

*Shams El Arifeen, Tasnima Akhter, Hafizur Rahman Chowdhury,  
Kazi Mizanur Rahman, Enayet Karim Chowdhury,  
Nurul Alam, D M Emdadul Haque, Abdullah H Baqui*

## 9.1 INTRODUCTION

Knowledge of causes of death among children under five is important because it pertains to policy and programs. Patterns and trends in causes of under-five mortality help decisionmakers assess programmatic needs, prioritize interventions, and monitor progress. However, data on causes of death tend to be limited in developing countries, including Bangladesh. The vital registration systems are deficient in coverage and most deaths occur outside the health system, where cause of death is unreported. Verbal autopsy is a method of assessing the cause of death based on an interview with the next of kin or other caregivers who were present at the time of death or who are knowledgeable about the events leading up to the death. Verbal autopsies have been used previously in Bangladesh to provide important data on causes of child death (Chen et al., 1980; Zimicki et al., 1985; D'Souza, 1985; Bhatia, 1989; Fauveau et al., 1994; Snow et al., 1992; Kalter et al., 1990; Kamal et al., 1989; Salway et al., 1994; Baqui et al., 1998).

Baqui and others have reported on causes of death under age five based on verbal autopsy interviews in the 1993-1994 and 1996-1997 BDHS sample (Baqui et al., 1998; Baqui et al., 2001). Causes of deaths were assigned using predefined computer algorithms. The verbal autopsy study in the BDHS 1993-94 revealed that about one-quarter of deaths among children under five years were associated with acute respiratory infections (ARI) and about one-fifth of the deaths were associated with diarrhea (Baqui et al., 1998). Drowning was a major cause of death in children age 1-4 years. Neonatal tetanus and measles were the other important causes of death. The same verbal autopsy instrument and cause of death algorithms were used in the 1996-1997 BDHS. Comparison of the two surveys revealed that deaths due to almost all causes declined. The exceptions were deaths due to neonatal tetanus, diarrhea, and malnutrition (Baqui et al., 2001). The reduction in ARI-related deaths was almost entirely limited to children 1-4 years old; there was almost no decline in ARI deaths in the neonatal and postneonatal periods. In both surveys, cause of death could not be assigned to a substantial proportion of deaths, particularly those occurring in the neonatal period. In the 1996-97 BDHS, 21 percent of deaths were classified as early neonatal and another 15 percent were not identified. This reflects the limitations of the algorithms used to assign cause of death. A verbal autopsy assessment was not included in the 1999-2000 BDHS, and thus we have no national data on cause of death for children in Bangladesh since the mid-1990s. The 2004 BDHS shows that the under-five mortality rate declined by about 6 percent since the 1999-2000 survey and by 24 percent since the 1996-97 survey. This impressive decline in child mortality warrants further investigation. An assessment of the cause structure of child deaths may help explain this decline while guiding attention towards those causes of death that remain persistently high.

This chapter presents information on the proportional distribution of causes of neonatal, postneonatal, infant, and child deaths. The cause of death distribution is disaggregated by the sex of the child, urban-rural residence, division, and mother's education. During the survey, information on deaths of children under five in the sampled households was obtained from the birth history section of the questionnaire that was administered to eligible women. If a child under age five died in a household in the five years preceding the survey (which corresponds roughly to calendar years 1999-2003), a verbal autopsy questionnaire was administered by a supervisor of data collectors, or a specially trained data collector, within a day of identification of the death. This process is different from that used in the two previous verbal autopsy studies,

where information on the deceased was collected by revisiting those households with reported deaths after the main survey was completed.

## 9.2 DESCRIPTION OF THE DATA COLLECTION INSTRUMENT

The verbal autopsy instrument was developed from several instruments, including the questionnaire used in the two previous BDHS verbal autopsy surveys (Baqui et al., 1998; Baqui et al., 2001), the WHO verbal autopsy questionnaire, and the instrument being used since 2003 in the Matlab Health and Demographic Surveillance System (HDSS). This last instrument was developed based on the work done by the In-Depth Verbal Autopsy Working Group, which used the verbal autopsy questionnaire from the Adult Morbidity and Mortality Project (AMMP) in Tanzania, which, in turn, had evolved out of the WHO questionnaire. The final questionnaire was pre-tested and is somewhat different from the instrument used in the two previous surveys. The differences were primarily in terms of the structure of the instrument and in the level of specificity of the information collected. An entirely separate module on neonatal deaths (0-28 days old at death) was used. For the module on older children (age at death between 29 days and 5 years), sections were added to obtain additional information in cases with convulsions, unconsciousness, rash, malnutrition, glandular swellings, jaundice, vomiting, abdominal pain, mass in the body, urine color and amount, and any surgery. This was a structured instrument with sections allowing for collection of open-ended information including narrative stories. The complete instrument had the following sections: 1) identification including detailed address of respondent; 2) informed consent; 3) information on age of the deceased child; 4) information about caretaker or respondent of deceased child; 5) information on prenatal care, labor, delivery, and obstetrical complications; 6) open-ended section allowing the respondent to provide a narrative history; 7) information about accidental deaths; 8) detailed signs and symptoms preceding death; 9) and information about treatment preceding death, and on direct, underlying and contributing causes of death from the death certificate, if available.

## 9.3 ASSIGNING CAUSE OF DEATH

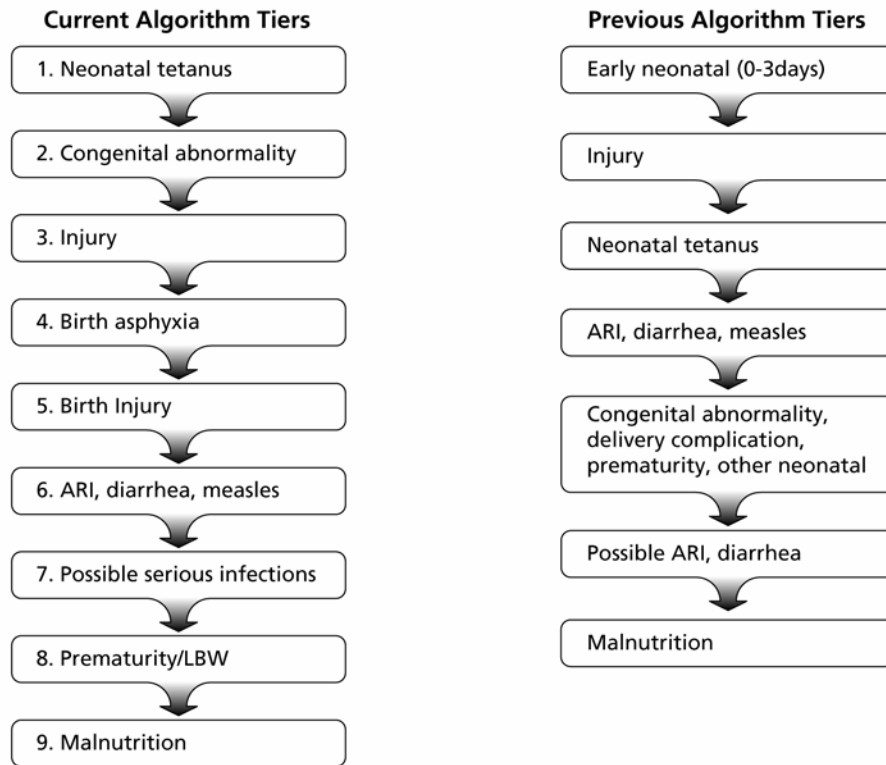
The death of a child often has more than one cause. The assignment of cause of death followed a hierarchical process whereby certain diagnoses were viewed as more certain than others—and thus given priority—with the possibility of assigning multiple causes of death included in the hierarchical process.

The hierarchical process followed several mutually exclusive tiers applied in sequence (Figure 9.1). In tier 1, neonatal tetanus was assigned as the cause in a child whose age at death was between 4 and 14 days, who had had convulsions any time during this period, and who either cried normally after birth and stopped crying at least one day before the final illness, or who suckled normally after birth and stopped suckling at least one day before the final illness. Tier 2 was limited to deaths before the age of 29 days. The cause of death of a child was confirmed as death due to congenital abnormality if the child had a reported malformation at birth. Tier 3 applied to accidental deaths at or after the age of 29 days, including drowning deaths. Tiers 4 and 5 applied to neonatal deaths at age 7 days or less. In tier 4, birth asphyxia was assigned as the cause of death if the child was not able to cry normally after birth and the baby was either not able to breathe after birth or not able to suckle normally after birth. In tier 5, deaths due to bruises or marks of injury on the body or head at birth were considered as birth injury.

Tier 6 allowed for the assignment of multiple causes of death simultaneously. ARI was assigned for neonates if difficult or rapid breathing started at least 1 day before death and lasted until death and the child had at least two of the following three specific symptoms: grunting, nostril flaring, and chest indrawing. ARI was confirmed for postneonatal and child deaths if the child had a cough that started at least three days before death and lasted at least until the day before death and at least two of the following six specific symptoms: noisy breathing, stridor, grunting, wheezing, nostril flaring, or chest indrawing. ARI was also assigned for

non-neonatal deaths if the child had difficult breathing or rapid breathing that started at least one day before death and lasted until death and had at least two of the six specific symptoms listed above for cough.

**Figure 9.1 Flow Chart Showing the Different Tiers Used in Assigning Cause of Death Based on Algorithms, and Comparison with Previously Used Algorithms**



Source: Baqui et al., 1998; Baqui et al., 2001

Diarrhea for neonates was assigned if frequent liquid or watery or loose or soft stools or diarrhea was reported with a peak of six or more stools in 24 hours. Diarrhea for older child deaths was assigned if there had been frequent loose or liquid stools starting from 1 to 13 days before death and continuing until death and with a peak number of six or more stools in 24 hours, and at least two of the four following specific symptoms were reported: dry mouth, sunken eyes, loose skin, and no or very little urine. Diarrhea for deaths at age 29 days to 59 months was also confirmed if frequent loose or liquid stools started from at least 14 days prior to death and continued until death. A child whose age at death was six months or more, and had a rash all over the body and on the face that appeared during the three months before death, and was accompanied by fever, with no water in the rash, and with at least one of the three following specific symptoms reported: dry cough, red or runny eyes and running nose during the illness, was assigned as measles. Any combinations of these causes were allowed in this tier.

Tier 7 was used to classify deaths due to other serious infections. Possible serious infection was assigned as cause of death if the child had at least two signs of serious infection. Among neonates, the signs included: child had stopped suckling, child had stopped crying, difficult breathing, rapid breathing, chest indrawing, convulsions, fever, child was cold to touch, child was lethargic, child was unresponsive or unconscious, bulging fontanelle, redness or drainage from the umbilical cord stump, skin rash with bumps containing pus, vomiting everything. Among postneonates, the signs included: difficult breathing, rapid

breathing, chest indrawing, convulsions, fever, child was unresponsive or unconscious or stopped being able to grasp or stopped being able to respond to a voice or stopped being able to follow movements with the eyes, stiff neck, bulging fontanelle, and vomiting everything. In order to understand overlaps of possible serious infection with ARI and diarrhea, we used cause of death definitions of possible ARI and possible diarrhea. Among those with possible serious infection, possible ARI was classified if cough, difficult breathing or rapid breathing had been present before death. Possible diarrhea was assigned if frequent loose or liquid stools were reported.

Tier 8 was used if age at death was less than 29 days and pregnancy ended early or the baby was reported to be very small or smaller than usual. In these cases, the death was confirmed as due to prematurity or low birth weight (LBW). In tier 9, if the child was reported to have been very thin or the child's feet were reported to have been swollen, the cause of death was confirmed as due to malnutrition.

If no cause of death had been assigned in tiers 1 to 9, then a physician review process was used to assign cause of death. All the verbal autopsies in this category were independently reviewed by any two physicians from a panel of three. These three physicians had received guidance from the investigators on the cause of death assignment process. They were required to assign direct and underlying causes of death based on the International Classification of Diseases version 10 (ICD-10). If the two physicians agreed on the direct and underlying cause, that cause was accepted. In the event of disagreement, the verbal autopsy was reviewed by the third physician. If his/her assigned cause of death agreed with that of either of the other two physicians then that cause was accepted. If there was still disagreement, a "not determined" cause of death was assigned. The physicians were allowed to assign "unspecified" as a cause of death if they felt there was not enough information to lead to a definite cause of death. If any two physicians agreed on "unspecified" as cause of death then that was assigned.

This algorithm is somewhat different from the one used in the two previous surveys (Baqui et al., 1998; Baqui et al., 2001). There are three differences. The case definitions used in the current survey, for deaths due to ARI and diarrhea, differ from previous definitions because of differences in the questionnaires. For ARI, the current questionnaire asked about rapid and difficult breathing in two separate questions; while previously, the queries were included in one question. Unlike the previous questionnaire, the current one does not ask about cough, noisy breathing, stridor, and wheezing in neonates, resulting in different algorithms for neonates. In the diarrhea set of algorithms, there are differences in three of the specific symptoms used to confirm the assignment of diarrhea as cause of death. The symptoms of weakness and depressed fontanel present in the previous questionnaire were not present in the new one, while the symptom of loose skin used in the new questionnaire was not collected previously. None of the specific symptoms were available for neonates in the new questionnaire. The diagnosis of persistent diarrhea is now made only for postneonates and children age 1-4 years. The tiers were also modified in order to reduce the number of unspecified causes of death as shown in the chart (Figure 9.1). The physician review was added for the same reason. The two major changes in the tiers are the following:

1. The previous first tier—grouping together all neonatal deaths during 0-3 days of life—was dropped. Such a broad category did not allow understanding the causes of the large number deaths in this age group and, consequently, was not useful for policy or program purposes. The tier of birth asphyxia was added as a specific cause of death that contributed the most to these very early deaths; and
2. The inclusion of “possible serious infection” as a cause of death tier, replacing the previous possible ARI and diarrhea causes. This was done in an attempt to capture infections and sepsis as cause of death, as well as to reduce the number of deaths where a cause could not be assigned.

## 9.4 CAUSES OF DEATH AMONG CHILDREN UNDER FIVE

The percent distribution of children under five years by cause of death is presented in Table 9.1 by age group. Possible serious infection is the most important cause of death among neonates (33 percent), followed by birth asphyxia (21 percent), prematurity/LBW (11 percent) and ARI (10 percent). This large category of possible serious infection included 9 cases classified as such by the physician review. Of the remaining 102 cases in this category, 46 were also premature/LBW and 61 had possible ARI. Among neonates, 135 (39 percent) of the deaths were associated with prematurity/LBW (not presented in the table). Of these 135 cases, the direct causes of death indicated in Table 9.1 are: neonatal tetanus (4), congenital abnormality (7), birth Asphyxia (16), birth injury (5), diarrhea (2), ARI (15), possible serious infection (46), and prematurity/LBW (42).

Among infants aged 29 days-11 months, ARI was associated with almost half of the deaths (ARI alone: 43 percent and ARI and diarrhea 5 percent). A quarter of the post-neonatal deaths were due to possible serious infections, and diarrhea (with or without ARI) contributed 15 percent of deaths in this age group.

Among older children (12-59 months), possible serious infection was the most important killer (37 percent), followed by injuries (22 percent) — particularly drowning (19 percent) — ARI (17 percent), malnutrition (11 percent) and diarrhea (9 percent). This large category of possible serious infection among post-neonates and children aged 12-59 months (n=78) was examined. In 64 of these cases, the child had fever along with at least one other symptom. Half of these 78 cases were malnourished, 28 had possible ARI, 13 had possible diarrhea, and 14 had possible ARI and diarrhea.

Overall among all under-five children, possible serious infections (31 percent) and ARI (21 percent) were responsible for most of the deaths. This was followed by birth asphyxia (12 percent), diarrhea (7 percent) and prematurity/LBW (7 percent). Malnutrition was associated with 131 (22 percent) of all under-five deaths (not presented in the table). Of these 131 cases, the direct causes of death indicated in Table 9.1 are: injuries (2), measles with ARI diarrhea (1), diarrhea (16), ARI (47), ARI and diarrhea (5), Possible serious infection (39), and malnutrition alone (21). Overall, a cause could not be assigned to 31 (6 percent) of the under-five deaths.

Compared to the cause of death pattern observed in the 1996-97 survey, several differences are observed in even the current survey, limiting this comparison to those unlikely to be complicated by the changes in methodology. A big difference has been the reduction of the number of post-neonatal and child deaths. In 1996-97, deaths at ages 0-28 days, 1-11 months, and 12-59 months were 42 percent, 30 percent and 28 percent respectively; in 2004 this distribution was 56 percent, 31 percent and 13 percent respectively. Drowning is responsible for about 19 percent of deaths at 12-59 months, similar to the proportion in 1996-97. The proportion of neonatal deaths attributed to neonatal tetanus shows a dramatic decline from 17 to 4 percent. Of considerable interest is the reduction of “confirmed” Diarrhea as a cause of death from 13 percent in 1996-97 to 7 percent in 2004.

**Table 9.1 Causes of death among children under five by age group**

Percent distribution of deaths among children under five years, by cause of death according to age group, Bangladesh 2004

Cause of death	Age group			
	Neonatal (0-28 days)	Postneonatal 29 days - 11 months	Child 12-59 months	Under five years total
Neonatal tetanus	4.2	0.0	0.0	2.3
Congenital abnormality	5.1	0.0	0.0	2.8
Injury	0.0	3.2	22.3	4.1
Drowning	0.0	0.9	19.3	3.0
Birth asphyxia	21.1	0.0	0.0	11.7
Birth injury	3.9	0.0	0.0	2.2
Measles	0.0	0.4	1.6	0.3
Measles followed by ARI or diarrhea	0.0	0.0	1.8	0.3
Diarrhea	1.2	10.3	9.3	5.1
ARI	10.3	42.7	17.0	21.1
ARI and diarrhea	0.5	4.9	0.0	1.8
Possible serious infection <sup>1</sup>	33.2	24.6	37.3	31.2
Premature birth/LBW	10.9	1.2	0.0	6.5
Malnutrition	0.0	7.1	10.7	3.6
Other causes <sup>2</sup>	2.3	1.0	0.0	1.6
Unspecified	3.9	3.5	0.0	3.2
Undetermined	3.4	1.1	0.0	2.3
Total	100.0	100.0	100.0	100.0
Number of deaths	326	183	78	587

Note: Estimates are weighted.

<sup>1</sup> Possible serious infections include possible ARI and diarrhea.

<sup>2</sup> Causes includes umbilical hemorrhage (1), hemorrhage disorder of newborn (3), otitis media (1), neonatal malnutrition (1), intestinal obstruction (1), aspiration pneumonia (1), and congenital heart disease (1).

## 9.5 DIFFERENTIALS IN CAUSE OF UNDER-FIVE DEATHS

Differentials in cause of death by sex of child, urban-rural residence, mother's education and administrative division are presented in Tables 9.2-9.4. There are some differences between boys and girls in terms of causes of death (Table 9.2). Birth asphyxia and possible serious infections are more common causes of death among boys, while ARI is more common among girls. However, the confidence intervals are wide and overlapping therefore these differences are not statistically significant. In the 1996-97 BDHS, drowning deaths were more common in boys. This was still true in 2004 but the difference is smaller. ARI deaths were also more common among girls in 1996-97. An interesting change that has occurred between 1996-97 and 2004 that while in the previous BDHS, death to girls outnumbered deaths to boys (348 vs. 330); this was reversed in 2004 with 321 deaths to boys to 266 deaths to girls.

Urban-rural comparisons reveal that ARI is a more common cause of death in rural areas, while malnutrition as a cause of death is more common in urban areas (Table 9.2). The other causes do not differ when all under-five children are considered. However, data disaggregated by age at death (not presented) indicate that birth asphyxia contributes to higher percentage of neonatal deaths in urban areas (27 percent versus 20 percent), and drowning is almost twice as common among 12-59 month old children in rural areas (22 percent vs. 12 percent).

**Table 9.2 Causes of death among children under five by sex of child and residence**

Percent distribution of deaths among children under five years by cause of death, according to sex of child and residence, Bangladesh 2004

Cause of death	Sex of child		Residence	
	Male	Female	Rural	Urban
Neonatal tetanus	1.5	3.4	2.4	2.2
Congenital abnormality	2.3	3.5	3.2	1.6
Injury	4.3	3.9	4.1	4.0
Drowning	3.3	2.5	3.1	2.4
Birth asphyxia	13.0	10.1	11.4	12.9
Birth injury	1.9	2.4	2.2	2.2
Measles	0.2	0.5	0.3	0.6
Measles followed by ARI or diarrhea	0.0	0.6	0.2	0.5
Diarrhea	4.5	5.9	4.7	6.3
ARI	19.1	23.5	22.3	16.8
ARI and diarrhea	1.8	1.8	1.5	2.7
Possible serious infection <sup>1</sup>	33.8	27.9	31.2	31.0
Premature birth/LBW	7.2	5.6	6.7	5.6
Malnutrition	4.6	2.4	2.3	8.3
Other causes	1.5	1.8	1.6	1.7
Unspecified	2.6	4.0	3.8	1.3
Undetermined	1.8	2.8	2.3	2.3
Total	100.0	100.0	100.0	100.0
Number of deaths	321	266	408	179

Note: Estimates are weighted.  
<sup>1</sup>Possible serious infections include possible ARI and diarrhea

Congenital abnormalities, injuries including drowning, prematurity/LBW and birth asphyxia are more important causes of death among children whose mothers had at least secondary education compared to those with no education (Table 9.3). Malnutrition, possible serious infections, ARI and diarrhea are associated with a larger proportion of deaths among children of mothers with no education.

Small numbers and wide confidence intervals make it difficult to be conclusive about the divisional variations in cause death presented in Table 9.4. Barisal, and Khulna divisions are presented together due to small numbers and because they were part of same division previously. Several patterns are of interest: possible serious infections are the most important cause of childhood death in all divisions. Malnutrition is important in Dhaka and Chittagong divisions while ARI deaths are proportionately more common in Sylhet and least common in Rajshahi divisions. Diarrhea deaths were relatively more common in Chittagong and Sylhet divisions, and asphyxia deaths in Barisal/Khulna and Rajshahi divisions. Drowning deaths contribute more to under-five deaths in Chittagong and Rajshahi divisions.

**Table 9.3 Causes of death among children under five by mother's education**

Percent distribution of deaths among children under five years by cause of death, according to mother's level of education, Bangladesh 2004

Cause of death	Mother's education		
	None	Primary complete	Secondary complete or higher
Neonatal tetanus	3.4	2.3	0.0
Congenital abnormality	2.6	2.3	4.5
Injury	3.6	1.2	10.2
Drowning	2.0	1.2	9.0
Birth asphyxia	6.7	13.9	22.0
Birth Injury	1.5	3.2	2.5
Measles	0.5	0.0	0.0
Measles followed by ARI or diarrhea	0.2	0.5	0.0
Diarrhea	5.8	5.2	3.8
ARI	23.0	21.4	15.4
ARI and diarrhea	1.8	2.0	1.7
Possible serious infection <sup>1</sup>	32.8	29.3	28.7
Premature birth/LBW	4.8	9.4	6.9
Malnutrition	3.9	4.0	1.7
Other causes	2.0	1.3	1.3
Unspecified	4.8	2.0	0.8
Undetermined	2.6	2.1	0.8
Total	100.0	100.0	100.0
Number of deaths	288	180	104

Note: Estimates are weighted.  
<sup>1</sup>Possible serious infections include possible ARI and diarrhea



Table 9.4 Causes of death among children under five by division					
Percent distribution deaths among children under five years by cause of death, according to division, Bangladesh 2004					
Cause of death	Division				
	Chittagong	Dhaka	Barisal/ Khulna	Rajshahi	Sylhet
Neonatal tetanus	1.6	3.2	0.0	0.0	7.5
Congenital abnormality	2.2	3.0	2.4	3.3	2.8
Injury	6.4	2.0	2.9	8.0	0.9
Drowning	5.6	0.7	1.2	6.9	0.0
Birth asphyxia	8.8	10.0	20.0	15.3	7.4
Birth Injury	2.5	1.7	2.0	1.7	3.8
Measles	0.0	0.0	0.0	1.7	0.0
Measles followed by ARI or diarrhea	1.3	0.0	0.0	0.0	0.0
Diarrhea	8.5	4.8	4.4	2.1	6.2
ARI	21.3	22.3	20.3	17.5	24.2
ARI and diarrhea	1.1	3.6	0.8	1.1	0.0
Possible serious infection <sup>1</sup>	33.0	30.8	31.2	29.8	31.4
Premature birth/LBW	1.4	4.5	9.6	10.6	10.3
Malnutrition	5.3	5.4	2.8	1.1	0.6
Other causes	1.3	0.5	0.4	4.2	1.9
Unspecified	2.0	4.8	3.2	1.6	3.2
Undetermined	3.5	3.2	0.0	2.1	0.0
Total	100.0	100.0	100.0	100.0	100.0
Number of deaths	124	153	101	102	107

Note: Estimates are weighted.  
<sup>1</sup> Possible serious infections include possible ARI and diarrhea

