results. They included, for instance, varieties such as spaghetti bolognese, meat pie with potato, vegetables and gravy in addition to the type of meals served by the mothers in Madrid.

The main differences between the British and Spanish meals can be found in the energy, protein and sodium content. British meals had a higher energy density and contained less protein. The extra energy in the British meals was provided by a higher carbohydrate content. Average sodium content was higher in the British meals, as probably more mothers added salt to the meals.

7.5 Conclusions

The home-prepared baby meals in this study showed a great similarity in their recipe. All were based on a mixture of vegetables, to which potatoes, meat, oil and other ingredients were added. The choice of ingredients was influenced by culture and local availability of products. Many mothers prepared one recipe of baby meals for several days at the time. The quantities of fat and starch in these recipes was often not proportional to the number of prepared meals.

With few exceptions the meals in this study had a low energy density. As one of the aims of this type of meals is to provide extra energy, mothers should be stimulated to add more fat and carbohydrates to the meals in the form of olive oil and starch. The latter can be achieved by increasing the amount of potato in the meals or by using other starch sources such as pulses and pasta.

The protein content was high in proportion to the energy provided by the meals. Once the energy density increases and the amount of meat used in the meals remains the same, then the relation between the three macronutrients will improve considerably. Some meals contained exceptionally high quantities of protein, up to almost five times the minimum protein level set by the EC for commercial baby-meals. Better information should be provided to the mother about the quantity of meat to be added to the meals. Veal and other lean meat varieties supply about 20 g of protein per 100 g product (Holland et al, 1991). In theory, a quantity of 15 g per meal is therefore sufficient to cover the minimum protein level set by the EC. The final protein content of the meal will anyhow be higher as the other ingredients also provide some protein.

About 20% of the meals had a higher than desired sodium level. To all but two of these meals salt had been added. In the case of the other two meals an ingredient with a high salt level, cured Spanish ham, was used to preprare stock in which the meal was cooked. Mothers should be made aware, that there is no need for salt to be added, but if they wish to do so, then the amount should be minimal.

Both home-prepared and commercial baby-meals are a poor source of calcium, but are an important supply of magnesium. Veal-based meals only have minor levels of iron, although meat-containing meals are often thought to provide the extra iron needed by infants in the second half year of life. They contribute a significant amount of zinc.

Chapter eight will discuss in greater detail the importance of the baby meals in the total food intake of the children in this study.

CHAPTER 8

ENERGY AND NUTRIENT INTAKE

An assessment of daily energy and nutrient intake of a group of children between seven and eight months old

8.1 Introduction

In the second half of the first year, infants pass from an exclusively milk diet to a diet which includes foods eaten by the rest of the family. This diversification of the diet makes it more difficult to estimate if the nutritional requirements of the infant are met in a period when growth and development still depend heavily on an adequate supply of nutrients. The aim of this part of the study was

(a) to estimate the intake of energy, macronutrients and six minerals, sodium, potassium, calcium, magnesium, iron and zinc of infants between seven and eight months old,
(b) to compare the results with the recommended nutrient intakes,
(c) to compare the results with those of similar studies carried out in other countries, and
(d) to evaluate the importance of the baby meals and infant and follow-on formulas in these diets.

8.2 Methods

Methods are discussed in detail in chapter 2, section 2.3.

8.3 Results

8.3.1 Meal pattern

The meal patterns of the 27 children were very similar, as were the recipes of the home-made meals. Mothers appear to receive similar instructions from their paediatricians and from others who may influence the way they feed their babies.

Breakfast and supper were generally of the same type and consisted for 24 infants (89%) of formula with infant cereals. One child took formula alone and two children received milk-cereals as their only milk source. More follow-on formula (63%) than infant formula (26%) was used. No child was given cow's milk. Table 8.1 specifies the type of milk for the whole sample.

Table 8.1. Type of milk used by 27 children

follow-on formula	n=17	63%
infant formula	n= 7	26%
milk cereals	n= 2	7%
hypo-allergenic formula	n= 1	4%

Of the 27 children, 13 (48%) were taking gluten-free cereals, four (15%) took both gluten-free and gluten-containing cereals and 10 (37%) were given only gluten-containing cereals.

Dinner was served at midday and consisted of a complete meal based on meat, vegetables and a starch component as discussed in chapter 7, section 7.2.1. In 30 cases (56%) the child only received the complete meal. In the other 24 cases (44%), the infant was offered some other food after the meal. Table 8.2 shows which foods were given as a dessert.

Table 8.2. Foods offered to the baby after dinner

food	number of occasions
yoghurt	14
yoghurt and fresh orange juice	1
fresh orange juice	5
formula (infant or follow-on)	3
formula with infant cereals	1
total	24

After the afternoon nap, the children were given a *merienda*, an afternoon snack. In all but four cases this was a fruit purée. This purée was either home-made, ready-to-use in a jar or prepared from instant fruit cereals. Table 8.3 shows which foods were given.

Table 8.3. Afternoon snack offered in 54 occasions to 27 children

food	number of occasions
fresh fruit purée	32
fresh fruit purée and formula	5
baby fruit jar	9
baby fruit jar and biscuits	1
infant fruit cereals	3
total fruit	50
formula with infant cereals	2
custard and cake	1
yoghurt	1
total other foods	4
GRAND TOTAL	54

In between meals, four of the children received an extra bottle of formula on one or two occasions, because they had not finished their main meals. Three of these bottles were given during the night. Most children drank water between meals. One mother added saccharine to the water. Two infants took fresh orange juice between meals, two were given biscuits and one had a sweet.

8.3.2 Energy and nutrient intake

Nutrient intake based on the food diaries have been calculated separately for boys and girls. Table 8.4 summarizes the results. As could be expected, boys had higher energy intakes than girls. The difference in energy was mainly provided by carbohydrates. The complete data can be found in Appendix D.

Table 8.4. Energy and nutrient intake of boys and girls in this study

			mean	SD	minimum value	maximum value
energy	kcal	boys	897	118	595	1176
		girls	807	123	548	1063
energy	MJ	boys	3.7	0.5	2.5	4.9
		girls	3.4	0.5	2.3	4.7
protein	g	boys	29	4	23	39
		girls	29	6	18	39
fat	g	boys	22	4	16	32
		girls	22	5	14	29
carbohydrates	g	boys	145	21	84	184
		girls	125	20	86	166
sodium	mg	boys	365	113	229	595
		girls	419	177	138	737
potassium	mg	boys	1619	270	1038	2322
		girls	1457	343	838	2120
calcium	mg	boys	651	90	438	784
		girls	666	168	306	890
magnesium	mg	boys	130	24	92	169
		girls	115	27	75	205
iron	mg	boys	15.2	4.5	6.0	21.9
		girls	12.0	4.9	4.5	23.7
zinc	mg	boys	4.8	1.2	2.8	8.1
		girls	4.4	0.8	3.1	6.3
En% protein		boys	13.0	1.9	10.6	18.0
		girls	14.4	2.5	10.0	22.3
En% fat		boys	22.4	3.2	16.0	26.7
		girls	23.4	5.1	10.4	32.8
En% carbohydrates		boys	64.5	3.8	56.0	72.7
		girls	61.8	4.2	52.8	68.5

boys: n=22 food diaries; girls: n=24 food diaries

8.4 Discussion

8.4.1 Meal pattern

The children in this study took about four meals per day. In Sweden, Persson (1984c) found that children of six months took four meals per day, whereas this increased to five meals at the age of 12 months. Kylberg (1984a), also in Sweden, observed a meal frequency of 4.4 at the age of nine months, while Kjaernes et al. (1988) in Norway registered a frequency of four meals per day in children of 10 months of age. The number of meals offered per day to children in the second half of the first year do not vary much between a Northern and a Mediterranean country.

The study on feeding habits in 1989 showed that between about a half and two thirds of the babies were given a follow-on formula at some stage, see chapter three, section 3.3.2. In this study, 63% of the babies were taking a follow-on formula, which is well within the range found in the first study. One child was prescribed a hypo-allergenic formula by the paediatrician because of a supposed intolerance to the ordinary infant formula. The same child, though, had yoghurt on a daily basis and was already introduced to fish, which, according to the mother, he tolerated well. The justification for the use of the hypo-allergenic formula may thus be questioned.

8.4.2 Energy and nutrient intake

The advantages and limitations of a one-day dietary food record are already discussed in chapter one, section 1.5.1. This method gives a good impression of the energy and nutrient intake of the sample as a whole. In this study, it also shows the nutritional value of the home-prepared meals in the context of a whole day.

Energy and proteins

The U.K., the Netherlands, the U.S. and the EC give estimated average requirements for energy and a reference nutrient intake for protein. In table 8.5 the results of this study are compared to these recommendations.

Table 8.5. Recommended daily intakes for energy and protein for children (taking 9 kg as the weight of the child when the recommendation is given per kg body weight) compared to the results of this study.

	energy, MJ/day		protein, g/day		age range
	boys	girls	boys	girls	in months
U.K.	3.44	3.20	13.7		7 to 9
Netherlands	3.5		22		6 to 12
U.S.	3.57		14		6 to 12
EC	no data		15		6 to 12
This study:					7 to 8
mean ± SD	3.7±.05	3.4±0.5	29±4	29±6	
minimum	2.5	2.3	23	18	
maximum	4.9	4.7	39	39	

Average energy intake is slightly higher than recommended by the various nutrition authorities, although there is a wide range of energy intakes both for boys and girls. Most of the energy, about 45% was delivered by the infant formulas and follow-on milks. Persson (1984b) observed, that whereas follow-on milks supplied about 57% of the daily energy intake at the age of six months in Sweden, this percentage had decreased to 26% at the age of 12 months. In the U.K. (Mills and Tyler, 1992), cow's milk contributed 18% to the daily energy intake of children between six and nine months, infant formulas 23% and breast milk 6%. The contribution of all milks was thus similar to the results of this study. The meals provided on average 13% of the daily energy intake.

Protein intake was high. The lowest protein intake in the male group is even higher than the highest recommendation for protein. Particularly taking into account that these recommendations already include a safety margin to cover even the needs of those children with high requirements, it is clear that intakes exceed the real needs of the infants. The milks contributed about 43% of the daily intake and the meals 33%.

Studies carried out in other European countries and in the U.S. also show high protein intakes, as table 8.6 shows. Persson (1984b) comments that the possible clinical significance of a low fat, high protein diet remains to be determined.

Table 8.6. Energy and protein content of diets of young children in various countries compared to the results of this study

Study	year*	method of recording	country	age-group	number of infants	energy kcal	energy MJ	protein grams
This study	1994	1-day dietary record	Spain	7-8 m	m 11	m 897±118	3.7±0.5	29±4
					f 13	f 807±123	3.4±0.5	29±6
McKillop & Durnin	1982	5-day weighing record	U.K.	0.6-1.0 years	91	m 924±251	3.87±1.05	34±3.3
						f 801±169	3.35±0.71	28±3.2
Persson	1984	24-h recall	Sweden	6 m	76	676±95	2.8±0.4	26±6
				12 m	136	1027±233	4.3±1.0	43±12
Geuns	1985	5-day weighing	NL	6-12 m	76	764±140		31±7
Montalto**	1985	24-h recall	USA	7-8 m	F 20	750		25
					CM 51	820		41
Kylberg***	1986	7-day weighing	Sweden	9 m	40		3.4	32
Horst	1987	24-h recall	NL	6 m	F 96	702±106	2.9±0.4	20±4
Kjaernes	1988	24-h recall	Norway	10 m	154	930±200		35±11
Francescato	1990	7-day dietary record	Italy	8 m	192	838±175	3.5±0.7	33±4.6****
Bellù	1991	24-h recall	Italy	12 m	164	996		49±1.3
Mills & Tyler	1992	7-day dietary record	U.K.	6-9 m	m 130	836±163	3.5±0.7	28±8
					f 128	795±207	3.3±0.9	27±8

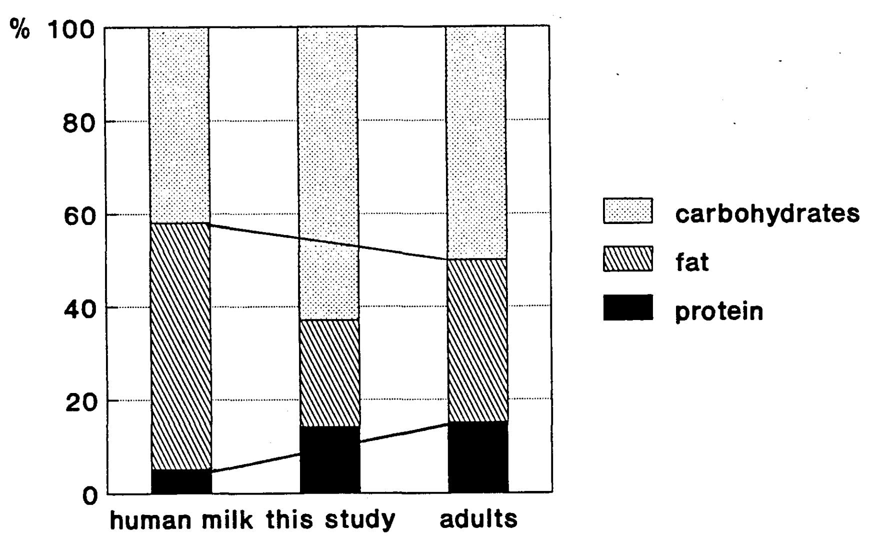
* year of publication
** median values, not mean values
*** median values, calculated from original data for a baby of 9 kg
**** calculated from original data
m= male, f= female; F= formula-fed, CM= taking cow's milk
figures are rounded off to integers (except for the megajoules, MJ)

Energy distribution between macronutrients

The weaning period is a transitional phase between human milk and family foods, as it is in relation to the macronutrients, protein, fat and carbohydrates. This period should mean a gradual change from the low protein, high fat human milk to the higher protein, lower fat, healthy adult diet. The Dutch recommendation for the energy distribution between macronutrients in the second half of the first year suggests therefore a protein intake of about 11 energy percent and a fat intake of between 35 and 40 energy percent. The Scientific Committee for Food from the European Community state in their conclusions and recommendations on baby foods, as already commented in chapter 7, section 7.3.2, that strict limitation of fat in the diet, e.g. down to 30% of energy as advised for adults, is inappropriate for weanlings. On the other hand, fat should not exceed 40% of energy (EC, 1989/1990). An average of 23% of energy provided by fat, as found in this study, is thus undesirable in the older infant's diet. More than three quarters of the fat intake was supplied by the infant and follow-on milks, thereby assuring a minimum intake of essential fatty acids as required by ESPGAN (1991) and the EC (1991). The meals should be another main source of fat, but in this study only contributed an average of 12% of the total fat intake. Neither the cereals nor the fruit purées were important sources of fat. As the home-made meal had low fat content, as discussed in chapter 7, section 7.3.2, the total fat content of the diets remained very low.

Protein intake was high, as was the carbohydrate content of the diet to compensate the low fat content. The comparison is shown in figure 8.1.

Figure 8.1 Energy distribution of human milk and the recommended adult diet, compared to the results of this study



	human milk	this study	adults
carbohydrates	42	63	50
fat	53	23	35
protein	5	14	15

Other studies have found lower than desired fat intakes, but none of them have observed such a low fat content as seen in this study, see table 8.7.

Table 8.7. Energy distribution among macronutrients

Study	age-group	protein	fat	carbohydrates
This study	7-8 months	14	23	63
McKillop	0.6-1.0 years	14	40	46
Persson	6 months	16	29	55
	12 months	17	33	50
Kylberg*	9 months	15	28	55
Horst	6 months	12	31	57
	9 months	16	28	56
Francescato	8 months	16	33	51
Bellù	12 months	19	31	50
Mills & Tyler	6-9 months	14	36	50

* median values, they do not sum up to 100%

Sodium

Only the U.K. gives recommendations for the intake of sodium. The Lower Reference Nutrient Intake (LRNI) is set at 200 mg per day for infants of seven to nine months and the Reference Nutrient Intake (RNI) at 320 mg per day. Average intake of sodium of the children in this study was well above the RNI, although two girls both had one day when their intake did not meet the LRNI. In both cases, the infants took less than half a litre of milk and a meal to which no salt was added. As cereals and fruit hardly supply any sodium, the total sodium intake of these girls was very low.

Milk is the main source of sodium in the diets of the children in this study, providing about half of the daily intake. The meals were another source of sodium, but their contribution varied widely, 7 to 69 % of the daily sodium intake, depending on the recipe of the meal and the addition or not of salt.

Other studies have found intakes that ranged between 227 mg and 1000 mg of sodium per day. Only Horst observed lower sodium intakes than those found in this study. The use of cow's milk and table foods, as well as the addition of salt to the main meal rapidly increase the intake of sodium. This is clearly shown by a study of Endres et al. (1987) in the U.S., who compared two group of infants of four to seven months. One group took only commercially prepared baby foods, the other group was fed table foods. Sodium intake in the first group was lower than in the second group. Data on the children of seven months is included in table 8.8, which gives an overview of the findings of this and other studies compared to the recommendation in the U.K. Mills and Tyler (1992) commented that the sodium intake they recorded was likely to be higher as the addition of salt during cooking or at the table was not quantified.

Table 8.8. Findings of this and other studies for the daily intake of sodium in the second half of the first year compared to the U.K. recommendations for children between seven and nine months

recommendations	intake in mg/day	comments
U.K. LRNI	200	lowest reference nutrient intake
RNI	320	reference nutrient intake
findings	**intake in mg/day**	**comments**
This study	365(±113)	boys (min. 229 - max. 595)
	419(±177)	girls (min. 138 - max. 737)
Montalto et al.	580	median value, formula-fed
	1000	median value, cow's milk fed
Kylberg et al.	981	median value
Horst et al.	227(±82)	formula-fed
Endres et al.	249(±64)	fed commercial baby foods
	799(±430)	fed table foods
Francescato et al.	612(±390)	
Mills & Tyler	589(±276)	

Potassium
Only the U.K. and the E.C. give recommendations for the intake of potassium. The LRNI for infants of seven to nine months is 400 mg per day and the RNI set in the U.K. is 700 mg per day, while the Population Reference Intake (PRI) of the E.C. is 800 mg. All children, even those with the lowest intakes, took more potassium than the reference intakes. Milk contributed more than a third and the meals more than a quarter to the daily intake. The fruit purée was another important source of potassium.

Other studies have found intakes that ranged between 1020 mg and 1630 mg of potassium per day. All values exceed the reference intakes, see table 8.9.

Table 8.9. Daily intake of potassium. Recommendations and findings of this and other studies for the second half of the first year of life. The U.K. recommendations are for children between 7 and 9 months, the other recommendations are for infants of 6 to 12 months

recommendations		intake in mg/day	explanation of acronyms
U.K.	LRNI	400	lowest reference nutrient intake
	RNI	700	reference nutrient intake
EC	PRI	800	population reference intake
findings		intake in mg/day	comments
This study		1619(±270)	boys (min. 1038 - max. 2322)
		1457(±343)	girls (min. 838 - max. 2120)
Montalto et al.		1020	median value, formula-fed
		1630	median value, cow's milk fed
Kylberg et al.		1555	median value
Horst et al.		1156 (±373)	formula-fed
Francescato et al.		1594 (±550)	
Mills & Tyler		1239 (±335)	

Calcium

The recommended daily intake of calcium for infants of seven and eight months varies between 400 and 600 mg per day. Average calcium intake, both for boys and for girls, was above the highest recommendation of 600 mg per day in this study. All children had intakes above the U.K. LRNI. About 70% of the daily calcium intake was provided by the infant and follow-on milks. A low calcium intake was always caused by a low milk intake. Cereals only contributed substantially to the calcium intake, when milk-cereals were used or a brand that was enriched with calcium. Another calcium source was yoghurt, which was mentioned in 15 (33%) of the food diaries.

Intakes of calcium in other studies carried out in children of this age-group also show that the requirements for calcium were generally met, see table 8.10.

Table 8.10. Daily intake of calcium. See table 8.9 for further explanation

recommendations	intake in mg/day	explanation
U.K. LRNI	240	lowest reference nutrient intake
EAR	400	estimated average requirement
RNI	525	reference nutrient intake
U.S.	600	
The Netherlands	400-600	
EC PRI	400	population reference intake
findings	**intake in mg/day**	**comments**
This study	650(±90)	boys (min. 438 - max. 784)
	666(±168)	girls (min. 306 - max. 890)
McKillop & Durnin	727(±238)	boys
	653(±173)	girls
Persson	785(±154)	6 months
	862(±228)	12 months
Geuns et al.	785(±187)	
Montalto et al.	580	median value formula-fed
	1020	median value cow's milk fed
Kylberg et al.	740	median value
Horst et al.	606(±155)	formula-fed
Kjaernes et al.	863(±303)	
Francescato et al.	871(±247)	
Bellù	758	
Mills & Tyler	760(±236)	boys
	729(±245)	girls

Magnesium

The recommended daily intake of magnesium for infants of seven and eight months varies between 35 and 75 mg per day. In this study magnesium intake was high and the requirements were easily met. The lowest observed magnesium intake, 75 mg per day, is higher than the Dutch and U.S.A. recommendations and equals the RNI in the U.K. All these recommendations are set to cover the needs of the majority of infants, which makes the possibility of a magnesium deficiency in this group of children even less likely.

Milk was a major source of magnesium and contributed about a third of the daily intake. The meals were another important source of magnesium, covering about 25% of the daily intake. Infant cereals provided about 15% of the daily intake.

Other studies in children in the second half of the first year showed a similarly high intake of magnesium, confirming our findings that magnesium requirements were readily met, see table 8.11.

Table 8.11. Daily intake of magnesium. See table 8.9 for further explanation

recommendations		intake in mg/day	
U.K.	LRNI	45	
	EAR	60	
	RNI	75	
U.S.		60	
The Netherlands		35-60	
findings		**intake in mg/day**	**comments**
This study		130(±24)	boys (min. 92 - max. 169)
		115(±27)	girls (min. 75 - max. 205)
Kylberg et al.		125	median value
Bellù		113	
Mills & Tyler		111(±35)	

Iron

The recommended daily intake of iron for infants of seven and eight months varies between 6 and 10 mg per day. On average, the infants in this study had their iron requirements amply met. Even the children with low intakes, were still getting more than the U.K. EAR in case of the boys, and more than the U.K. LRNI in case of the girls.

The infant and follow-on milks were the main sources of iron, contributing almost half of the daily intake. Infant cereals were another major source of iron, although their share of the daily intake varied widely, from 12 to 75%. This was due to several reasons. Firstly, the amount taken by the infant was variable. Some children received just a small amount of cereal added to their milk in the feeding bottle. Other children were given a thick spoonable pap prepared with milk and cereals. Secondly, the number of meals in which infant cereals were used varied from one to three. Finally, the quantity of iron with which the cereals were fortified ranged from four to 18.5 mg per 100 g cereal. The meals provided on average less than ten percent of the daily intake of iron.

The iron intakes in this study were high compared to the results of other studies. As explained before, both the infant and follow-on milks as well as the infant cereals supplied significant amounts of iron. In those studies, where the children were (partially) taking cow's milk or unfortified infant cereals, iron intake might be considerably lower. Most studies did not specify, however, the type of milk the children were taking, nor mentioned if the infant cereals were fortified with iron or not. Mills and Tyler (1992) observed that over 70% of the infants between six and 12 months who were consuming cow's milk as their main milk, had iron intakes below the reference nutrient intake, compared with only 21% of those who were fed infant formula. Table 8.12 gives an overview of both the recommendations and the findings of this and other studies.

Table 8.12. Daily intake of iron. See table 8.9 for further explanation.

recommendations	intake in mg/day	
U.K. LRNI	4.2	
EAR	6.0	
RNI	7.8	
U.S.	10	
The Netherlands	7	
EC PRI	6	population reference intake
findings	**intake in mg/day**	**comments**
This study	15.2(±4.5)	boys (min. 6.0 - max. 21.9)
	12.0(±4.9)	girls (min. 4.5 - max. 23.7)
McKillop & Durnin	8.0(±2.8)	boys
	8.4(±3.6)	girls
Persson	11(±3)	6 months
	12(±4)	12 months
Montalto et al.	14.9	median value, formula-fed
	7.8	median value, cow's milk fed
Kylberg et al.	10	median value
Horst et al.	4.6(±1.3)	formula-fed
Kjaernes et al.	8.4(±3.3)	
Francescato et al.	7.6(±3.3)	
Bellù	5.5	
Mills & Tyler	9.6(±4.1)	boys
	9.0(±4.4)	girls

Zinc

The recommended daily intake of zinc for infants of seven and eight months ranges from 3.8 to 5 mg per day. Average daily zinc intake in this study was higher than the amount recommended in the Netherlands and by the European Community, and surpassed the EAR of the U.K. Only one value (2.8 mg) was slightly under the U.K. LRNI of 3 mg per day.

The main source of zinc were the infant and follow-on formulas, contributing more than half of the daily intake. The home-prepared meals were the second significant source of zinc and provided more than a quarter of the daily intake.

The findings in Madrid were slightly higher than those found by other investigators. The recommended nutrient intake of both the U.K. and U.S. of five milligrammes of zinc per day is however only met by a minority of the children. Table 8.13 gives an overview of both the recommendations and the findings of this and other studies.

Table 8.13. Daily intake of zinc. See table 8.9 for further explanation

recommendations		intake in mg/day	
U.K.	LRNI	3.0	
	EAR	3.8	
	RNI	5.0	
U.S.		5	
The Netherlands		4	
EC	PRI	4	
findings		**intake in mg/day**	**comments**
This study		4.8(±1.2)	boys (min. 2.8 - max. 8.1)
		4.4(±0.8)	girls (min. 3.1 - max. 6.3)
Kylberg et al.		4	median value
Bellù		4.2	
Mills & Tyler		4.5	boys (median 4.5)
		4.2	girls (median 4.0)

8.5 Conclusions

Meal pattern was very similar for all children. Four meals were given per day. In general, two meals were based on infant and follow-on milks with cereals, one consisted of a complete meal, sometimes complemented with a dessert, and one was based on fruit. Snacks in between meals were usually not given.

Energy and nutrient intakes were calculated on the basis of food diaries kept by the mothers. Mean energy intake, both for boys and girls, slightly exceeded the estimated recommended intake. Protein intake was very high and ranged from a minimum of 129% of the U.K. and U.S. recommended intake to a maximum of 279%. Of the daily protein intake, an average of 43% was provided by the milks and 33% by the home-prepared meals. A high protein intake in the second half of the first year was also observed in other studies on infant feeding in Europe and the U.S.

The amount of fat in the diets in this study was very low. This was mainly due to the low fat content of the home-made meals.

All daily intakes of the minerals studied, i.e. sodium, potassium, calcium, magnesium, iron and zinc, were adequate. Except for one observation of a low zinc intake, the results for all minerals exceeded the U.K. lower recommended nutrient intake.

About 70% of the daily calcium intake was provided by the infant and follow-on milks. A low calcium intake was always caused by a low milk intake. The magnesium intake ranged from 100% to 273% of the highest recommendation for this mineral. Other studies on infant feeding in Europe have also showed such high magnesium intakes.

Iron requirements of the children in this study were amply met. The main sources of iron were the infant and follow-on milks and infant cereals. The use of iron-fortified milks and cereals may explain the high iron intakes found in this study compared to studies elsewhere. Iron content of the infant's diet drops substantially as cow's milk is used or when infant cereals are not iron-fortified.

These results stress the importance of the use of infant and follow-on milks in the diets of children of seven and eight months. The lower protein content of the milks compared to cow's milk prevented the protein intake increasing even more. The milks were the principal source of fat, thereby assuring a minimum intake of essential fatty acids. The formulas were also important sources of calcium, magnesium, iron and zinc.

The home-made meals provided on average 33% of the daily protein intake and only 12% of the daily fat intake. An increase of fat in these meals would give a better balance between the total daily macronutrient intake of these children. The meals were an important source of potassium, magnesium and zinc. They only contributed substantially to the sodium intake if salt was added to the meal. Their importance for the daily iron supply was only marginal.

In general, the children were adequately fed, although an increase in the fat content as well as a decrease in the protein content would provide a better balanced diet.

CHAPTER 9

CONCLUSIONS

A summary of the results of this study and proposals for further research

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The first and general conclusion of this thesis is that **the feeding of infants was remarkably similar across all socioeconomic groups**: children were fed the same types of food prepared in the same way, no matter their socioeconomic group or their sex. The literature review revealed that different behaviour could be anticipated between socioeconomic groups, with the high socioeconomic group complying better with actual guidelines on infant feeding than the low socioeconomic group. Although results reported in this thesis showed small differences in feeding behaviour among socioeconomic groups, the differences were mostly small and few of them were statistically significant.

After birth, 83% of the mothers started **breast-feeding** their baby, but this proportion declined rapidly in the first months. At the age of three months only 41% of the infants continued to be fed with breast-milk and at the age of five months this had further decreased to 18%. Slightly more mothers in the high socioeconomic group breast-fed than those in the low socioeconomic group, but differences were not significant. **Infant formulas** were given as a substitute for breast-milk in the first months. Twenty eight percent of the mothers used an infant formula from the baby's birth, 39% of them (11% of the total sample) did so in combination with breast-feeding.

From about four months onwards **follow-on formulas** were used. Between half and two thirds of the babies received a follow-on milk at some stage. The actual recommendation to delay the introduction of **cow's milk** until after the infant's first birthday, was followed by the majority of the mothers, only 26% started with cow's milk before the age of 12 months. No statistically significant differences were observed between socioeconomic groups in the use of either follow-on or cow's milk.

Almost half of the children received their first **complementary food** before the age of four months, which is earlier than recommended by international and national paediatric advisory groups. Mothers in the high socioeconomic group introduced weaning foods somewhat later than mothers in the low socioeconomic group, but differences were not statistically significant.

No relationship could be found between either the **age of the mother** and the **feeding method**, breast- or formula-feeding, at birth, or with the duration of breast-feeding. Observations in the U.K. and Denmark described a positive relation between breast-feeding and the age of the mother. A statistically highly significant relationship was however observed between the time of introduction of complementary foods and the mother's age, where younger mothers were more likely to start solids earlier than older mothers.

Based on literature research, where breast-feeding mothers were reported to start later with weaning foods than formula-feeding mothers, a possible relationship was examined between **feeding method** and **the timing of weaning**. At the age of three months, significantly less breast-fed infants were given solids than formula-fed babies. Within this subdivision, no influence of socioeconomic group was seen.

Infant **cereals** were usually the first non-milk foods that a child received. Although mothers were familiar with the word "gluten", as infant cereals indicated for the initial period of weaning usually claim the absence of gluten, 29% of the children who used gluten-free cereals before the age of six months, were given mistakenly at the same time gluten-containing bread or biscuits. This practice was statistically significantly more often reported in the low than in the high socioeconomic group.

The **order** in which complementary foods were introduced was similar between socioeconomic groups. Infants received most foods for the first time sometime between the ages of six and twelve months. More attention should be given to the advantages of introducing foods one by one, as fruits or vegetables were often introduced as a mixture of several varieties. Pulses and pasta were introduced late in the infant's diet, often after the age of one year, without there being a nutritional reason for this behaviour. Potentially allergenic foods, such as fish, egg and cow's milk, were on the contrary given to the infants earlier than thought desirable.

The majority of mothers added **salt** to their children's meals. The higher the socioeconomic group, the less frequent salt was added, but differences were not statistically significant. Statistically significant differences were observed however for the addition of **sugar**. More mothers from the low socioeconomic group added sugar to their baby's foods than mothers from the middle and high socioeconomic group. However, the use of sweetened foods was highest in the high and lowest in the middle socioeconomic group. Most commercial infant foods, such as cereals and fruit purées in jars, had sugar added at the time of the research. Mothers may not expect these special products to contain sugar and may thus be unaware of their sugar content.

Almost 19% of the infants received **herbal drinks**, most of them in the first few months of life. Anise and chamomile were the most popular varieties. None of the herbal drinks used by the mothers in this study were special infant products. Except for star-anise that was sold as such, herbs came in bags and were prepared like tea. Herbal drinks were used to alleviate minor digestive problems, especially gases. More mothers in the low than in the middle and high socioeconomic group used herbal drinks. Hardly any data are available on the pharmacological effect of herbal drinks, or on a possible influence of these drinks on energy and nutrient intake of the infants. More research is needed to answer these questions and to formulate guidelines for the use of herbal drinks in infancy.

Anthropometric results of the children in this study were compared to the Bilbao, the WHO, the NCHS and the U.K. growth references. Children were on average **taller and heavier** than those of the references, but appear to be **leaner** than the children of the Bilbao and WHO references as suggested by their smaller triceps and subscapular skinfolds, and mid-upper arm circumferences. The triceps skinfold measurements were in line with the results of the Cambridge Growth Study, but this was not the case with the mid-upper arm circumference. The children in this study had greater mid-upper arm circumferences than those in the Cambridge sample. Head circumferences of the children were, on average, greater than those of the Bilbao and NCHS references and corresponded better with those of the Cambridge Growth Study. A need for new growth references for the present generation of infants has been expressed by a number of authorities, now that infant feeding practices have changed. The results of the present research confirm this need.

No statistically significant differences were observed between socioeconomic groups for weight and height indices. Neither did the feeding method in the first months, i.e. breast- or formula-feeding, or timing of complementary feeding result in any statistically significant differences in the children's weight-for-height. This does not necessarily mean that no relation existed as the research was not designed to study these influences in detail.

Finally in the thesis a study was reported which examined the nutritional value of 51 **home-prepared baby meals** for infants of seven and eight months old. In this study the 28 mothers were also instructed to record in a diary the food intake of their child during the two days that the meal samples for analysis were prepared.

Both veal and chicken are popular meat varieties in Spain for young children. Fifty meals contained veal and one was based on chicken. Chemical analysis showed the meals to have generally a low energy density. This was mainly due to the low fat content of the meals. Protein content, on the other hand, was high in proportion to the energy provided. The addition of fat in the form of olive oil would have improved considerably the relation between the three macronutrients in the meals.

About 20% of the meals had a higher than desired **sodium** level, due to the addition of salt to the meals, or, in case of one mother, to the use of cured Spanish ham for the preparation of stock in which the meal was cooked. The meals supplied significant amounts of **magnesium** and **zinc**, but were poor suppliers of **calcium**. The amount of **iron** provided by the meals was only minor compared to the increased need for iron in the second half of the first year.

The meal pattern of children of seven and eight months old was also very similar. Most received four meals per day. The energy and nutrient intakes of 46 food diaries were calculated. Mean **energy** intake of both boys and girls was slightly higher than recommended. **Protein** intake was high, an average of 43% was provided by the milks and 33% by the home-prepared meals, whereas the amount of **fat** was very low. This was mainly due to the low fat content of the home-made meals. Daily intakes of all the **minerals** studied, i.e. sodium, potassium, calcium, magnesium, iron and zinc, were adequate.

About 70% of the daily calcium intake was provided by the infant milk and follow-on milks. A low calcium intake was always caused by a low milk intake. Iron requirements of the children in this study were amply met, with infant and follow-on milks and infant cereals as the main iron sources. These results stress the importance of the use of infant and follow-on milks in the diets of children of seven and eight months. The formulas were the principal source of fat, thereby assuring a minimum intake of essential fatty acids. The imbalance of the macronutrients in the home-prepared meals was reflected in the total diet, thus emphasizing the need for better instructions to be given to the mothers concerning the preparation of baby meals at home. All conclusions were based on group mean estimations as the food record method is not accurate enough for the classification of individual infants within a group.

In the course of the interviews became apparent that mothers follow the paediatrician's advice, whether it is understood or not. This explains to a great extent the homogeneity in feeding behaviour found between mothers. The possible influences of personal circumstances like socioeconomic group, age of the mother and sex of the baby disappear when uniform recommendations are given to all mothers and these guidelines are followed closely.

This research has been carried out in Madrid, the capital of Spain. Although the results give a good idea of feeding habits of infants and young children in Madrid, further research is needed to evaluate feeding patterns in other parts of the country. It may well be that infants are differently fed in more rural areas, or that differences may be found between the Northern and Southern parts of Spain. Madrid often serves as the leader for the rest of Spain, and the findings of the present study indicate that certain feeding patterns need to be changed to bring them in line with international guidelines on infant feeding. Then feeding errors reported in this thesis might be avoided by mothers in other parts of the country.

Energy and nutrient intake should also be studied at ages other than in seven and eight months-old infants. Studies should concentrate on children after the age of one year, when cow's milk becomes the main milk source and an important change in the nutrient intake will take place.

Finally, a longitudinal growth study of children in Madrid and elsewhere in Spain may reveal to what extent the Bilbao growth references are appropriate for children in the country as a whole. With more data available, a national growth reference might be developed for assessing a child's growth performance and nutritional status.

REFERENCES

Abellán, P., et al. (1994) Mineral composition of meat-based infant beikosts. A preliminary study. Int. J. Food Sci. Nutr. 45, 209-215.

American Academy of Pediatrics, Committee on Nutrition (1980) On the feeding of supplemental foods to infants. Pediatrics 65, 1178-1181.

American Academy of Pediatrics, Committee on Nutrition (1992) The use of whole cow's milk in infancy. Pediatrics 89, 1105-1109.

Anderson, T.A. & E.E. Ziegler (1987) Recent trends in weaning in the United States. In: *Weaning: why, what and when?* Ed. by A. Ballabriga and J. Rey. Nestlé Nutrition, Vevey/Raven Press, New York, p. 153-168.

Arnon, S.S. (1985) Infant botulism. In: *Clostridia in gastrointestinal disease.* Ed. by S.P. Borriello. Boca Raton, Florida: CRC Press, p. 48-51.

Association of Official Analytical Chemists (1990) Official methods of analysis of the association of official analytical chemists. Ed. by K. Helrich. Arlington, Association of Official Analytical Chemists Inc., 15th edition, 1105-1106.

Bellú, R. et al. (1991) Nutritional survey on a sample of one-year-old infant in Milan: intake of macronutrients. Nutr. Res. 11, 1221-1229.

Birkbeck, J.A., P.M. Buckfield & P.A. Silva (1985) Lack of long-term effect of the method of infant feeding on growth. Hum. Nutr.:Clin. Nutr. 39C, 39-44.

Black, A.E. et al. (1983) Daily variation in food intake of infants from 2 to 18 months. Hum. Nutr.: Appl. Nutr. 37A, 448-458.

Bonell, J. (1786) Perjuicios que acarrean al género humano y al Estado las madres que rehusan criar a sus hijos y medios para contener el abuso de ponerlos en Ama. Madrid

Brogan, B.D. & H.M. Fox (1984) Infant feeding practices of low- and middle-income families in Nebraska. J. Am. Diet. Assoc. 84, 5, 560-563.

Buishand, T., H.P. Houwing & K. Jansen (1986) Groenten uit alle windstreken. Utrecht, Het Spectrum.

Burke, B.S. (1947) The dietary history as a tool in research. J. Am. Diet. Assoc. 23, 1041-1046.

Casado de Frías, E. (1983) Lactancia natural. Serie monográfica 7. Madrid, Ministerio de Sanidad y Consumo, p. 12.

Cohen, R.J. et al. (1994) Effects of age of introduction of complementary foods on infant breast milk intake, total energy intake, and growth: a randomised intervention study in Honduras. Lancet 344, 288-293

Cole, T.J. (1993) The use and construction of anthropometric growth reference standards. Nutr. Res. Rev. 6, 19-50

Comunidad de Madrid (1993) Anuario Estadístico 1992. Volumen I. Consejería de Economía. Madrid, 1993.

Crowder, M.J., A.C. Kimber, R.L. Smith & T.J. Sweeting (1991) Statistical analysis of reliability data. Chapman & Hall, London, p. 16-22 and 45.

Davies, P.S.W. & A. Lucas (1990) The prediction of total body fatness in early infancy. Early Hum. Dev. 21, 193-198.

Department of Health (1991) Dietary reference values for food energy and nutrients for the United Kingdom. Department of Health. Report on Health and Social Subjects, 41. Report of the Panel on Dietary Reference Values of the Committee on Medical Aspects of Food Policy. London, HMSO.

Department of Health and Social Security (1988) Present day practice in infant feeding: third report. Report of a Working Party of the Panel on Child Nutrition. Committee on Medical Aspects of Food Policy. London, HMSO.

Dewey, K.G. et al. (1992) Growth of breast-fed and formula-fed infants from 0 to 18 months: the DARLING study. Pediatrics 89, 1035-1041.

Dewey, K.G. et al. (1993) Breast-fed infants are leaner than formula-fed infants at 1 y of age: the DARLING study. Am. J. Clin. Nutr. 57, 140-45.

Eaton-Evans, J. & A.E. Dugdale (1986) Recall by mothers of the birth weights and feedinbg of their children. Hum. Nutr.: Appl. Nutr. 40A, 171-175.

Endres, J. et al. (1987) Dietary sodium intake of infants fed commercially prepared baby food and table food. J. Am. Diet. Assoc. 87, 6, 750-753.

European Communities, The Commission of the (1989/1990) First report of the Scientific Committee for Food on the essential requirements for weaning foods. Food - science and techniques. Reports of the Scientific Committee for Food (Twenty-fourth series).

European Communities, The Commission of the (1991) Commission Directive of 14 May 1991 on infant formulae and follow-on formulae (91/321/EEC). Official Journal of the European Communities No. L175/35 of 4/7/91..

European Communities, The Commission of the (1993) A report of the Scientific Committee for Food of the European Community. Proposed nutrient and energy intakes for the European Community. Nutr. Rev. 51, 209-212.

European Communities, The Commission of the (1994) Draft Commission Directive on processed cereal-based foods and baby foods for infants and young children (III/5886/94-Rev. 1-EN).

ERC Statistics International PLC (1993) Baby food in Europe: the 1993 survey. Kennett, ERC Statistics, Ltd..

European Society of Pediatric Gastroenterology and Nutrition, Committee on Nutrition (1977) Guidelines on infant nutrition I. Recommendations for the composition of an adapted formula. Acta Paediatr. Scand., suppl. 262.

European Society of Pediatric Gastroenterology and Nutrition, Committee on Nutrition (1981) Guidelines on infant nutrition II. Recommendations for the composition of follow-up formula and beikost. Acta Paediatr. Scand., suppl. 287.

European Society of Pediatric Gastroenterology and Nutrition, Committee on Nutrition (1982) Guidelines on infant nutrition III. Recommendations for infant feeding. Acta Paediatr. Scand., suppl. 302.

European Society of Pediatric Gastroenterology and Nutrition, Committee on Nutrition (1990) Comment on the composition of cow's milk based follow-up formulas. Acta Paediatr. Scand. 79, 250-254.

European Society of Pediatric Gastroenterology and Nutrition, Committee on Nutrition (1991) Comment on the content and composition of lipids in infant formulas. Acta Paediatr. Scand. 80, 887-896.

Falkner, F. (1991) Growth monitoring: Fetus to the first two postnatal years. In: *Clinical nutrition of the young child*. Ed. by Brunser et al.. New York, Raven Press, p. 23-38.

Farmacopea Europea (1988) Consejo de Europa. Madrid, Ministerio de Sanidad.

Farmacopea Oficial Española (1954) Real Academia Nacional de Medicina. Madrid, 9th. ed..

Ferris, A.G., M.J. Laus, D.W. Hosmer & V.A. Beal (1980) The effect of diet on weight gain in infancy. Am. J. Clin. Nutr. 33, 2635-2642.

Florack, E. et al. (1984) Breast-feeding, bottle-feeding and related factors: the Leiden pre-school children study. Acta Paediatr. Scand. 73, 6, 789-795.

Fomon, S.J. (1987) Reflections on infant feeding in the 1970s and 1980s. Am. J. Clin. Nutr. 46, 171-182.

Fomon, S.J., K.D. Sanders & E.E. Ziegler (1990) Formulas for older children. J. Pediatr. 116, 690-696.

Fomon, S.J. (1993a) Trends in infant feeding since 1950. In: *Nutrition of normal infants*. Ed. by S.J. Fomon. St. Louis, Mosby, p. 15-35.

Fomon, S.J. (1993b) Cow milk and beikost. In: *Nutrition of normal infants*. Ed. By S.J. Fomon. St. Louis, Mosby, p. 443-454.

Fomon, S.J. & S.E. Nelson (1993) Size and growth. In: *Nutrition of normal infants*. Ed. by S.J. Fomon. St. Louis, Mosby, p. 36-84.

Food and Nutrition Board (1989) Recommended Dietary Allowances. Food and Nutrition Board, Commission on Life Sciences, National Research Council. National Academy Press, Washington, D.C..

Francescato, M.P. et al. (1990) Feeding practices of Italian children 8-36 months old. J. Hum. Nutr. Diet. 3, 273-281.

Frisancho, A.R. (1990) Necessity for new anthropometric standards. In: *Anthropometric standards for the assessment of growth and nutritional status*. Ed. by A.R. Frisancho. The University of Michigan Press, Ann Arbor, p. 1-2

Garrahie, E.J. et al. (1991) The value of debriefing mothers of 3- to 7-year-old children when analyzing children's food diaries. J. Am. Diet. Assoc. 91, 710-711.

Geuns, M. et al. (1985) Intake of energy, protein and calcium and weaning pattern of a group of Dutch infants aged 6-12 months. Tijdschr. Kindergeneeskd. 53, 2, 50-56.

Giblin Wolman, P. (1984) Feeding practices in infancy and prevalence of obesity in preschool children. J. Am. Diet. Assoc. 84, 436-438.

Gorstein, J. et al. (1994) Issues in the assessment of nutritional status using anthropometry. Bull. WHO 72, 2, 273-283.

Haaga, J.G. (1988) Reliability of retrospective survey data on infant feeding. Demography 25, 377-314.

Ham, J.M. van (1985) Venkelthee bij darmkrampen. Pharmaceutisch weekblad 120, 1055-1056.

Hamill, P.V.V. et al. (1979) Physical growth: National Center for Health Statistics percentiles. Am. J. Clin. Nutr. 32, 607-629.

Harlow, S.D. & M.S. Linet (1989) Agreement between questionnaire data and medical records; the evidence for accuracy of recall. Am. J. Epidemiol. 129, 233-248.

Heinig, M.J. et al. (1993) Energy and protein intakes of breast-fed and formula-fed infants during the first year of life and their association with growth velocity: the DARLING study. Am. J. Clin. Nutr. 58, 152-161.

Hernández Rodríguez, M. et al. (1988) Curvas de crecimiento. Instituto de investigación sobre desarrollo y crecimiento. Fundación F. Orbegozo, Bilbao.

Herrero Martín, J. et al. (1983) Conceptos actuales de la alimentación en el primer año de vida. Pediátrika III, 11-12, 405-414.

Hitchcock, N.E. & E.N. Owles (1980) Australian growth studies: the Perth study. Proc. Nutr. Soc. Aust. 5, 71-78.

Hitchcock, N.E. & E.N. Owles (1981) Growth of healthy breast-fed infants in the first six months. Lancet II, July 11, 64-65.

Hitchcock, N.E., M. Gracey & A.I. Gilmour (1985) The growth of breast fed and artificially fed infants from birth to twelve months. Acta Paediatr. Scand. 74, 240-245.

Hitchcock, N.E. & J.F. Coy (1988) Infant-feeding practices in Western Australia and Tasmania: a joint survey. Med. J. Aust. 148, 114-117.

Hitchcock, N.E. & J.F. Coy (1989) The growth of healthy Australian infants in relation to infant feeding and social class. Med. J. Aust. 150, 306-311.

Hoffmans, M.D.A.F. et al. (1986) Energy, nutrient and food intake during infancy and early childhood: the Leiden pre-school children study. Hum. Nutr.: Appl. Nutr. 40A, 421-430.

Holland, B. et al. (1991) McCance and Widdowson's The composition of foods. Fifth revised and extended edition, The Royal Society of Chemistry.

Horst, C.H., G.L. Obermann-de Boer & D. Kromhout (1987a) Type of Milk Feeding and Nutrient Intake during Infancy. Acta Paediatr. Scand. 76, 865-871.

Horst, C.H., G.L. Obermann-de Boer & D. Kromhout (1987b) De voeding van vier, zes en negen maanden oude Leidse zuigelingen. Voeding 48, 173-176.

Horst, C.H., G.L. Obermann-de Boer & D. Kromhout (1987c) De energie- en voedingsstoffenvoorziening van zuigelingen naar type melkvoeding. Het Leidse zuigelingen- en peuteronderzoek. Voeding 48, 232-236.

Horst, C.H., G.L. Obermann-de Boer & D. Kromhout (1988) Validity of the 24-hour recall method in infancy: the Leiden pre-school children study. Int. J. Epidemiol. 17, 217-221.

Instituto Nacional de Estadística (1988) Padrón municipal de habitantes. Caraterísticas de la población, 1 de abril de 1986. Madrid.

Jelliffe, D.B. (1966) The assessment of the nutritional status of the community. Geneva, World Health Organization.

Jelliffe, D.B. & E.F.P. Jelliffe (1989) Direct assessment of nutritional status. In: Community nutritional assessment with special reference to less technically developed countries. Oxford university press, Oxford, p. 123-124.

Jelliffe, E.F.P. & D.B. Jelliffe (1969) The arm circumference as a public health index of protein-calorie malnutrition of early childhood. J. Trop. Pediat. 15, monograph No. 8.

Jones, D.A. (1987) The choice to breast feed or bottle feed and influences upon that choice: a survey of 1525 mothers. Child: care, health and development, 13, 75-85.

Kjaernes, U., G. Botten, B. Lande & D. Nilsson (1988) Food intake and patterns of feeding of Norwegian infants. Eur. J. Clin. Nutr. 42, 249-260.

Kromhout, D. (1994) Rijksinstituut voor Volksgezondheid en hygiëne, Bilthoven, the Netherlands. Personal communication.

Kylberg, E., Y. Hofvander & S. Sjölin (1984) Diets of healthy Swedish children 4-24 months old. I Meal pattern and food intake. Näringsforskning 28, 123-130.

Kylberg, E., Y. Hofvander & S. Sjölin (1986a) Diets of healthy Swedish children 4-24 months old. II Energy intake. Acta Paediatr. Scand. 75, 932-936.

Kylberg, E., Y. Hofvander & S. Sjölin (1986b) Diets of healthy Swedish children 4-24 months old. III Nutrient intake. Acta Paediatr. Scand. 75, 937-946.

Langeland, T. & K. Aas (1987) Allergy to Hen's Egg White: Clinical and Immunological Aspects. In: *Food allergy and intolerance*. Ed. by J. Brostoff & S.J. Challacombe. London: Baillière Tindall.

Launer, L.J. et al. (1992) Maternal recall of infant feeding events is accurate. J. Epidemiol. Community Health 46, 203-206.

Leung, S.S.F., S. Lui & D.P. Davies (1988) Energy intake from birth to 2 years. Lancet I, May 21, 1161.

Lipsitz, D.J. (1984) Herbal teas and water intoxication in a young child. J. Family Practice 18, 933-937.

Lönnerdal, B. (1990) Cow's milk during the second half-year of life - Effect on iron status. J. Pediatr. Gastroenterol. Nutr. 11, 302-303.

Lozoff, B., E. Jiménez & A.W. Wolf (1991) Long-term developmental outcome of infants with iron deficiency. N. Engl. J. Med. 325, 687-694.

Marlin, D.W., M.F. Piccano & E. Calkins Livant (1980) Infant feeding practices. J. Am. Diet. Assoc. 77, 668-676.

Martin, J. & A. White (1988) Infant feeding 1985. A survey carried out by Social Survey Division of OPCS on behalf of the Department of Health and Social Security and the Scottish Home and Health Department. London, HMSO..

Martindale The Extra Pharmacopoeia (1989) Ed. by J.E.F. Reynold. London, The Pharmaceutical Press, 29th ed.

Martínez, G.A., D.A. Dodd & J.A. Samartgedes (1981) Milk feeding patterns in the United States during the first 12 months of life. Pediatrics 68, 863-868.

Martínez Gómez, M.J. & M. Hernández Rodríguez (1993) Alimentación durante el primer año de vida. In: *Alimentación infantil*. Ed. by M. Hernández Rodríguez. Madrid, Díaz de Santos, 2nd. ed., p. 43-53.

McKillop, F.M. & J.V.G.A. Durnin (1982) The energy and nutrient intake of a random sample (305) of infants. Hum. Nutr.: Appl. Nutr. 36A, 405-421.

Merck Index, The (1989) An encyclopedia of chemicals, drugs and biologicals. Ed. by S. Budavari et al. Rahway, Merck & Co, Inc..

Mills, A. & H. Tyler (1992) Food and nutrient intakes of British infants aged 6-12 months. Ministery of Agriculture, Fisheries and Food. London, HMSO..

Montalto, M.B., J.D. Benson & G.A. Martínez (1985) Nutrient intakes of formula-fed infants and infants fed cow's milk. Pediatrics 75, 343-351.

Morgan, J.B., P. Mumford & E. Evans (1976) Food intake and anthropometric data on children under 4 years old living in the south of England. Proc. Nutr. Soc. 35, 74A-75A.

Morgan, J.B. & P. Mumford (1977) Feeding practices and food intake of children under two years of age. Proc. Nutr. Soc. 36, 47A.

Morgan, J.B. (1978) An investigation into the energy and protein intakes of pre-school children, together with anthropometric measurements and preliminary studies of energy expanditure in four children under 4 months of age. Ph.D. thesis, Queen Elisabeth College, University of London..

Morgan, J.B. (1980) The pre-school child diet: diet, growth and obesity. J. Hum. Nutr. 34, 117-130.

Morgan, J.B., A.M. Redfern & B.J. Stordy (1994) Nutritional composition (by chemical analysis) of home-prepared weaning foods for infants. Proc. Nutr. Soc. 52, 384A.

Oski, F.A. (1990) Whole cow milk feeding between 6 and 12 months of age? Go back to 1976. Pediatrics in review 12, 187-189.

Osuna Jiménez, J.M. (1946) Alimentación complementaria en el lactante sano. Rev. Esp. Ped. 2, 683-720.

Ounsted, M., V.A. Moar & A. Scott (1985) Head circumference charts updated. Arch. Dis. Child. 60, 936-939.

Owen, G.M. (1982) Measurement, recording, and assessment of skinfold thickenessin childhood & adolescents: report of a small meeting. Am. J. Clin. Nutr. 35, 629-638.

Owen, G.M., Ph.J. Garry & E.M. Hooper (1984) Feeding and growth of infants. Nutr. Res. 4, 727-731.

Owles, E.N., N.E. Hitchcock & M. Gracey (1982) Feeding patterns of Australian infants: birth to one year. Hum. Nutr.: Appl. Nutr. 36A, 202-207.

Paul, A.A., E.A. Ahmed & R.G. Whitehead (1986) Head circumference charts updated (letter). Arch. Dis. Child. 61, 927-928.

Paul, A.A. et al. (1988) Breastmilk intake and growth in infants from two to ten months. J. Hum. Nutr. Diet. 1, 437-450.

Paul, A.A., R.G. Whitehead & A.E. Black (1990) Energy intakes and growth from two months to three years in initially breast-fed children. J. Hum. Nutr. Diet. 3, 79-92.

Paul, A.A., T.J. Cole & R.G. Whitehead (1994) Growth standards for infancy (letter). Arch. Dis. Child. 70, 554.

Paul, A.A. (1994) Dunn Nutrition Centre, Cambridge. Personal communication.

Pekkarinen, M. (1970) Methodology in the collection of food consumption data. World Rev. Nutr. Diet. 12, 145-171.

Peña, A.S. (1991) History of coeliac disease. Dicke and the origin of the gluten-free diet. In: *Coeliac disease, 40 years gluten-free.* Ed. by M.L. Mearin and C.J.J. Mulder. Dordrecht, Kluwer Academic Publishers, p. 3-7.

Persson, L.Å. & G. Carlgren (1984a) Measuring children's diets: evaluation of dietary assessment techniques in infancy and childhood. Int. J. Epidemiol. 13, 506-517.

Persson, L.Å., E. Johansson, G. Samuelson (1984b) Dietary intake of weaned infants in a Swedish community. Hum. Nutr.: Appl. Nutr. 38A, 247-254.

Persson, L.Å. & G. Samuelson (1984c) From breastmilk to family food: infant nutrition in three Swedish communities. Acta Paediatr. Scand. 73, 685-692.

Persson, L.Å. (1985a) Infant feeding and growth - a longitudinal study in three Swedish communities. Ann. Hum. Biol. 12, 41-52.

Persson, L.Å. (1985b) Multivariate approaches to the analysis of breast-feeding habits. Bull. WHO 63, 1129-1136.

Polanco Allue, I. (1990) Nutrición y lactancia. In: *Nutrición pediátrica*. Ed. by I. Polanco Allue. Madrid, Saned, p. 191-202.

Post, G.B. (1990) Maten en gewichten van voedingsmiddelen. In: *Informatorium voor voeding en diëtetiek: deel 1 Voedingsleer*. Ed. by E.C. Carbasius Weber, E.C. Post & T.W. Swager. Alphen aan den Rijn, Stafleu.

Prentice, A.M. et al. (1988) Are current dietary guidelines for young children a prescription for overfeeding? Lancet I, November 5, 1066-1068.

Quandt, S.A. (1984) The effect of Beikost on the diet of breast fed infants. J. Am. Diet. Assoc. 84, 47-51.

Redfern, A. (1994) School of Biological Sciences, University of Surrey, Guildford. Personal communication.

Rincón-León, F., P. Abellán-Ballesta & G. Zurera-Cosano (1990) Elemental composition of infant beikosts. J. Micronutr. Anal. 8, 43-53.

Rosti, L., A. Nardini, M.E. Bettinelli & D. Rosti (1994) Toxic effexts of a herbal tea mixture to two newborns. Acta Paediatrica 83, 683.

Salmenperä, L., J. Perheentupa & M.A. Siimes (1985) Exclusively breast-fed healthy infants grow slower than reference infants. Pediatr. Res. 19, 307-312.

Scott, B.J., H. Artmen & S.T. St. Jeor (1992) Growth assessment in children: a review. Top. Clin. Nutr. 8, 5-31.

Seward, J.F. & M.K. Serdula (1984) Infant feeding and infant growth. Pediatrics 74, 728-762.

Sheard, N.F. (1994) Iron deficiency and infant development. Nutr. Rev. 52, 137-140.

Smith, D.E. & I.W. Booth (1989) Nutritional assessment of children: guidelines on collecting and interpreting anthropometric data. J. Hum. Nutr. 2, 217-224.

Sobradillo Ruiz, C.B. (1984) Estudio longitudinal de crecimiento en los dos primeros años de vida en la población infantil de Vizcaya. Tesis doctoral, Universidad del País Vasco, Vitoria..

Sobradillo Ruiz, C.B. (1994) Hospital de Basurto, Bilbao. Personal communication.

Stam-Dresselhuys, J.P. & J.C. Wessel-Nijenhuis (1966/1980) Oudnederlandse streekrecepten. Ede, Zomer & Keunig, p. 106.

Staveren, W.A. van, K.F.A.M. Hulshof, W.G.M. Boeijen & A.B. Cramwinckel (1981) Het voedselkonsumptieonderzoek. In: *Informatorium voor voeding en diëtetiek: deel 1. Voedingsleer*. Ed. by E.C. Carbasius Weber, E.C. Post & T.W. Swager. Alphen aan den Rijn, Stafleu.

Studiegroep Zuigelingenvoeding (1991) Zuigelingenvoeding. Uitgangspunten en praktische aanbevelingen. GHI bulletin. Rijswijk, Geneeskundige Hoofdinspectie van de Volksgezondheid.

Stuff, J.E. & B.L. Nichols (1989) Nutrient intake and growth performance of older children fed human milk. J. Pediatr. 115, 959-968.

Sutphen, J.L. (1989) Growth and nutritional status. In: *Textbook of gastroenterology and nutrition in infancy*. Ed. by E. Lebenthal. New York, Raven Press, 2nd. ed., p. 87-93.

Talalaj, S. & A. Czechowics (1990) Cautions in the use of herbal remedies during pregnancy and for small children. Med. J. Aust. 152, 52.

Taitz, L.S. (1977) Obesity in pediatric practice: infantile obesity. Pediatr. Clin. of North Am. 24, 107-115.

Tanner, J.M., R.H. Whitehouse & M. Takaishi (1966) Standards from birth to maturity for height, weight, height velocity and weight velocity: British children, 1965. Part I. Arch. Dis. Child. 41, 454-471.

Tembouri, M.C., M.R. Olmo Lama & M. Tomás Ros (1990) Incidencia y duración de la lactancia materna en una población del extrarradio de Madrid. Pediátrika 10, 30-33.

Thomas B., ed. (1994) Appendix 5: Typical weights and portion sizes of common foods. In: *Manual of dietetic practice*. Oxford, Blackwell Scientific Publications.

Tormo Carnicé, R. (1983) Alimentación en el primer año de la vida. MTA-Pediatría 4, 223-255.

Trowbridge, F.L. et al. (1987) Body composition of Peruvian children with short stature and high weight-for-height. II. Implications for the interpretation for weight-for-height as an indicator of nutritional status. Am. J. Clin. Nutr. 46, 411-418.

Tunnessen, W.W. & F.A. Oski (1987) Consequences of starting whole cow milk at 6 months of age. J. Pediatr. 111, 813-816.

Underwood, B.A. & Y. Hofvander (1982) Appropriate timing for complementary feeding of the breast fed infant. Acta Paediatr. Scand., supplement 294.

Vestermark, V. et al. (1991) The duration of breast-feeding. Scand. J. Soc. Med. 19, 105-109.

Vet, H.C.W. de (1984) De voedingsanamnese. In: *Voeding in de praktijk: leidraad voor voedingsadvies ten behoeve van artsen en paramedici, [part] A1*. Ed. by R. Kroes et al. Utrecht, Scheltema en Holkema.

Vitoria Cormenzana, J.C. (1986) Alimentación infantil en el primer año de vida. An. Esp. Ped. 25, 481-488.

Vobecky, J.S., J. Vobecky & S. Froda (1988) The reliability of the maternal memory in a retrospective assessment of nutritional status. J. Clin. Epidemiol. 41, 261-265.

Voedingsraad (1992) Nederlandse voedingsnormen 1989. Den Haag, Voorlichtingsbureau voor de Voeding, 2e druk.

Voorhoeve, H.W.A. (1990) A new reference for the mid-upper arm circumference? J. Trop. Pediat. 36, 256-262.

Walker, A.F. (1990) The contribution of weaning foods to protein-energy malnutrition. Nutr. Res. Rev. 3, 25-47.

Warrington, S. & D.M. Storey (1988a) Comparative studies on Asian and Caucasian children. 1: Growth. Eur. J. Clin. Nutr. 42, 61-67.

Warrington, S. & D.M. Storey (1988b) Comparative studies on Asian and Caucasian children. 2: Nutrition, feeding practices and health. Eur. J. Clin. Nutr. 42, 69-80.

Waterlow, J.C. et al. (1977) The presentation and use of height and weight data for comparing the nutritional status of groups of children under the age of 10 years. Bull. WHO 55, 489-498.

Weigley, E.S. (1989) Aldolphe Quetelet (1796-1874): pioneer anthropometrist. Nutrition Today 24, 12-16.

Weile, B. et al. (1990) Infant feeding patterns during the first year in Denmark: factors associated with the discontinuation of breast-feeding. J. Clin. Epidemiol. 43, 1305-1311.

Weizman, Z., S. Alkrinawi, D. Goldfarb & C. Biotran (1993) Efficacy of herbal tea preparation in infantile colic. J. Pediatr. 122, 650-652.

Wetherill, G.B. (1972) Elementary statistical methods. Chapman & Hall, London, chapter 12.

Wharton, B. (1989) Weaning and child health. Annu. Rev. Nutr. 9, 377-394.

Wharton, B. (1990) Milk for babies and children. Br. Med. J. 301, 774-775.

White, A., S. Freeth & M. O'Brien (1992) Infant feeding 1990. A survey carried out by the Social Survey Division of OPCS on behalf of the Department of Health, the Scottish Home and Health Department, the Welsh Office and the Department of Health and Social Services in Northern Ireland. London, HMSO..

Whitehead, R.G. & A.A. Paul (1984) Growth charts and the assessment of infant feeding practices in the western world and in developing countries. Early Hum. Dev. 9, 187-207.

Whitehead, R.G. (1985) The human weaning process. Pediatrics 75, supplement, 189-193.

Whitehead, R.G., A.A. Paul & E.A. Ahmed (1986) Weaning practices in the United Kingdom and variations in anthropometric development. Acta Paediatr. Scand. supplement 323, 14-23.

Whitehead, R.G., A.A. Paul & T.J. Cole (1989) Diet and the growth of healthy infants. J. Hum. Nutr. Diet. 2, 73-84.

Wood, C. et al. (1988) Exclusively breast fed infants: growth and caloric intake. Pediatric Nursing 14, 117-124.

World Health Organization (1978) A growth chart for international use in maternal and child health care: guidelines for primary health care personnel. Geneva, WHO.

World Health Organization (1983) Measuring change in nutritional status: guidelines for assessing the nutritional impact of supplementary feeding programmes for vulnerable groups. Geneva, WHO.

World Health Organization Working Group (1986) Use and interpretation of anthropometric indicators of nutritional status. Bull. WHO 64, 929-941.

Wright, C.M., A. Waterston & A. Aynsley-Green (1993) Comparison of the use of Tanner and Whitehouse, NCHS, and Cambridge standards in infancy. Arch. Dis. Child. 69, 420-422.

Yeung, D.L. et al. (1979) Longitudinal survey of infant nutrition. J. Can. Diet. Assoc., 40, 4, 288-295.

Ziegler, E.E. (1990) Milks and formulas for older infants. J. Pediatr. 117, S76-S79.

Appendix A

Data collection sheets for the first part of the study

Número: fecha:

NIÑO:nombre apellidos
dirección
dto.postal teléfono
MADRE:nombre apellidos
fecha nac. edad profesión
PADRE:profesión

sexo v / h edad gestacional (sem) fecha nacimiento
peso al nacer (g) talla al nacer (cm) edad (m)

código niño		código madre	
talla cm peso g		talla cm peso (antes embarazo) kg peso actual kg peso/(talla)^2	
perímetro craneal cm perímetro brazo cm pliegue tríceps mm pliegue subescapular mm			

¿Tiene su hijo alguna enfermedad?
¿Ha estado enfermo alguna vez?
¿Le ha dado el pecho a su hijo? sí / no ¿Durante cuanto tiempo? sem / m
¿Le ha dado a su hijo alguna leche artificial? sí / no ¿Cuál?
¿Cuando empezó a darle leche de vaca? meses
¿Cuando le dio por primera vez algo que no fuera leche? meses

[Reverse of the sheet]

Número: fecha:

leche materna / fórmula de inicio tomas al día
antes del desayuno:
desayuno: leche: cereales: otros: materna sin / con gluten inicio sin / con leche seguimiento vaca otro
en el curso de la mañana:
comida: carne sí / no pescado sí / no huevo sí / no verduras sí / no patatas sí / no arroz sí / no pastas sí / no ¿Con sal? sí / no potitos sí / no postre sí / no
merienda: fruta adición de azúcar cereales con fruta / potitos / zumos yogur / petit suisse
cena: leche: cereales: otros: materna sin / con gluten inicio sin / con leche seguimiento vaca otro
comentario:

Número: fecha:

¿Varía mucho el tipo de alimentos que toma su hijo de un día para otro?
si / no

¿Cuáles son las diferencias?

¿Toma su niño minerales o vitaminas? sí / no

¿Cuál?

Comentario:

Introducción de alimentos

mes	alimento	tipo / marca / comentario
	LECHE fórmula de inicio fórmula de seguimiento leche de vaca otro	
	CEREALES sin gluten, sin leche sin gluten, con leche con gluten, sin leche con gluten, con leche otros	con azúcar si / no
	yogur petit suisse otro	

[Reverse of the sheet]

Número: fecha:

mes	alimento	tipo / marca / comentario
	FRUTA fresca potito cereal ZUMO natural comercial otro	con azúcar si / no
	PAN galletas otro	
	VERDURAS PATATAS LEGUMBRES PASTAS	con sal sí / no
	CARNE PESCADO HUEVO clara yema QUESO	con sal sí / no
	POTITOS	
	BEBIDAS café/té/infusiones refrescos otros	con azúcar sí / no

Appendix B
Data collection sheets for the second part of the study

Número: fecha:

NIÑO:nombre	apellidos	
dirección		
dto.postal	teléfono	
MADRE:nombre	apellidos	
fecha nac.	edad	profesión
PADRE:profesión		
sexo v / h	edad gestacional (sem)	fecha nacimiento
peso al nacer (g)	talla al nacer (cm)	edad (m)
¿Tiene su hijo alguna enfermedad?		
¿Ha estado enfermo alguna vez?		
¿Le ha dado el pecho a su hijo? sí / no	¿Durante cuanto tiempo?	sem / m
¿Le ha dado a su hijo alguna leche artificial? sí / no	¿Cuál?	
¿Cuando le dio por primera vez algo que no fuera leche?		meses

[Reverse of the sheet]

Instrucciones para guardar las comidas de muestra

1. Apunte Ud. durante dos días que le vengan bien TODOlo que tome su hijo en 24 horas, es decir de medianoche a medianoche. Hay que apuntar tanto líquidos como sólidos.

2. En esos dos días, del puré de verduras y carne, prepare la cantidad suficiente para dar de comer a su hijo y para llenar hasta arriba el frasco. Anote en el formulario la forma de preparar y la cantidad que comió el niño, lo mismo que para las demás comidas de ese día.

3. Cierre bien el frasco y déjelo enfriar.

4. Ponga el frasco en el congelador y déjelo allí hasta que lo recogamos.

Muchas gracias por su colaboración

FORMULARIO A RELLENAR POR LA MADRE

(Ver instrucciones al dorso)

El día .. de ..... de 1994 le di a mi hijo:

Hora	Descripción del alimento	Marca	Cantidad	Cantidad que sobró	Dejar en blanco

[Reverse of the sheet]

Por favor, indique en el reverso todo lo que tome su hijo en 24 horas, es decir de medianoche a medianoche, del día en el cual Ud. prepara la comida para análisis. Apunte líquidos y sólidos.

Hay 6 columnas:

Hora: la hora a la cual su hijo tomó el alimento.

Descripción: indique detalladamente lo que tomó su hijo, sea una comida, una bebida o cualquier cosa que tomó entre horas.
Si la comida fue preparada por Ud., dénos por favor una pequeña descripción de los ingredientes y la preparación, por ejemplo: *papilla de frutas de ½ manzana, ½pera, el zumo de una naranja y 1 galleta María, todo pasado por la minipimer.*

Marca: apunte la marca si algún alimento o ingrediente lo tenga, por ejemplo: si el niño tomó una papilla de cereales hecha con leche infantil "Almirón 2" y con cereales "Blevit multicereales", apunta Ud. *Almirón 2* y *Blevit multicereales*.

Cantidad: anote la cantidad que tomó su hijo, por ejemplo *180 ml de agua con 6 cucharaditas de Almirón 2*. Si no sabe la cantidad exacta, ponga por favor la cantidad en medidas caseras, por ejemplo: *½ manzana* o *1 vaso* o *1 rebanada* (de pan) o *½ cucharadita*.

Cantidad que sobró: apunte la cantidad (de comida o bebida) que sobró, si su hijo dejó algo. Por ejemplo: si Ud. le dió un potito de frutas de 200 gramos y su hijo dejó ¼ potito, apunte *¼ potito* o *50 gramos*.

La columna en blanco la utilizaremos para poder meter los datos en ordenador.

Recuerde que hay que apuntar <u>todo</u> lo que toma el niño durante 24 horas, también lo que Ud. le dé por la noche, o la galleta que le dé la abuela.
No cambie sus costumbres al participar en este estudio.

Appendix C: Composition of the home-prepared baby meals

Results of the chemical analysis of 51 baby meals made by 26 mothers. The results are expressed in units per 100 g of baby meal. The infants were 7 and 8 monthsold.

Code of the sample		1a	2a	2b	3a	3b	4a	4b	5a	5b
Total solids	g	12.8	14.3	12.6	15.4	11.5	9.3	10.7	11.5	9.5
Protein	g	3.2	3.4	3.8	5.8	4.2	3.5	3.9	2.9	2.6
Fat	g	1.8	2.2	2.0	4.1	1.3	0.1	1.2	0.9	1.0
Ash	g	0.7	1.0	0.8	0.6	0.5	0.5	0.5	0.5	0.5
Fibre	g	1.1	1.2	1.1	1.3	1.0	0.8	0.7	1.0	0.8
Carbohydrates	g	6.1	6.5	4.9	3.6	4.6	4.5	4.4	6.4	4.7
Na	mg	58	177	135	31	13.7	25	29	11	27
K	mg	185	217	190	192	131	157	153	158	146
Ca	mg	21.8	19.9	22.3	16.2	15.7	15.3	13.6	12.5	17.4
Mg	mg	17.8	17.0	13.6	15.4	11.8	12.1	12.1	10.4	12.5
Fe	mg	0.7	0.4	0.5	0.8	0.8	0.4	0.4	0.3	0.3
Zn	mg	0.8	0.5	0.4	1.5	0.7	0.4	0.3	0.4	0.4
Energy	kcal	53	59	53	74	47	33	44	45	38
	kJ	223	250	223	311	197	140	185	189	160

Code of the sample		6a	6b	7a	7b	8a	8b	10a	10b
Total solids	g	11.0	11.9	10.4	10.5	11.6	9.5	14.3	16.1
Protein	g	5.2	5.6	5.6	5.7	4.2	3.7	6.2	6.3
Fat	g	0.8	0.2	0.6	0.6	0.7	0.1	1.3	1.9
Ash	g	0.8	0.7	0.5	0.6	0.8	0.6	0.9	0.8
Fibre	g	0.9	1.0	0.9	0.9	0.9	0.8	1.2	1.3
Carbohydrates	g	3.3	4.4	2.8	2.7	5.1	4.4	4.8	5.7
Na	mg	57	65	24	23	31	20	36	25
K	mg	229	199	166	167	237	165	274	255
Ca	mg	23.8	16.0	10.4	10.1	13.0	10.4	25.5	24.7
Mg	mg	18.6	17.8	11.4	11.3	14.9	11.5	18.2	14.4
Fe	mg	0.5	0.5	0.4	0.4	0.3	0.3	0.7	0.8
Zn	mg	0.5	0.4	0.9	0.9	0.4	0.4	1.3	1.1
Energy	kcal	41	42	39	39	43	33	55	65
	kJ	175	177	165	165	182	141	232	275

Code of the sample		11a	11b	12a	12b	13a	13b	14a	14b
Total solids	g	11.2	11.8	13.4	13.4	14.5	13.0	10.2	10.2
Protein	g	3.2	3.1	3.8	3.8	6.6	4.8	2.2	2.3
Fat	g	0.6	0.7	1.4	1.4	1.5	0.5	1.9	2.0
Ash	g	1.0	0.6	1.1	0.8	0.8	0.7	0.6	0.6
Fibre	g	0.9	1.0	1.1	1.1	1.2	1.1	0.9	0.9
Carbohydrates	g	5.5	6.4	5.9	6.3	4.4	5.9	4.6	4.5
Na	mg	218	78	125	109	119	74	36	36
K	mg	194	147	289	187	226	192	171	174
Ca	mg	10.3	10.4	16.6	17.9	29.2	8.0	24.5	25.9
Mg	mg	12.2	10.3	18.7	13.3	14.0	12.0	10.8	10.9
Fe	mg	0.6	0.3	0.6	0.4	0.6	0.4	0.3	0.3
Zn	mg	0.5	0.4	0.9	0.6	1	0.7	0.3	0.3
Energy	kcal	40	44	52	53	58	47	45	45
	kJ	170	188	218	224	243	200	187	188

Code of the sample		16a	16b	18a	18b	19a	19b	20a	20b
Total solids	g	14.7	13.3	9.1	8.3	14.4	15.7	12.4	12.9
Protein	g	4.5	3.8	4.7	4.1	6.3	5.5	3.8	4.0
Fat	g	1.8	2.1	0.2	0.5	2.2	3.3	0.4	0.4
Ash	g	0.7	0.7	0.6	0.5	1.0	1	0.8	0.7
Fibre	g	1.2	1.1	0.8	0.7	1.5	1.3	0.9	1.1
Carbohydrates	g	6.5	5.7	2.7	2.5	3.4	4.6	6.6	6.7
Na	mg	17	45	23.3	25.6	257	250	16.7	17.3
K	mg	220	220	191	144	159	166	227	230
Ca	mg	14.1	15.3	9.4	7.7	15.0	10.7	6.4	6.2
Mg	mg	15.5	16.2	10.1	8.7	11.8	11.3	11.6	12.8
Fe	mg	0.5	0.5	0.3	0.3	0.7	0.6	0.4	0.4
Zn	mg	0.8	0.5	0.6	0.6	0.8	0.9	0.3	0.3
Energy	kcal	60	56	32	31	58	70	45	47
	kJ	252	236	135	131	246	292	190	198

Code of the sample		21a	21b	22a	22b	23a	23b *	24a	24b
Total solids	g	8.9	9.1	14.5	17.4	17.3	15.8	15.2	15.1
Protein	g	3.5	3.4	5.9	9.6	4.7	6.1	4.0	3.7
Fat	g	0.3	0.2	1.1	0.8	1.5	0.6	2.9	3.6
Ash	g	0.4	0.4	0.6	0.6	0.9	1.0	1.0	0.8
Fibre	g	0.7	0.8	1.2	1.4	1.4	1.3	1.3	1.3
Carbohydrates	g	4.0	4.3	5.6	5.0	8.9	8.2	6.1	5.7
Na	mg	14.9	43	12	28	21.9	20.9	155	138
K	mg	112	123	179	156	280	263	256	238
Ca	mg	7.5	8.2	11.9	5.5	17.7	16.9	11.7	12.6
Mg	mg	7.3	7.9	13.1	11.6	17.3	18.7	14.7	14.3
Fe	mg	0.5	0.3	0.7	0.9	0.4	0.3	0.5	0.4
Zn	mg	0.6	0.4	1.1	1.1	0.6	0.3	0.6	0.6
Energy	kcal	32	33	56	65	68	62	66	70
	kJ	138	139	237	277	285	265	277	293

* sample based on chicken

Code of the sample		25a	25b	26a	26b	27a	27b	28a	28b	29a	29b
Total solids	g	9.9	10.6	12.9	13.2	13.0	12.6	11.3	11.3	14.8	13.4
Protein	g	5.2	3.9	5	4.7	3.6	3.7	3.8	3.5	5.1	3.0
Fat	g	0.5	0.7	1.1	3.0	1.6	1.7	0.8	1.5	2.1	2.4
Ash	g	0.6	0.7	0.8	0.5	0.6	0.5	0.4	0.2	1.0	0.8
Fibre	g	0.8	1	1.1	1.1	1.1	1.0	0.9	0.9	1.2	1.1
Carbohydrates	g	2.8	4.4	4.9	3.8	6.2	5.7	5.3	5.2	5.4	6.0
Na	mg	39	21.2	130	90	35	36	21	14	164	151
K	mg	193	175	252	118	201	174	123	145	271	238
Ca	mg	8.7	7.8	17.4	14.2	19.2	21.5	21.6	11.6	12.5	13.1
Mg	mg	11.8	10.8	15.0	8.7	12.5	12.7	15.7	12.6	16.2	14.3
Fe	mg	0.2	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.5
Zn	mg	0.5	0.5	0.7	0.9	0.8	0.8	0.7	0.9	0.6	0.4
Energy	kcal	36	39	49	62	53	52	44	48	61	58
	kJ	153	165	208	258	225	221	185	202	257	243

Appendix D

Results of the analysis of the food diaries of infants of 7 and 8 months.

Boys

child code	energy kcal	kJ	prot. g	fat g	CHO g	Na mg	K mg	Ca mg	Mg mg	Fe mg	Zn mg	Energy percent prot.	fat	CHO
3a	1176	4930	39.1	32.0	184.3	337	1605	754	125.8	21.8	8.1	13.0	24.0	63.0
3b	1021	3650	29.5	20.5	142.2	243	1038	615	93.2	17.2	4.8	12.0	18.0	56.0
4a	889	3751	29.9	16.2	158.0	272	1776	766	153.3	18.5	4.6	13.0	16.0	71.0
4b	836	3524	30.9	20.5	134.2	288	1758	784	147.7	16.2	4.3	15.0	22.0	64.0
6a	911	3857	26.8	22.8	149.8	289	1515	627	106.2	12.5	5.3	11.8	22.5	65.8
6b	777	3276	29.8	18.5	124.4	334	1586	686	118.9	11.8	4.4	15.3	21.4	64.0
10a	815	3427	23.8	23.9	128.6	229	1552	660	129.5	15.9	5.5	11.7	26.4	63.1
10b	937	3944	29.7	27.7	144.0	300	1547	755	128.4	20.4	6.2	12.7	26.6	61.5
12a	862	3621	23.0	16.0	156.7	562	1614	438	112.6	16.7	4.4	10.7	16.7	72.7
12b	955	4017	25.3	18.2	172.8	553	1454	512	106.0	18.7	3.9	10.6	17.2	72.4
14a	867	3642	25.1	25.7	136.7	405	1692	679	121.4	14.9	3.9	11.6	26.7	63.1
14b	887	3725	25.3	24.6	144.5	385	1835	646	128.0	15.2	4.2	11.4	25.0	65.2
20a	745	3126	24.0	19.0	118.5	266	1192	636	91.5	8.3	3.9	12.9	23.0	63.6
20b	777	3260	25.6	20.0	122.5	280	1250	666	97.2	8.4	4.0	13.2	23.2	63.1
23a	595	2513	26.4	17.2	84.1	263	1448	518	103.2	6.0	3.3	18.0	26.0	57.0
23b	830	3523	36.2	18.6	132.9	345	1829	541	147.5	12.4	2.8	17.0	20.0	64.0
24a	1009	4227	28.8	27.1	163.8	438	1556	772	162.5	10.0	4.5	11.4	24.2	64.9
24b	967	4051	26.7	27.0	155.4	385	1497	699	153.6	10.2	4.5	11.0	25.1	64.3
28a	910	3830	32.1	23.5	145.8	378	1679	688	152.9	16.7	6.0	14.1	23.2	64.1
28b	927	3901	31.0	24.3	148.7	279	1856	682	150.3	19.1	6.5	13.4	23.6	64.2
29a	1007	4248	34.1	23.4	165.2	595	2010	595	155.2	21.9	5.1	13.5	20.9	65.6
29b	1025	4324	34.9	23.5	169.5	594	2322	594	168.5	20.9	5.6	13.6	20.6	66.1
mean	896	3744	29.0	22.3	144.7	364	1618	650	129.7	15.2	4.8	13.0	22.4	64.5
SD	117	479	4.2	4.1	21.4	113	269	90	23.5	4.5	1.2	1.9	3.2	3.8
min.	595	2513	23.0	16.0	84.1	229	1038	438	91.5	6.0	2.8	10.6	16.0	56.0
max.	1176	4930	39.1	32.0	184.3	595	2322	784	168.5	21.9	8.1	18.0	26.7	72.7

Girls

child code	energy kcal	kJ	prot. g	fat g	CHO g	Na mg	K mg	Ca mg	Mg mg	Fe mg	Zn mg	Energy percent prot.	fat	CHO
1a	984	4146	32.9	26.6	149.7	522	1353	890	117.7	11.0	3.8	13.4	24.3	60.9
2a	933	3905	32.3	28.9	136.1	737	1475	830	118.4	13.7	5.5	14.0	28.0	58.0
2b	899	3755	33.3	29.4	125.1	647	1450	864	111.1	13.1	5.4	15.0	29.0	56.0
5a	791	3327	19.0	20.4	133.2	143	1031	379	83.1	4.5	3.1	10.0	23.0	67.0
5b	762	3189	18.1	21.1	125.3	277	957	372	84.1	4.7	3.2	10.0	25.0	66.0
7a	690	2906	18.2	18.0	114.3	138	838	306	75.0	16.9	3.5	10.6	23.5	66.3
8a	610	2558	23.1	15.2	97.1	242	1606	455	103.7	8.3	3.6	15.0	22.0	64.0
8b	548	2300	21.5	13.8	86.3	212	1277	443	85.4	8.1	3.6	16.0	23.0	63.0
11a	749	3153	26.5	16.3	125.9	629	1551	686	112.5	8.5	4.2	14.2	19.6	67.2
11b	761	3199	24.8	16.4	130.4	392	1482	639	108.4	8.1	3.9	13.0	19.4	68.5
13a	1063	4665	39.0	28.2	165.7	675	2120	815	147.4	12.3	6.3	14.7	10.6	62.4
13b	984	4085	34.0	25.6	156.5	556	1927	733	134.9	11.7	5.5	13.8	10.4	63.6
16a	800	3361	29.0	25.3	115.5	337	1860	735	115.0	8.3	4.7	14.5	28.5	57.8
16b	780	3274	28.3	28.4	102.9	424	1650	776	102.6	8.5	4.2	14.5	32.8	52.8
18a	831	3492	30.6	20.1	133.4	309	1598	602	121.8	15.2	4.2	14.7	21.8	64.2
18b	810	3410	35.1	16.1	132.7	359	1559	605	205.4	14.6	3.3	17.3	17.9	65.5
19a	876	3693	31.6	22.2	139.9	712	1439	643	109.6	19.4	5.0	14.4	22.8	63.9
19b	929	3900	31.0	27.0	141.9	649	1405	735	111.7	20.0	5.4	13.3	26.2	61.1
21a	669	2817	22.6	17.7	105.0	239	861	534	78.3	18.9	4.3	13.5	23.8	62.8
21b	918	3853	31.5	25.1	141.5	368	1168	845	99.5	23.7	4.8	13.7	24.6	61.7
22a	679	2855	31.4	19.7	95.0	362	1266	838	137.1	7.8	4.7	18.5	26.1	56.0
22b	697	2935	38.8	19.1	93.8	394	1220	825	135.1	8.2	4.7	22.3	24.7	53.8
25a	811	3411	30.4	22.9	124.0	375	2083	717	137.9	10.8	4.5	15.0	25.4	61.2
25b	802	3364	28.9	25.0	117.4	365	1786	719	116.8	11.6	4.7	14.4	28.1	58.6
mean	807	3398	28.8	22.0	124.5	419	1456	666	114.7	12.0	4.4	14.4	23.4	61.8
SD	122	530	5.8	4.7	20.1	176	342	168	27.0	4.9	0.8	2.5	5.1	4.2
min.	548	2300	18.1	13.8	86.3	138	838	306	75.0	4.5	3.1	10.0	10.4	52.8
max.	1063	4665	39.0	29.4	165.7	737	2120	890	205.4	23.7	6.3	22.3	32.8	68.5

MATERIAL REDACTED AT REQUEST OF UNIVERSITY