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Rising under-5 mortality in Africa: who bears the brunt?

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Summary

OBJECTIVES To identify the socioeconomic and geographical groups in which the recent under-5 mortality increase observed in several African countries was most pronounced, and to explore the contribution of a number of proximate determinants of under-5 mortality.

METHODS Time trends in under-5 mortality were assessed with Cox Proportional Hazards regression analysis, using Demographic and Health Surveys data for Burkina Faso, Cameroon, Côte d'Ivoire, Kenya and Zimbabwe for the late 1980s – 1990s. We tested for differences in time trends between socioeconomic and rural/urban subgroups, and described the inequalities in time trends in living conditions, malnutrition and health care use.

RESULTS Under-5 mortality increased substantially (ranging from 25% to 71% in 10 years) within the five countries. In Kenya, the increase was the largest among children born to less educated mothers (test for difference between educational groups: $P = 0.074$) and in rural areas ($P = 0.090$). In Cameroon, the increase was the largest among the higher educated ($P = 0.013$), and in Zimbabwe among the higher educated ($P = 0.098$) and in urban areas ($P = 0.093$). For Burkina Faso and Côte d'Ivoire, we did not observe statistically significant differences between educational and rural/urban subgroups. The decline in skilled delivery attendance in Zimbabwe and Kenya was similar among the less and higher educated. The decline in immunization coverage during the mid-1990s in Zimbabwe was the largest in the group with the highest mortality increase, but in Kenya it was as large among the less and higher educated. Whereas in Kenya the increase in malnutrition was the largest in the group with the highest mortality increase, this was not the case in Zimbabwe.

CONCLUSIONS The recent increase in under-5 mortality in some African countries was highly concentrated in specific population subgroups. Exactly which groups were most affected was highly variable. It cannot be assumed that lower socioeconomic groups are always most vulnerable. Strategies to halt the under-5 mortality increase should be based on disaggregate information for individual countries.

keywords under-5 mortality, trends, health inequality, Africa, malnutrition, health care utilization

Introduction

After a period of declining under-5 mortality, childhood survival has deteriorated recently in several African countries (WHO 2003; UNICEF 2004). In many cases, the improvements made during the 1970s and early 1980s are being wiped out. Economic decline (Ahmad *et al.* 2000; UNICEF 2004), the HIV/AIDS epidemic (Adetunji 2000; Walker *et al.* 2002; UNICEF 2004), an increase in drug-resistant malaria (Snow *et al.* 2001; WHO & UNICEF 2003) and armed conflict (UNICEF 2004) have been related to this mortality increase.

The above deteriorating trends refer to national averages of under-5 mortality. Children of poor and low-educated mothers have, however, a much higher chance of dying in childhood than those of richer and more educated mothers (Bicego & Boerma 1993; Gwatkin *et al.* 2000). The pattern of mortality change over time may also differ between socioeconomic groups. Mortality decline, it has been suggested, starts earlier among higher socioeconomic groups (Victora *et al.* 2000). There is, however, little evidence on differential mortality trends from low-income countries and, to our knowledge, no study set within the context of mortality increase.

Already disadvantaged groups might be more vulnerable to the deteriorating circumstances discussed earlier, thereby increasing the already-large mortality gap between socioeconomic groups. If the Millennium Development Goal of a two-third reduction in under-5 mortality by 2015 is to be achieved, it is important to know which groups are most vulnerable to a mortality increase. By identifying the socioeconomic and geographical groups in which the under-5 mortality increase is concentrated, our study hopes to contribute to priority

setting in policies aimed at confronting this important public health problem.

This study aimed to investigate to what extent the increase in under-5 mortality observed in several African countries during the 1990s was concentrated in specific socioeconomic or geographical groups. As urban areas can be highly heterogeneous, separate analyses are presented for lower and higher socioeconomic strata within urban and within rural areas.

In order to understand the mortality changes among the socioeconomic and rural/urban subgroups, we explore the role of several proximate, modifiable, determinants of under-5 mortality. Specifically, we describe time trends in levels of health care use (i.e. childhood immunization, delivery attendance by medical person) and acute and chronic childhood malnutrition for each of the socioeconomic and rural/urban subgroups.

Data and methods

Data were obtained from the Demographic and Health Surveys (DHS) (http://www.measuredhs.com). These are nationally representative surveys among women aged 15–49 years. DHS includes retrospective birth history data, with survival information on all children ever born to the respondents, and information on determinants of mortality. All sub-Saharan African countries with at least two DHS surveys in the 1990s, showing an increase in under-5 mortality, were included in our study (Table 1). The countries vary distinctly in HIV prevalence, from 6% in Burkina Faso, 13% in Kenya, to 25% in Zimbabwe (http://www.odci.gov/cia/publications/factbook/fields/2155.html).

First, we calculated the probability of those dying under 60 months of age for the total population and the educational and rural/urban subgroups. These probabilities were estimated using Cox Proportional Hazards regression analysis. All children who were alive and under 60 months of age within the pre-defined time frame, were considered exposed. All deaths among these children were included. Children could enter the time frame at birth (when born during the time frame) or at any age until 59 months old (when born before the time frame). Time frames were generally no longer than 5 years prior to the survey, to minimize the potential problem of a positive correlation between maternal and child deaths (Mahy 2003).

Secondly, time trends in under-5 mortality were estimated using a Cox Proportional Hazards model in which the Hazard Ratios between survey years (year defined as linear variable) provided the annual percentage mortality change. We tested whether the mortality time trends were significantly different between the lower and higher educated, and between rural and urban areas. Time trends were also estimated for infant (<12 months) and child (12–59 months) mortality separately, as the strength of the effects of the studied determinants is known to vary with the age of children.

Demographic and Health Surveys are based on a cluster-sampling scheme. This design effect should be taken into account when calculating the confidence intervals. Standard errors were obtained by bootstrapping the Cox analyses, keeping the number of clusters per survey year constant. For every model, 1000 bootstrap replications were obtained (Efron & Tibshirani 1993). Cox analyses and bootstraps were performed in S-PLUS 6.0 (release 2, Insightful Corporation, Seattle, WA, USA).

Finally, a first step towards explaining the mortality trends assessed whether changes in proximate determinants of mortality ran parallel with the observed mortality trends. The following determinants were studied: household living conditions, childhood malnutrition, full childhood immunization coverage and skilled delivery attendance. Data were obtained from the STATcompiler, on the DHS website, and were cross-checked with information in the Final Reports. We focussed on the most interesting comparison, between Kenya and Zimbabwe. The two countries showed very different patterns of mortality increase across educational and rural/urban subgroups (see below). They are also the only countries with three surveys.

Results

The countries were heterogeneous in terms of the distribution of exposed children across the educational categories, with 92% of children in Burkina Faso born to mothers without any education, compared with 9% in Zimbabwe (Table 1). In all countries, the majority of children were born in rural areas.

Under-5 mortality increased substantially during the mid-1980s/1990s (Table 2), varying from an estimated 2.2% per year in Kenya to 5.5% in Côte d'Ivoire (i.e. a 25% and 71% increase in 10 years, respectively). The increases were highly statistically significant in most countries. The point estimates per subgroup give some indication of differential trends (Tables 2 and 3). In Burkina Faso and Kenya, the mortality increase was concentrated among the less educated and those in rural areas. In Côte d'Ivoire, mortality increased among all groups except the highest educated. In Cameroon and Zimbabwe, all groups experienced a mortality increase. In Cameroon, the increase was the largest among the higher educated, and in Zimbabwe among the higher educated and in urban areas. Absolute changes in under-5 mortality over time generally reflect the above-mentioned relative changes.

Table 1 Distribution of children (number of deaths) under age 60 months, for the total population and educational and rural/urban groups in the late 1980s/1990s for five African countries

Subgroups	Survey 1	Survey 2	Survey 3
Burkina Faso		1992/1993	1998/1999
Total*	NA (NA)	9511 (810)	9656 (972)
Education (%)			
No education	NA (NA)	89 (740)	92 (915)
Some primary	NA (NA)	5 (37)	4 (33)
Primary completed	NA (NA)	3 (22)	2 (15)
Secondary+	NA (NA)	3 (12)	2 (9)
Rural/urban (%)			
Rural	NA (NA)	86 (732)	90 (896)
Urban	NA (NA)	14 (76)	10 (53)
Cameroon		1991	1998
Total*	NA (NA)	5709 (344)	6907 (499)
Education (%)			
No education	NA (NA)	45 (220)	37 (231)
Some primary	NA (NA)	24 (65)	25 (116)
Primary completed	NA (NA)	13 (20)	15 (69)
Secondary+	NA (NA)	18 (39)	24 (84)
Rural/urban (%)			
Rural	NA (NA)	60 (227)	74 (378)
Urban	NA (NA)	40 (115)	26 (98)
Cote d'Ivoire		1994	1998/1999
Total*	NA (NA)	12585 (955)	3658 (354)
Education (%)			
No education	NA (NA)	70 (691)	67 (244)
Some primary	NA (NA)	17 (158)	13 (54)
Primary completed	NA (NA)	5 (47)	13 (45)
Secondary+	NA (NA)	8 (59)	7 (11)
Rural/urban (%)			
Rural	NA (NA)	64 (672)	71 (258)
Urban	NA (NA)	36 (283)	29 (68)
Kenya	1989	1993	1998
Total*	12000 (511)	9873 (427)	9999 (528)
Education (%)			
No education	31 (150)	22 (74)	14 (87)
Some primary	32 (192)	32 (192)	37 (254)
Primary completed	21 (106)	25 (106)	24 (112)
Secondary+	16 (64)	21 (56)	25 (75)
Rural/urban (%)			
Rural	87 (433)	87 (372)	83 (452)
Urban	13 (77)	13 (55)	17 (74)
Zimbabwe	1988/1999	1994	1999
Total*	6243 (218)	7693 (288)	6526 (347)
Education (%)			
No education	20 (59)	17 (46)	9 (32)
Some primary	43 (104)	33 (102)	24 (92)
Primary completed	21 (30)	22 (64)	24 (80)
Secondary+	16 (25)	28 (76)	43 (142)
Rural/urban (%)			
Rural	73 (180)	77 (225)	69 (238)
Urban	27 (38)	23 (61)	31 (97)

* Total number of children (total number of deaths). As the number of missing values varies between variables, the total number of deaths also varies between the variables.

The difference in mortality trends between the two lower and two higher educational groups was of borderline statistically significance for Kenya ($P = 0.074$) and Zimbabwe ($P = 0.098$), and statistically significant for Cameroon ($P = 0.013$). As the distribution of children was highly skewed in Burkina Faso and Côte d'Ivoire, we

compared the mortality trends between the categories 'no education' and 'some education' for these countries. No statistically significant differences were found. The stronger mortality increase in rural areas in Kenya was of borderline statistical significance ($P = 0.090$), as was the stronger increase in urban areas in Zimbabwe ($P = 0.093$).

In Zimbabwe, there was a systematic gradient, with the smallest mortality increase among the lower educated in rural areas and the strongest increase among the urban higher educated (Figure 1). In Kenya, the reverse gradient from the one found for Zimbabwe was observed.

The percentage increase in child mortality was larger than that in infant mortality (Table 4). In Zimbabwe, child mortality increased by almost 14% annually among the secondary education group, in comparison with 1.5% among the group without schooling. The educational gradient in the mortality increase was much weaker for infant mortality. In Kenya, also, the gradient was stronger for child mortality; however, the largest increases were observed among the less educated.

Determinants of under-5 mortality

The proportion of households without any toilet facility and the proportion with a dirty floor generally remained stable or slightly decreased among all educational groups in Kenya and Zimbabwe (results not shown). Household ownership of durable consumer goods and the availability of electricity generally remained stable or increased.

Table 2 Under-5 mortality and annual change in under-5 mortality for the total population and educational groups, in the 1980s/1990s, for five African countries

Subgroups	Probability of death under age 5 years (per 1000 live births)			Annual change (%) in under-5 mortality (95% CI)*	*P* value†
Burkina Faso		1989–1993	1995–1999		
Total	NA	168	202	3.2 (1.1–5.4)	
No education	NA	172	207	3.3 (1.2–5.4)	0.452
Some primary	NA	158	180	2.5 (−6.8–12.7)	
Primary completed	NA	137	127	−1.0 (−11. 5–10.8)	
Secondary+	NA	90	88	−0.2 (−10.9–11.8)	
Cameroon		1987–1991	1994–1998		
Total	NA	102	140	3.3 (0.3–6.3)	
No education	NA	151	175	0.5 (−2.9–4.0)	0.013
Some primary	NA	78	130	5.8 (0.5–11.5)	
Primary completed	NA	40	133	17.0 (7.1–27.7)	
Secondary+	NA	58	95	5.7 (0.0–11.8)	
Cote d'Ivoire		1990–1994	1994–1999		
Total	NA	145	168	5.5 (0.1–11.2)	
No education	NA	154	176	4.9 (−2.0–12.4)	0.751
Some primary	NA	134	179	9.3 (−0.7–20.4)	
Primary completed	NA	129	168	8.7 (−3.3–22.2)	
Secondary+	NA	103	71	−7.4 (−21.0–8.5)	
Kenya	1985–1989	1990–1993	1994–1998		
Total	87	99	105	2.2 (−0.1–4.6)	
No education	94	89	142	4.8 (0.4–9.4)	0.074
Some primary	102	141	132	2.8 (−0.1–5.8)	
Primary completed	77	88	89	1.9 (−1.7–5.6)	
Secondary+	60	59	58	−0.1 (−4.8–4.9)	
Zimbabwe	1984–1989	1990–1994	1995–1999		
Total	64	75	102	4.2 (2.2–6.1)	
No education	91	81	126	1.9 (−3.0–7.0)	0.098
Some primary	71	85	119	4.4 (1.3–7.7)	
Primary completed	41	76	98	7.7 (3.6–12.0)	
Secondary+	40	60	88	7.3 (3.2–11.6)	

Because of the skewed educational distribution in Burkina Faso and Cote d'Ivoire, for these two countries, the *P* value gives the test on difference between the category 'no education' and the other three groups.

* Trend estimate, based on linear trend in mortality across all surveys.

† P-value of test on difference between the lowest two and the highest two educational categories.

Table 3 Under-5 mortality and annual change in under-5 mortality for the total population and rural/urban groups, in the 1980s/1990s, for five African countries

Subgroups	Probability of death under age 5 years (per 1000 live births)			Annual change (%) in under-5 mortality (95% CI)*	*P* value†
Burkina Faso		1989–1993	1995–1999		
Total	NA	168	202	3.2 (1.1–5.4)	
Rural	NA	165	206	3.3 (1.2–5.5)	0.167
Urban	NA	110	111	−0.2 (−4.5–4.3)	
Cameroon		1987–1991	1994–1998		
Total	NA	102	140	3.3 (0.3–6.3)	
Rural	NA	126	151	3.0 (−0.8–6.8)	0.815
Urban	NA	96	111	2.4 (−1.0–5.9)	
Cote d'Ivoire		1990–1994	1994–1999		
Total	NA	145	168	5.5 (0.1–11.2)	
Rural	NA	156	174	5.7 (−0.8–12.6)	0.457
Urban	NA	118	115	2.4 (−2.7–7.8)	
Kenya	1985–1989	1990–1993	1994–1998		
Total	87	99	105	2.2 (−0.1–4.6)	
Rural	88	103	113	2.9 (0.3–5.6)	0.090
Urban	99	102	88	−1.3 (−5.4–2.9)	
Zimbabwe	1984–1989	1990–1994	1995–1999		
Total	64	75	102	4.2 (2.2–6.1)	
Rural	73	77	107	3.4 (1.1–5.7)	0.093
Urban	41	66	91	7.3 (3.3–11 4)	

* Trend estimate, based on linear trend in mortality across all included surveys.
† Test on difference between rural and urban subgroups.

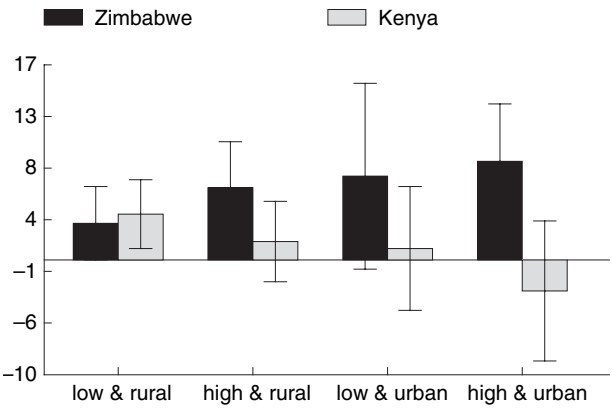

Figure 1 Change in under-5 mortality per year (%) by subgroup, Zimbabwe and Kenya, mid-1980s to mid-1990s. Low and rural = no education or some primary and living in rural area; high and rural = primary education completed or higher and living in rural area; low and urban = no education or some primary and living in urban area; high and urban = primary education completed or higher and living in urban area.

Malnutrition among 0- to 2-year olds has increased in Kenya and Zimbabwe (Table 5). In Kenya, chronic malnutrition, especially the prevalence of severe cases, increased among the lower educated. Also, acute and chronic malnutrition has increased across educational groups. Among the less educated, severe forms of malnutrition increased, whereas among the higher educated, moderate forms increased.

In Kenya, immunization coverage strongly improved among all groups between the first and second survey (i.e. in the early 1990s) but declined considerably thereafter (i.e. mid-1990s) (Table 6). Skilled delivery attendance declined over time. The decline in immunization coverage and delivery attendance was about as strong (in absolute terms) among the lowest and highest educated. Also in Zimbabwe, immunisation coverage initially increased, and subsequently declined. This subsequent decline was stronger among the higher educated. Skilled delivery attendance declined somewhat among all groups.

Discussion

Our study shows that under-5 mortality has strongly increased in a number of African countries. At the end of the 1990s, under-5 mortality in some countries had fallen back to the level as it was two decades earlier. By identifying the groups where this reversal has been most pronounced, our study has enhanced the understanding of this urgent public health problem.

In Kenya, the increase in under-5 mortality was concentrated among the less educated and among those in rural areas, thereby increasing socioeconomic mortality

Table 4 Annual change in infant mortality and child mortality, for the total population and educational and rural/urban subgroups, in the 1980s/1990s, for two African countries

Subgroups	Annual change (%) in infant mortality (95% CI)*	*P* value†	Annual change (%) in child mortality (95% CI)*	*P* value‡
Kenya				
Total	1.9 (−0.4–4.4)		2.9 (−0.6–6.6)	
Education				
No education	3.1 (−2.2–8.8)	0.257	7.7 (1.4–14.4)	0.161
Some primary	2.7 (−0.6–6.0)		3.0 (−1.8–8.0)	
Primary completed	1.5 (−2.8–6.0)		2.5 (−3.3–8.8)	
Secondary+	0.2 (−4.7–5.3)		−0.8 (−9.9–9.2)	
Rural/urban				
Rural	2.5 (−0.4–5.4)	0.215	3.6 (−0.4–7.8)	0.301
Urban	−1.5 (−6.8–4.1)		−0.9 (−8.0–6.7)	
Zimbabwe				
Total	3.4 (1.1–5.7)		5.9 (2.3–9.5)	
Education				
No education	2.1 (−4.5–9.2)	0.215	1.5 (−6.0–9.6)	0.123
Some primary	3.3 (−0.4–7.1)		6.6 (0.4–13.1)	
Primary completed	6.8 (1.9–11. 9)		9.6 (2.2–17.4)	
Secondary+	5.4 (0.7–10.4)		13.7 (4.7–23.4)	
Rural/urban				
Rural	2.7 (0.1–5.4)	0.161	5.1 (1.0–9.3)	0.331
Urban	6.6 (2.0–11.3)		9.4 (1.7–17.6)	

* Trend estimate, based on linear trend in mortality across all included surveys.
† Test on difference between the lowest two and the highest two educational groups.
‡ Test on difference between rural and urban sub-groups.

Table 5 Time trends in childhood malnutrition, in the late 1980s/1990s, for two African countries*

	Severe chronic malnutrition (%)†				Moderate + severe chronic malnutrition (%)‡				Moderate + severe acute malnutrition (%)§			
Subgroups	Survey 1	Survey 2	Survey 3	Change (abs)	Survey 1	Survey 2	Survey 3	Change (abs)	Survey 1	Survey 2	Survey 3	Change (abs)
Kenya												
Total	NA	10.0	12.7	2.7	NA	29.0	33.0	4.0	NA	4.6	6.1	1.5
No education	NA	12.9	21.4	8.5	NA	37.8	46.4	8.6	NA	9.0	8.8	−0.2
Primary	NA	11.2	14.3	3.1	NA	31.3	36.4	5.1	NA	4.2	6.4	2.2
Secondary+	NA	6.1	5.0	−1.1	NA	19.4	19.2	−0.2	NA	3.0	3.9	0.9
Zimbabwe												
Total	7.6	6.1	9.2	1.6	27.4	21.4	26.4	−1.0	1.6	5.5	7.1	5.5
No education	8.1	9.8	14.5	6.4	36.3	27.1	40.1	3.8	4.0	6.0	10.8	6.8
Primary	8.4	6.9	11.8	3.4	29.2	25.0	30.6	1.4	1.6	5.4	8.0	6.4
Secondary+	5.8	3.6	6.8	1.0	18.6	14.6	21.8	3.2	0.4	5.3	6.0	5.6

* Children born during the 3 years prior to the survey.
† Stunting: height-for-age below −3 SD.
‡ Stunting: height-for-age below −2 SD.
§ Wasting: weight-for-height below −2 SD.

inequalities. In Zimbabwe and Cameroon, the mortality increase was the largest among the higher educated, and, in Zimbabwe, in urban areas. In Burkina Faso and Côte d'Ivoire, the mortality trends did not differ statistically significantly between subgroups. In summary, there is a highly variable pattern to show how the mortality increase is distributed across socioeconomic and geographical subgroups. In all countries, under-5 mortality levels

Table 6 Time trends in health care use, in the late 1980s/1990s, for two African countries

	Deliveries attended by medical person (%)*				Full childhood immunization coverage (%)†			
Subgroups	Survey 1	Survey 2	Survey 3	Change (abs)	Survey 1	Survey 2	Survey 3	Change(abs)
Kenya								
Total	51	44	44	−6	44	78	60	16
No education	34	22	27	−6	29	63	53	24
Primary	50	40	36	−13	49	78	62	13
Secondary+	78	72	72	−6	47	88	79	32
Zimbabwe								
Total	71	69	73	2	67	80	64	−3
No education	46	42	43	−3	67	73	63	−4
Primary	71	63	63	−7	68	77	61	−8
Secondary+	90	87	85	5	62	87	67	5

* Percentage of deliveries that were attended to by a medically trained person, defined as a doctor, nurse or nurse–midwife, during 3 years prior to survey.
† Percentage of children 12–23 months who are fully vaccinated (i.e. those who have received BCG, measles, and three doses of DPT and polio (excluding polio 0).

remained, however, highest among the less educated and those in rural areas.

When evaluating the above findings, the following issues should be considered. First, as DHS uses standardized questionnaires, it seems unlikely that our main results are explained by problems of data comparability. Secondly, whereas the observed mortality increases were often highly significant, statistical power was limited when determining the difference in trends between subgroups. Although the above are probably the best estimates available, it would be desirable if more powerful data sources become available for monitoring health inequalities (Korenromp *et al.* 2004). Finally, it should be stressed that, rather than making causal assertions, this article describes the concentration of the increase in childhood mortality in specific population subgroups. Such descriptions are important for targeting purposes. Moreover, monitoring of mortality inequalities across socioeconomic and geographical groups is internationally recognised as an important public health task.

Explaining the results

Sociodemographic change

Female educational attainment improved at about the same rate in Kenya and Zimbabwe. Increased negative selection among the lower educated, with only the most marginalized having no education, may cause mortality rates to rise among this smaller group of uneducated. Similarly, as obtaining a high education became attainable for a much broader group, reduced positive selection may cause mortality to rise among the higher educated. It is unlikely, however, that the selection effects fully explain the differences in mortality trends between the educational groups. More specifically, they cannot explain why the mortality increase was concentrated among the lower educated in Kenya and among the higher educated in Zimbabwe. The mortality trends for the educational groups in Kenya and Zimbabwe were also not explained by increased urbanization. After adjustment for rural/urban residence in a multivariate analysis, the mortality trends remained virtually the same (results available upon request). Yet, statistical power decreased, probably because of multicollinearity. Finally, the stronger mortality increase among the higher educated in Zimbabwe cannot be explained by a change in ethnic composition. The white elite, probably highly educated, has been leaving this country. Yet, as in 1988 only 4.4% of the higher educated were white, it is unlikely that this influenced the mortality trends.

A number of other interrelated changes ran parallel with the observed mortality increase: economic decline, increasing childhood malnutrition, declining health care use, rising HIV prevalence and increasing drug-resistant malaria. Armed conflict, mentioned by UNICEF as a cause of rising childhood mortality (UNICEF 2004), did not play a role in the countries/periods under study. In the following section, we assess to what extent the above changes may explain the very different mortality patterns observed for Kenya and Zimbabwe.

Economic decline

Zimbabwe experienced economic decline during the 1990s, and in Kenya, economic growth slowed down and stagnated. In both countries, poverty has increased, with

higher levels of poverty among the less educated (Central Bureau of Statistics and Human Resources and Social Services Departments 2000; Alwang *et al.* 2002). The indicators of living conditions in our study did not worsen, suggesting that economic deterioration does not immediately translate in a decline in household assets.

Nutritional status may be more sensitive to economic decline. Malnutrition is an important underlying cause of childhood mortality (Black *et al.* 2003). The increase in severe malnutrition in Zimbabwe and Kenya was concentrated among the less educated. This suggests that although in Zimbabwe economic decline might have contributed to an overall mortality increase, it seems not to explain the stronger increase among the higher educated. Conversely, in Kenya, it might have contributed to a stronger mortality increase among the less educated.

Decline in health care use

We have mixed evidence on the possible contribution of health care utilisation. The decline in skilled delivery attendance was not largest in the groups with the highest mortality increase. The strong increase in child (12–59 months) mortality suggests that other factors besides those surrounding birth are important. The decline in immunization coverage during the mid-1990s might have contributed to the mortality increase. In Zimbabwe, the stronger decline in coverage among the higher educated might have contributed to the stronger mortality increase in this group. Whereas in Kenya, the decline was not concentrated among the less educated, the mortality effects might have been stronger in this group, through higher exposure to infections and higher levels of malnutrition (Bishai *et al.* 2003). Yet, immunization coverage still improved during the early 1990s in Kenya and Zimbabwe, suggesting that other factors were responsible for the early mortality increase.

Changing disease ecology: AIDS, malaria

An increase in drug-resistant malaria (Brinkmann & Brinkmann 1991) may have contributed to the observed mortality increase. Malaria has been estimated to cause at least 20% of all deaths in under-fives in Africa (WHO & UNICEF 2003). A doubling of malaria mortality has been reported for east and southern Africa between the 1980s and 1990s (WHO & UNICEF 2003), and also in West Africa a resurgence of malaria appears to have contributed to changing mortality patterns (Delaunay *et al.* 2001). Chloroquine treatment failure has been reported to be higher in Kenya than in Zimbabwe. The burden of malaria is higher among the poor and in rural areas (WHO &UNICEF, 2003). We hypothesize that increased malaria mortality might partly explain the stronger mortality increase among the lower educated and those in rural areas in Kenya, but that it cannot explain the stronger mortality increase in Zimbabwe among the higher educated and those in urban areas.

There is evidence suggesting that the increase in childhood mortality in Kenya and Zimbabwe during the 1990s and beyond is at least partly due to HIV/AIDS (Zaba *et al.* 2004). In 1999, 20% of under-5 mortality in Kenya, and 35% in Zimbabwe, has been estimated to be attributable to HIV/AIDS (Walker *et al.* 2002). Unfortunately, there is little reliable information on the association between educational attainment and HIV status. Seroprevalence data were included in nationally representative surveys in three sub-Saharan African countries (Kenya, Tanzania, Zambia). In these countries, HIV prevalence was substantially higher among women with at least some education and in urban areas [Central Statistical Office (Zambia) 2003; Central Bureau of Statistics (CBS) (Kenya) 2004; Tanzania Commission for AIDS (TACAIDS) 2005]. Yet, it has been argued that the increase in child mortality cannot be explained by HIV/AIDS alone (Walker *et al.* 2002). Moreover, the mortality decline in Kenya probably already decelerated during the 1980s (Obungu *et al.* 1994), before the start of the HIV/AIDS epidemic.

Conclusions

This article was born out of concern that the increase in under-5 mortality would be concentrated among the already most disadvantaged groups. Our results for Kenya support this concern. Possibly, the deteriorating economic conditions, the decline in health care use and the increase in drug-resistant malaria had a stronger impact on lower socioeconomic groups and rural areas. Although similar patterns might have been expected for other countries, the mortality increase seems the largest among the higher educated in Zimbabwe and Cameroon, and in urban areas in Zimbabwe. Further research is needed to assess to what extent HIV/AIDS has contributed to these opposite patterns.

Policy implications

Our study implies that the mortality increase observed in a number of African countries has been highly concentrated in specific subgroups. Strategies to halt the mortality increase should, therefore, not be based on average trends in national populations alone. Although under-5 mortality levels remained substantially higher among lower

socioeconomic groups, it cannot be assumed that the mortality *increase* is concentrated in these groups. Efforts to reverse the mortality increase should assess for individual countries, in which subgroups the mortality increase is concentrated, which factors are involved, and how policies to tackle the mortality increase can be targeted to these groups.

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Accroissement de la mortalité des moins de 5 ans en Afrique: Qui subi le choc?

OBJECTIF Identifier les groupes socioéconomiques et géographiques chez lesquels un accroissement prononcé de la mortalité des moins de 5 ans a été enregistré récemment dans plusieurs pays africains et explorer la contribution d'un nombre de déterminants associés avec la mortalité chez les moins de 5 ans.

MÉTHODES La tendance temporelle de la mortalité chez les moins de 5 ans a été estimée en utilisant l'analyse de régression de Cox pour les risques proportionnels et les données démographiques et de surveillance de santé. Nous avons testé les différences dans les tendances temporelles entre sous groupes socioéconomiques ruraux/urbains et avons décrit les inégalités dans les tendances temporelles dans les conditions de vie, la malnutrition et l'usage des soins de santé. L'étude a été effectuée en 1999 dans les pays suivants: le Burkina-Faso, le Cameroun, la Côte d'Ivoire, le Kenya et le Zimbabwe.

RÉSULTATS La mortalité chez les moins de 5 ans a augmenté substantiellement allant de 25% à 71% en dix ans dans les cinq pays. Au Kenya, l'augmentation était plus élevée chez les enfants nés de mères avec un niveau d'éducation peu élevé (test pour la différence entre les différents niveaux d'éducation, $p = 0{,}074$) et dans les zones rurales ($p = 0{,}090$). Au Cameroun, l'accroissement était plus élevé chez les enfants de mères avec un niveau d'éducation plus élevé ($p = 0{,}013$) et au Zimbabwe l'accroissement était plus élevé chez les enfants de mères avec le niveau d'éducation le plus élevé ($p = 0{,}098$) et dans les zones urbaines (0,093). Pour le Burkina-Faso et la Côte d'Ivoire, des différences statistiquement significatives n'ont pas été observées entre groupes avec différents niveaux d'éducation et zones rurales/urbaines. La réduction de la couverture vaccinale au Zimbabwe au courant de mi 1990 concernait plus le groupe avec la plus grande augmentation de la mortalité. Mais au Kenya cette réduction a concerné autant les personnes avec un niveau éducatif faible ou élevée. Au Kenya cependant, l'accroissement de la malnutrition était plus élevée dans le groupe avec la mortalité la plus élevée, ce qui n'était pas le cas au Zimbabwe.

CONCLUSIONS Le récent accroissement de la mortalité chez les moins de 5 ans dans certains pays d'Afrique était plus concentré dans des sous groupes spécifiques de la population. Les groupes les plus affectés sont très variables. Il n'est pas possible d'assumer que les groupes avec un faible niveau socioéconomique sont les plus vulnérables. Les stratégies pour stopper l'accroissement de la mortalité chez les moins de 5 ans devraient être basées sur des informations propres à chaque pays.

mots clés mortalité/tendance chez les moins de 5 ans, inégalité de la santé, Afrique, malnutrition, usage des soins de santé

Aumento de la mortalidad en menores de 5 años en África: ¿'Quien lleva la carga?

OBJETIVOS Identificar los grupos socio-económicos y geográficos en los que el reciente aumento de la mortalidad en menores de 5 años en varios países de África ha sido más pronunciado, y explorar la contribución de un número de determinantes próximos a la mortalidad en menores de 5 años.

MÉTODOS Se evaluaron las tendencias en el tiempo de la mortalidad en menores de 5 años aplicando el modelo de regresión de Cox de riesgos proporcionales en datos demográficos y encuestas sanitarias. Se buscaron diferencias en las tendencias en el tiempo entre subgrupos rural/urbano y socio-económicos y se describieron inequidades en tendencias en el tiempo en condiciones de vida, desnutrición y uso de los servicios sanitarios. Los emplazamientos fueron Burkina Faso, Camerún, Costa de Marfil, Kenia y Zimbabwe, durante la década de los 90.

RESULTADOS La mortalidad en menores de 5 años aumentó sustancialmente dentro de los cinco países (entre un 25% y hasta 71% en 10 años). En Kenia, el aumento fue mayor entre los niños nacidos de madres con un menor grado de educación (test para diferencia entre los diferentes grupos educacionales: $p = 0.074$) y en áreas rurales ($p = 0.090$). En Camerún, el aumento fue mayor entre aquellos con un mayor grado de educación ($p = 0.013$), y en Zimbabwe entre los más educados ($p = 0.098$) y en áreas urbanas ($p = 0.093$). Para Burkina Faso y Costa de Marfil, no observamos diferencias estadísticamente significativas entre los subgrupos educacionales y rural/urbano. El descenso en la atención especializada durante el parto en Zimbabwe y Kenia fue similar entre personas con menor y mayor grado de educación. El descenso en la cobertura vacunal durante mediados de los 90 en Zimbabwe fue mayor en el grupo con el mayor aumento en mortalidad, pero en Kenia fue igualmente grande entre grupos con mayor y menor grado de educación. Mientras que en Kenia el aumento en la desnutrición fue mayor en el grupo con el mayor aumento en mortalidad, este no fue el caso en Zimbabwe.

CONCLUSIONES El aumento en la mortalidad en menores de 5 años en algunos países africanos estaba altamente concentrado en subgrupos poblacionales específicos. Existía una gran variabilidad en los grupos más afectados. No se puede asumir que los grupos de estratos socio-económicos más bajos fueran siempre los más vulnerables. Las estrategias para parar el aumento en la mortalidad de los menores de 5 años debería basarse en información disgregada para países individuales.

palabras clave tendencias en mortalidad infantil/menores de 5 años, inequidad en salud, desnutrición, uso cuidados sanitarios, África