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NEW CONCEPTS

Improved Indicators of Infant Mortality for Integrated Primary Healthcare Programmes

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ABSTRACT

Mortality and fertility rates are decreasing rapidly in many developing countries. It is argued that the indices commonly used as measures of these changes, i.e. infant mortality rate and fertility rate, ignore the interaction between mortality and fertility, and do not reflect their combined impact in lowering overall infant mortality. The paper proposes new indicators of infant mortality, termed fertility-adjusted infant mortality ratio (FIMR), age-specific, fertility-adjusted IMR (AFIMR), and total infant mortality ratio (TIMR) that are more sensitive to rapid demographic changes. These indicators include the combined effects of changes in both fertility and infant mortality rates on overall infant mortality in a region and appear to measure the effects of integrated health programmes better. Further, these conceptualize the mother-infant pair as an appropriate unit with which to monitor mortality, and may be used for guiding allocation of resources intended to lower infant mortality. The application and usefulness of these indicators have been illustrated, using one hypothetical example and empirical data from the maternal-child health and family-planning programme in Matlab, Bangladesh, as well as data from white and black population groups in the U.S.A. The results of these examples demonstrate that the new indicators are more sensitive than traditional measures when describing infant mortality, and may better reflect the perception in infant mortality status in the community.

***Key words**:* Infant mortality; Maternal mortality; Fertility; Primary healthcare

INTRODUCTION

Developing countries are often characterized as having high infant mortality and high fertility. These two are demonstrated by high key indicators of infant mortality rates (IMR) and fertility rates. The IMR is the number of infant deaths divided by the number of live-births in a given population during a year and expressed as the number of infant deaths per 1,000 live-births. The IMR is an indication of the likelihood that a child who is born will die during the first year of life (1). Populations in developing countries, such as Bangladesh and sub-Saharan Africa, often had an IMR exceeding 100 per 1,000 live-births, while industrialized countries generally had an IMR less than 15 per 1,000 births (2,3).

For fertility measurements, several indices are used, of which total fertility rate (TFR) and general fertility rate (GFR) are commonly reported (4). The GFR is expressed as the number of live-births in a given year divided by the number of women in the child-bearing age (15-49 years) and expressed as the number of live-births per 1,000 women. The TFR indicates the average number of live children who would be born to a woman during her lifetime if she were to pass through her child-bearing years conforming to the age-specific fertility rates in a given year. The TFR may exceed 6 in some developing countries, but is generally less than 2 in industrialized countries (3).

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With national development and improved healthcare and family-planning services, these indicators generally decrease. The decrease in IMR is used as an indication of a successful child-survival programme, while a decreasing fertility rate is used as an indication of a successful family-planning programme. Conversely, public health programmes that are not accompanied with a fall in these indicators are thought to represent unsuccessful interventions. Although health planners realize that the two programmes are inter-related, these two indicators are generally reported separately. Reporting these separately, however, does not seem optimal for evaluation of integrated primary healthcare programmes for several reasons.

First, separating these obscures the programmatic and demographic inter-relationship between the two indicators. The IMR, taken by itself, assumes that all children are at equal risk; however, certain demographic variables are known to be important risk-factors for high mortality. For example, first-born children (especially of very young mothers) and children with short birth intervals are at higher risk of death (5). From a programmatic standpoint, a public health programme which includes family planning, prenatal and child health services in an integrated manner is likely to be more effective than isolated programmes, and the IMR and TFR are likely to be changing simultaneously. Furthermore, child-survival programmes stress the critical role of the maternal-infant relationship, but the current indicators for these programmes seemingly ignore this relationship.

Second, the IMR does not seem to reflect the health situation accurately as it is perceived in the community. This perception of child survival would seem more related to the number of infant deaths in the community rather than a proportion of infants who die. If there were fewer funerals for infants than in the past, the community would perceive a greater chance that infants are surviving. This perception of infant and childhood mortality may be important in determining family-planning behaviour since parents, in general, have wanted to insure the survival of some of their children. If they perceive high mortality, they are more likely to continue to have additional children (6,7).

Third, the IMR is not appropriate for detecting infant deaths when demographic events are changing rapidly. In the demographic field, rapid fluctuations in the number of births between years and within years are known to distort the level of and trend in infant mortality (4,8).

From the demographic transition theory (9-11), mortality and fertility are intricately related. However, there has been no single indicator to measure the concurrent changes in these two demographic events simultaneously. This paper proposes such indicators which may be useful to understand the level of infant mortality in populations and in selected segments of the population better. We have termed these indicators as fertility-adjusted infant mortality ratio (FIMR), age-specific, fertility-adjusted infant mortality ratio (AFIMR), and total infant mortality ratio (TIMR).

FERTILITY-ADJUSTED INFANT MORTALITY RATIO (FIMR): DEFINITION AND METHOD OF ESTIMATION

Let us define FIMR as an indicator reflecting the interaction between infant mortality rate (IMR) and fertility rate in which FIMR=IMR*GFR. Both IMR and GFR are expressed as a rate per 1,000; and the FIMR similarly uses this denominator. The formula for the FIMR is thus:

$$
\begin{aligned}
FIMR &= IMR * GFR \\
&= \frac{D_0}{B} * \frac{B}{f_p} \\
&= \frac{D_0}{f_p}
\end{aligned}
$$

where D_o is the number of deaths of infants (aged 0-11 months), B is the number of living children born in a given period (year), and f_p is the mid-year female population (aged 15-49 years).

Thus, the FIMR is the number of infant deaths per 1,000 women in the childbearing age (15-49 years). To calculate the FIMR, one can either use demographic information on the number of births, number of infant deaths, and the population of the women in the childbearing age. Alternatively, one can calculate the FIMR from GFR and IMR, using the formula GFR*IMR, if one has access to these calculated data but not to the actual numbers.

Abbreviations used

Age-specific, fertility-adjusted infant mortality ratio	**AFIMR**	**FIRM in specific age cohorts**
Fertility-adjusted infant mortality ratio	**FIMR**	**Infant deaths per 1,000 women aged 15-49 years in a year**
General fertility rate	**GFR**	**Births per 1,000 women aged 15-49 years in a year**
Infant mortality rate	**IMR**	**Infant deaths per 1,000 live-births in a year**
Total fertility rate	**TFR**	**Number of infants born to a woman, on an average, during her reproductive life**
Total infant mortality ratio	**TIMR**	**Number of infant deaths per 1,000 women's reproductive life**

This indicator suggests that the 'at-risk population' includes both children who were born as well as those who might have been born if there had been no effective contraception. One might prevent an infant death either through an effective MCH-FP programme or by preventing a high-risk pregnancy. Thus, the number of mothers and potential mothers seems to be an appropriate denominator. Although the number of 'potential mothers' is not the same as the number of 'potential infants', the two are directly correlated.

To further explain the need for the FIMR, consider that a major (albeit not the only) goal of an integrated maternal-child health programme is to prevent infant deaths. A successful family-planning programme will decrease the number of pregnancies (especially unwanted and high-risk pregnancies), and a successful child health programme will limit the number of infants who die. From the standpoint of the community, both types of programmes will result in a decrease in the total number of infant deaths. We illustrate the usefulness of FIMR and the problems of the traditional IMR with hypothetical and empirical examples.

Hypothetical example: Consider a hypothetical region in a developing country with a population of 200,000. [The overall rates for this example are taken from 1979 Demographic Surveillance System in Teknaf, Bangladesh (12)]. In keeping with a traditional society, assume that the region has no modern family-planning methods available and has minimal medical services for their children. Thus, the region is characterized as one with high fertility and high infant mortality. Further, let us presume that an intensive family-planning programme is then introduced in the region with hopes of reducing the high fertility rates, but let us also presume that the child-survival part of the programme was not funded and was not initiated.

When the hypothetical family-planning programme was introduced, a certain segment (say 50%) of the couples was very receptive to the family-planning programme, accepted the new interventions, and the fertility rate dropped by 50% among the acceptors within a few years. The other 50% of the couples did not accept the family planning, and there was no change in the fertility rate among the non-acceptors.

Let us further assume that the non-accepting families had other socioeconomic or educational attributes that correlated with higher IMR (5). For the purpose of this example, we will assume that the IMRs were 117 and 138 in the accepting and non-accepting segments of the population respectively. Finally, we will assume that there would be no change in the probability of infant death in the accepting and non-accepting families over the period of the family-planning intervention since the intervention was a 'pure' family-planning programme. What could happen to the overall IMR in this hypothetical region with 200,000 population? As illustrated in Table 1, the overall IMR actually increased. The rise in IMR is explained by the higher proportion of births originating from the non-accepting families, since these infants had a higher risk of death than those from the accepting families. The increase in IMR might lead to a conclusion that the programme was a failure, yet there were actually fewer infant deaths in this area than before the programme. As shown in Table 1, the FIMR demonstrated the real decrease in the number of infant deaths. For the 'acceptors' within the population, this amounted to a decrease of 50% since the number of births decreased by this number. For the population as a whole, including both groups, the decrease was less marked, but it still decreased significantly from 30 to 23.1 per 1,000 women.

An empirical example: To further explore the concept of the use of the FIMR as an appropriate indicator, data from the Matlab area of the ICDDR,B: Centre for Health and Population Research was used in calculating the IMR, GFR, and FIMR over a 20-year period from 1978 to 1997 (13). The Demographic Surveillance System (DSS) in this rural area of Bangladesh collects all demographic events in this area with a total population of over 200,000. In 1978, the DSS area was divided into (a) an intensive 'MCH-FP intervention' area where

Table 1. Hypothetical example of a calculated change of IMR before and after a successful family-planning programme in the absence of a child-survival programme

	Acceptors (n=100,000)		Non-acceptors (n=100,000)		Total population* (n=200,000)	
Indicator	**Before**	**After**	**Before**	**After**	**Before**	**After**
Births	4700	2350	4700	4700	9400	7050
Infant deaths	550	275	650	650	1200	925
Women (15-49 years)	20000	20000	20000	20000	40000	40000
Crude birth rate	47	24	47	47	47	35
Infant mortality rate	117	117	138	138	128	131
Fertility rate	235	118	235	235	235	176
Fertility-adjusted infant mortality ratio	27.5	13.8	32.5	32.5	30.0	23.1

Note: This example assumes a population of 200,000, including a segment of 100,000 who accepted and a segment of 100,000 who did not accept family planning child survival and family-planning services were introduced and evaluated, and (b) an adjacent 'comparison' area where the Ministry of Health provided its standard health services. In 1978 when the interventions were initiated, the infant mortality rates and fertility rates were thought to be similar in the two areas. With overall social development in Bangladesh, the GFR and IMR have decreased in both intervention and comparison areas. However, with the more intensive family-planning and child-survival services in the intervention area, the GFR and IMR declined faster in the intervention area than in the comparison area.

Figure 1 shows the decreasing fertility rates for the intervention and comparison areas over the same period. The decreased fertility is largely due to an intensive family-planning programme during which increasing numbers of couples began using modern family-planning methods, although other factors, such as increasing age of marriage, also play major roles in lowering the fertility rates. The use of modern family-planning methods has been consistently higher in the intervention area than in the comparison area, although both the areas have seen significant increases. The contraceptive prevalence rates increased from about 4 to 8% in 1978 to 68% and 49% in 1996 for the intervention and comparison areas respectively.

Figure 2 shows the IMR in the MCH-FP intervention and comparison areas. While the IMR is consistently lower in the intervention area than in the comparison area, the difference is perhaps less marked than one might have expected considering the intensive efforts in the intervention area, particularly during the initial periods. Since the rates in the two areas were not identical at the start of the intervention, Figure 3 and 4 show the percent decline in the GFR and IMR respectively from the base year 1978. It is evident that, during the early period of the MCH-FP programme, fertility decline was more rapid in the MCH-FP intervention area than during the later periods (Fig. 3). Conversely, decline in the IMR was very slow in the early periods compared to the later periods (Fig. 4).

Next, we examined the effect of the integrated MCH-FP programme, using the FIMR to compare the MCH-FP intervention and comparison areas. From Figure 5, it appears that the FIMR reveals a more distinct difference in the two areas. In contrast to the IMR that shows only modest differences between the two areas, the difference in the FIMR is more marked. The difference in ratios is illustrated by the year 1995 when the FIMR was 5.1 in the intervention area and 9.6 in the comparison area, nearly a 2-fold difference; yet the difference in the IMR is 51 and 79 respectively. A reduction in the FIMR relative to a reference year (1978) in the MCH-FP intervention area demonstrates a 3-fold fall in the FIMR in the intervention area and nearly a 2-fold drop in the comparison area. Further, the examination of percent FIMR declined, relative to the base year 1978 rate. This shows that the MCH-FP intervention area had consistently greater decline in fertility and infant mortality (Fig. 6). Thus, the comparison of IMR, GFR, and FIMR shows that the FIMR is a more sensitive index in capturing the effectiveness of this integrated health programme.

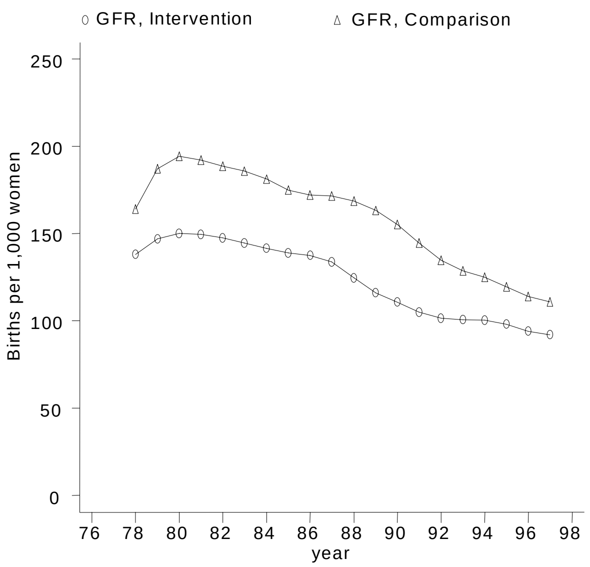

Fig. 1. Fertility rates in the MCH-FP intervention area and comparison area of Matlab, Bangladesh from 1978 to 1997

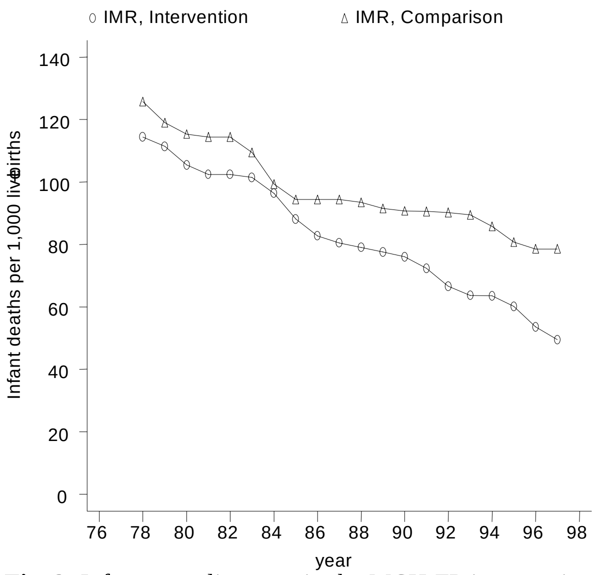

Fig. 2. Infant mortality rates in the MCH-FP intervention area and comparison area of Matlab, Bangladesh from 1978 to 1997

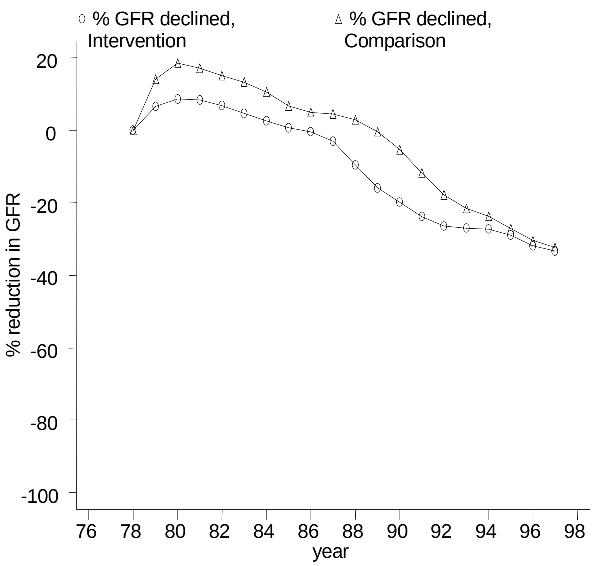

Fig. 3. Percent reduction in the general fertility rates in the MCH-FP intervention and comparison areas from the base year 1978

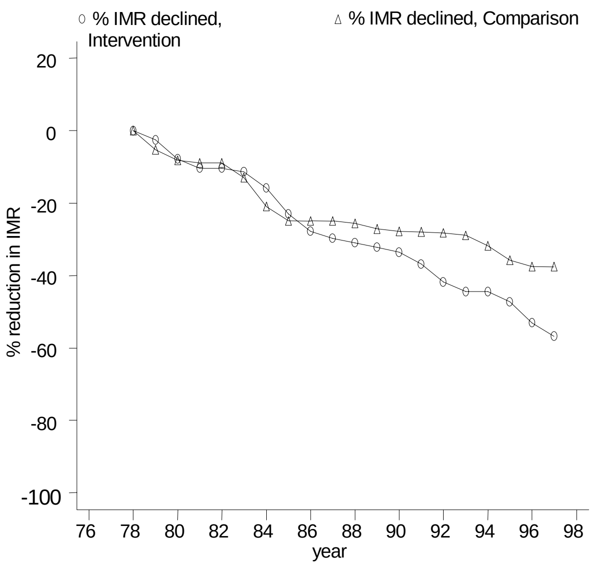

Fig. 4. Percent reduction in the infant mortality rates in the MCH-FP intervention and comparison areas from the base year 1978

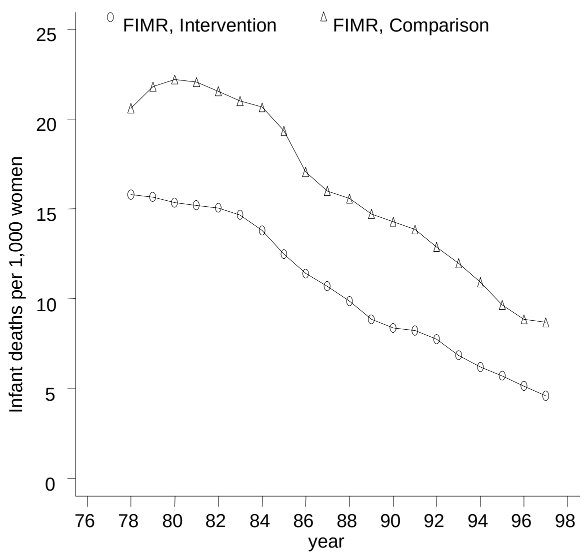

Fig. 5. Changes in the fertility-adjusted infant mortality ratio (FIMR) in the MCH-FP intervention and comparison areas of Matlab, Bangladesh since 1978

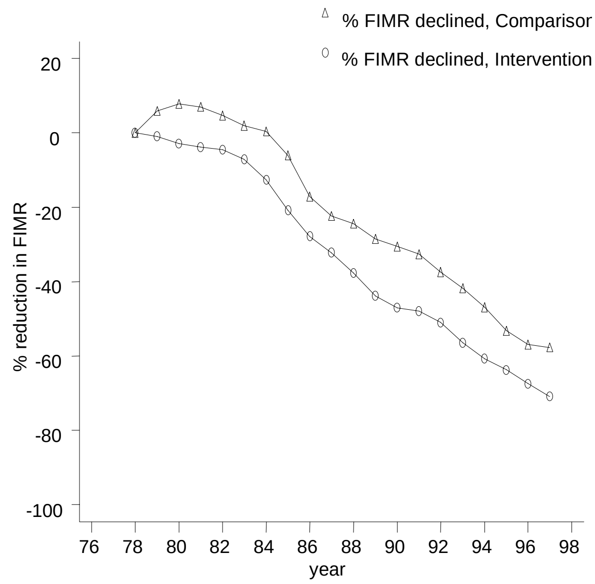

Fig. 6. Changes in the percent reduction in the FIMR in the MCH-FP intervention and comparison areas of Matlab, Bangladesh since 1978

Table 2 and 3 show the rates and ratios between the MCH-FP intervention and comparison areas. Again, the FIMR shows a more dramatic difference than do the IMR and FR.

EXTENSION OF FIMR: AGE-ADJUSTED AND TOTAL IMR RATES

Fertility levels vary by a woman's age, thus fertility indicators–age-specific fertility rate (ASFR) and total fertility rate (TFR)–take into account age differentials and better reflect the age-adjusted fertility level in the population. Similarly, we know that infant mortality rates also vary by the age of the mother (6,14,15), infant mortality generally being higher among women aged <20 and >40 years. Analogous to the ASFR and TFR, we propose to extend the FIMR measurement to age-specific, fertility-adjusted, infant mortality ratio (AFIMR), and total infant mortality ratio (TIMR).

Table 2. Changes in demographic indicators in the intervention and comparison areas of Matlab, Bangladesh during 1978-1997

Indicator	Intervention area			Comparison area		
	1978	1988	1997	1978	1988	1997
GFR	138	125	92	164	174	111
TFR	4.5	3.8	2.8	5.5	5.4	3.4
IMR	112	81	50	125	97	79
FIMR	15.5	10.0	4.6	20.4	16.7	8.7
TIMR	494	302	138	662	518	270

Table 3. Ratio of the different demographic indicators from 1978 to 1997 in Matlab, Bangladesh (intervention/comparison area ratios)

Indicator	1978	1988	1997
GFR	0.84	0.72	0.83
TFR	0.82	0.70	0.82
IMR	0.90	0.84	0.63
FIMR	0.76	0.60	0.53
TIMR	0.75	0.58	0.51

We define AFIMR as the number of infant deaths per 1,000 females in the different age strata (a,a+x) during the year:

$$AFIMR_{(a,a+x)} = \frac{D_{0(a,\ a\ +\ x)}}{f_{p(a,a+x)}}$$

We believe that the AFIMR can be an indicator for identifying maternal age groups at high risk when making decisions for allocation of programme. For example, Table 4 illustrates the calculation of the AFIMR for the comparison area in 1978 and contrasts the IMR with the AFIMR. As frequently seen, the IMR is highest in the younger (<20 years) and older (>40 years) groups, yet the AFIMRs are highest in the 'middle-age' groups. In a sense, the IMR shows the individual-level risks, but the AFIMR shows the population-level risks. From IMR information, it may seem that 'younger' and 'older' mothers should be targeted to reduce infant mortality, but the examination of AFIMR shows that the programmes should address needs of the 'middle-aged' women where most infant deaths occur in terms of absolute numbers. Age-specific FIMR is also useful in comparing the two population groups within the same region. Since the two populations may vary by the age-distribution, the AFIMR will provide a more precise estimate of the infant mortality.

Table 4. Infant mortality rates and age-specific, fertility-adjusted IMR in the comparison area of Matlab, Bangladesh, 1978

Age (in years)	No. of women	Birth	Death	IMR	AFIMR
15-19	5430	695	105	151.1	19.3*
20-24	3432	847	108	127.5	31.5
25-29	2219	595	59	99.2	26.6
30-34	2448	559	60	107.3	24.5
35-39	2204	355	53	149.3	24.0
40-44	2143	124	11	88.7	5.1
45-49	1615	13	2	153.8	1.2
Total	19491	3188	398	124.8	20.4

*infant deaths per 1,000 women in the age strata

We estimated TIMR, analogous to TFR as:

$$TIMR = \sum AFIMR_{(a,a+x)} * x \text{ (per 1,000 women)}$$

where, usually x=5-year age-range

Table 2 shows that unadjusted FIMRs were 4.6 and 8.7 per 1,000 women for the MCH-FP intervention and comparison areas respectively in 1997. The corresponding TIMRs were 138 and 270 per 1,000 women respectively. A TIMR of 138 can be interpreted as being indicative of a 13.8% chance, on an average, that a child will die in infancy during reproductive life span of a woman. As shown in the table, this indicator has decreased from 49.4% in 1978 to 13.8% in 1997 in the intervention area and from 66.2% in 1978 to 27.0% in the comparison area. A comparison of the intervention and comparison areas shows that the FIMRs and TIMRs have decreased more rapidly in the intervention area than in the comparison area (Table 3).

To put these numbers in perspective, 1997 data from the U.S.A. were used in calculating the FIMR, AFIMR, and TIMR for the black, white, and total U.S. populations (Table 5). As has been known, the mortality among black infants is higher than among white infants, but all U.S. groups have much lower infant mortality indicators than in Bangladesh. With a 3-fold increase in the AFIMR for infants of black teens compared to white teens, this indicator further emphasizes the needs of this group.

DISCUSSION

We propose the use of FIMR, AFIMR, and TIMR as additional indicators for assessing infant mortality. The primary uses for these indicators include: (a) evaluation of integrated public health programmes intended to improve both family planning and child-survival services, (b) evaluation of different geographic areas to refine the problem of infant mortality and determine where programme resources are needed, and (c) evaluation of infant mortality risks among different maternal age groups.

The IMR has been preferred as an epidemiological indicator since it measures the outcome (mortality) in the population at risk (the live infants who were born that year). Defining the 'at-risk' population is central to epidemiological concepts; however, it also assumes that the live infants within the cohort are uniformly at risk. Many confounders, such as age of parents, socioeconomic status, parity, and education of parents

Table 5. Indicators of infant mortality in white and black populations in the U.S.A. in 1997

	IMR				AFIMR			
Age (in years)	**Total**	**White**	**Black**	**B/W ratio**	**Total**	**White**	**Black**	**B/W ratio**
15-19	10.4	9.0	14.0	1.6	0.6*	0.4	1.3	3.0
20-24	8.0	6.7	13.4	2.0	0.9	0.7	1.9	2.6
25-29	6.2	5.2	13.2	2.6	0.7	0.6	1.3	2.2
30-34	5.8	5.0	13.6	2.7	0.5	0.4	0.9	2.0
35-39	6.8	5.9	14.4	2.4	0.2	0.2	0.4	2.0
40-44	8.7	7.7	15.6	2.0	0.1	0.1	0.1	1.9
All ages	7.2	6.0	13.7	2.3				
FIMR					0.5	0.4	1.0	2.5
TIMR					14.8	12.2	29.3	2.4

*infant deaths per 1,000 women in the age strata

alter this risk and thus affect the IMR. Since the acceptance of family-planning methods may be highly dependent on these same factors, the IMR when used as a single indicator is not able to assess the interaction of these factors.

As an indicator of infant mortality, the FIMR has several advantages. It is easily calculated since it uses information that is generally available and provides a single indicator that reflects the overall number of infant deaths in an area. It provides a simple answer to the question of whether there are more or fewer infants dying in a region compared to other times and other places. It also seems to better reflect the local perception of trends in infant mortality since it is highly dependent on the actual number of infant deaths in the community. Finally, it acknowledges the inter-relationship between mother and infant as a family unit rather than assuming that each infant is independent at birth.

To refine this indicator further, when the data are available, the AFIMR and TIMR provide additional information. The TIMR is specifically useful as an easily-understood indicator since this describes the probability of an infant death during a mother's lifetime. This probability is highly dependent on the number of children she bears, the spacing of births, and the health of her children. Like TFR, the TIMR views mortality of infants from the standpoint of the mother-infant unit and provides an additional perspective to infant mortality compared to the IMR which views the problem strictly from the standpoint of the infant.

The AFIMR is needed to calculate the TIMR, but it also provides additional information about the maternal age groups in which infants are dying and helps target resources to the appropriate maternal age groups. It also allows one to compare mortality statistics in two populations that may have a different age structure. As the age of marriage and age-specific contraception rates change, this indicator helps assess the effect of these changes.

The new indicators do not replace the traditional indicators of IMR and TFR. They have been used for a very long time, and provide a well-accepted way of quantifying fertility and infant mortality. The new indicators suggested here, however, supplement the traditional indicators by adding a new perspective, by combining the effects of family-planning and child-survival programmes, and by being responsive to the rapid changes in the factors affecting child survival.

This proposal to introduce new indicators of infant mortality is similar to the use of the two indicators of maternal mortality, that is, maternal mortality ratio and maternal mortality rate. For these indicators, the denominators are live-births and women of reproductive age respectively. The usefulness of these two indicators of maternal mortality is well-illustrated in the work of Koenig *et al*. (16). Future studies are needed to extend these indicators to other geographic areas and other situations.

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REFERENCES

1. Shryock HS, Siegel JS. The methods and materials of demography. Washington, D.C.: Govt. Printing Press Office, 1980. 888 p.
2. United Nations Children's Fund. The state of the world's children, 1999. New York: Oxford University Press, 1999. 131 p.
3. United Nations. Health and mortality: a concise report. New York: Population Division, United Nations, 1998. 45 p.

4. Shryock HS. The methods and materials of demography: New York: Academic Press, 1976.

5. Koenig MA, Phillips JF, Campbell OM, D'Souza S. Birth intervals and childhood mortality in rural Bangladesh. *Demography* 1990;27:251-65.

6. Preston SH. Mortality in childhood: lessons from WFS. *In*: Cleland J, Hobcraft J, Dinesen B, editors. Reproductive change in developing countries: insights from the World Fertility Survey. London: Oxford University Press, 1985:253-72.

7. Chowdhury AI, Fauveau V, Aziz KMA. Effect of child survival on contraceptive use in Bangladesh. *J Biosoc Sci* 1992;24:427-32.

8. Murray CJL. The infant mortality rate, life expectancy at birth, and a linear index of mortality as measures of general health status. *Int J Epidemiol* 1988;17:122-8.

9. Caldwell JC. The Asian fertility revolution: its implications for transition theories. *In*: Leete R, Alam I, editors. The revolution in Asian fertility: dimensions, causes, and implications. Oxford: Clarendon Press, 1994:299-316.

10. Caldwell JC. Theory of fertility decline. London: Academic Press, 1982. 386 p.

11. Murray CJL, Chen LC. In search of a contemporary theory for understanding mortality change. *Soc Sci Med* 1993;36:143-55.

12. Alam N, Alam S, Patwari Y, Munshi MH, Rahaman MM, Aziz KMS. Demographic Surveillance System–Teknaf. V. 1: Census (1975), vital events and migration, 1976-1978. Dhaka: International Centre for Diarrhoeal Disease Research, Bangladesh, 1984. 37 p. (ICDDR,B scientific report, 60).

13. van Ginneken J, Bairagi R, de Francisco A, Sarder AM, Vaughan P. Health and demographic surveillance in Matlab: past, present and future. Dhaka: International Centre for Diarrhoeal Disease Research, Bangladesh, 1998. 44 p. (ICDDR,B special publication, 72).

14. Friede A, Baldwin W, Rhodes PH, Buehler JW, Strauss LT. Older maternal age and infant mortality in the United States. *Obstet Gynecol* 1988;72:152-7.

15. Mosley WH, Chen LC. An analytical framework for the study of child survival in developing countries. *In*: Mosley WH, Chen LC, editors. Child survival: strategies for research. New York: Population Council, 1984:25-45.

16. Koenig MA, Fauveau V, Chowdhury AI, Chakraborty J, Khan MA. Maternal mortality in Matlab, Bangladesh: 1976-85. *Stud Fam Plann* 1988;19:69-80.