
Downloaded from: http://researchonline.lshtm.ac.uk/15490/

DOI:

Usage Guidelines

Please refer to usage guidelines at http://researchonline.lshtm.ac.uk/policies.html or alternatively contact researchonline@lshtm.ac.uk.

Available under license: http://creativecommons.org/licenses/by/2.5/
The silent burden of anaemia in Tanzanian children: a community-based study

D. Schellenberg,1,2 J.R.M. Armstrong Schellenberg,1,3 A. Mushi,1 D. de Savigny,4,5 L. Mgalula,5,6 C. Mbuya,5 & C.G. Victora7

Objective To document the prevalence, age-distribution, and risk factors for anaemia in Tanzanian children less than 5 years old, thereby assisting in the development of effective strategies for controlling anaemia.

Methods Cluster sampling was used to identify 2417 households at random from four contiguous districts in south-eastern United Republic of Tanzania in mid-1999. Data on various social and medical parameters were collected and analysed.

Findings Blood haemoglobin concentrations (Hb) were available for 1979 of the 2131 (93%) children identified and ranged from 1.7 to 18.6 g/dl. Overall, 87% (1722) of children had an Hb <11 g/dl, 39% (775) had an Hb <8 g/dl and 3% (65) had an Hb <5 g/dl. The highest prevalence of anaemia of all three levels was in children aged 6–11 months, of whom 10% (22/226) had an Hb <5 g/dl. However, the prevalence of anaemia was already high in children aged 1–5 months (85% had an Hb <11 g/dl, 42% had an Hb <8 g/dl, and 6% had an Hb <5 g/dl). Anaemia was usually asymptomatic and when symptoms arose they were nonspecific and rarely identified as a serious illness by the care provider. A recent history of treatment with antimalarials and iron was rare. Compliance with vaccinations delivered through the Expanded Programme of Immunization (EPI) was 82% and was not associated with risk of anaemia.

Conclusion Anaemia is extremely common in south-eastern United Republic of Tanzania, even in very young infants. Further implementation of the Integrated Management of Childhood Illness algorithm should improve the case management of anaemia. However, the asymptomatic nature of most episodes of anaemia highlights the need for preventive strategies. The EPI has good coverage of the target population and it may be an appropriate channel for delivering tools for controlling anaemia and malaria.

Keywords Anemia/epidemiology/prevention and control/drug therapy; Malaria, Falciparum/complications; Antimalarials/therapeutic use; Iron, Dietary/therapeutic use; Blood transfusion; Immunization programs; Child, Preschool; Cost of illness; Cluster analysis; United Republic of Tanzania (source: MeSH, INSERM).

Mots clés Anémie/épidémiologie/prévention et contrôle/chimiothérapie; Paludisme plasmodium falciparum/complication; Antipaludique/usage thérapeutique; Fer alimentaire/usage thérapeutique; Transfusion sanguine; Programmes de vaccination; Enfant âge pré-scolaire; Coût maladie; Sondage en grappes; République-Unie de Tanzanie (source: MeSH, NLM).

Palabras clave Anemia/epidemiología/previsión y control/quimioterapia; Paludismo falciparum/complicaciones; Antipaludicos/uso terapéutico; Hierro en la dieta/uso terapéutico; Transfusión sanguínea; Programas de inmunización; Infante; Costo de la enfermedad; Análisis por conglomerados; República Unida de Tanzania (fuente: DeCS, BIREME).


Introduction

More than 100 million African children are thought to be anaemic (1), and community-based estimates of anaemia prevalence (blood haemoglobin concentration (Hb) <11 g/dl) in children in settings where malaria is endemic range between 49% and 76% (2–5). The consequences, in terms of years of life lost, of such a high level of anaemia are hard to quantify, although the burden of malaria-associated anaemia has been estimated at 190 000–974 000 deaths per year in children under 5 years of age (6). Certainly, children admitted to hospital with severe anaemia (Hb <8 g/dl) are more likely to die than children admitted without anaemia, and anaemia is one of the largest killers of children admitted to hospital in sub-Saharan Africa (7–9). Even where blood transfusions are available there is a significant case fatality rate of 6–18% (7, 10, 11). However, most children at high risk of severe anaemia live beyond the easy reach of a hospital, the most common type of health facility that can perform blood transfusions.

The causes of anaemia are often multifactorial and are interrelated in a complex way. First, the relative importance of each factor — for example, hookworm or malaria — varies in different settings (12, 13). Anaemia may be chronic — for example, secondary to iron deficiency, infection with human immunodeficiency virus (HIV), or intestinal...
Research

worns — or it may be acute, owing to a sickle-cell crisis or 
Plasmodium falciparum infection, or chronic anaemia may 
be acutely exacerbated. The situation is complicated further 
because anaemia in childhood can result not only from 
events in childhood but also from maternal iron deficiency 
and anaemia, which are associated with impaired fetal 
development and iron-deficient and anaemic babies (14–17). 
Socioeconomic status may also affect the risk of anaemia by 
affecting nutritional status, family size, and birth interval, as 
well as intensifying problems of affordability and accessibil-
ity of preventive and curative measures.

Studies in east Africa have shown that P. falciparum 
malaria and iron deficiency account for much of the anaemia 
seen in young children (18, 19). One randomized study con-
cluded that approximately 60% of anaemia in infancy could 
be prevented by antimalarial chemoprophylaxis, illustrating 
the importance of malaria as a cause of anaemia in this set-
ting (18). The same study also found that iron supplemen-
tation reduced the incidence of anaemia by about 30%. In 
the same area, the prevalence of helminths in children under 
5 was only 2% (20), and genetic causes of anaemia, such as 
sickle-cell disease, were present, but at relatively low pres-
Alences (18, 21). The public health importance of anaemia 
resulting from HIV infection is not yet clear and is difficult 
to quantify:

The control of anaemia depends largely on the diagnosis 
and treatment of anaemia cases, rather than on the prevention 
of anaemia. However, clinical examination for detecting 
aemia in young children is only moderately sensitive 
(24–74%) for an Hb <11 g/dl and 37–81% for an Hb <8 g/dl 
(22–29) and may be particularly problematic in very young 
children examined by relatively poorly trained staff in the pri-
mary care setting (4–20%) (30). Various diagnostic tests exist 
but all reliable approaches require some equipment that is not 
readily available in many settings. In terms of prevention, 
insecticide-treated mosquito nets (ITNs) have been shown to 
Improve haemoglobin concentration in children living in 
malarious areas (31), but only recently has a potentially sus-
tainable approach to the distribution of ITNs been shown to 
have similar effects (32). It will take some considerable time 
before systems for the delivery of ITNs are functional on a 
large scale. The WHO/UNICEF (United Nations Children's 
Fund) iron supplementation policy recommends daily iron 
supplements starting at age 6 months for most children and 
anaemic (Hb <11 g/dl) were dispensed the standard 
treatment courses of sulfadoxine-
pyrimethamine/chloroquine and mebendazole, depending 
on age, whether febrile, and treatment history). All anaemic
Table 1. Descriptive data and risk factors for anaemia in Tanzanian children

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. of children</th>
<th>Mean Hb^h (g/dl)</th>
<th>No. of children with:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hb &lt;8 g/dl</td>
</tr>
<tr>
<td><strong>Gender (n=1979)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>996 (50.3)^c</td>
<td>8.5; 0.10^d</td>
<td>405 (41)^c</td>
</tr>
<tr>
<td>Female</td>
<td>983 (49.7)</td>
<td>8.6; 0.10</td>
<td>368 (38)</td>
</tr>
<tr>
<td><strong>Age (n=1979)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1 month</td>
<td>40 (2)</td>
<td>13.5; 0.40</td>
<td>1 (2)</td>
</tr>
<tr>
<td>1–5 months</td>
<td>221 (11.2)</td>
<td>8.5; 0.18</td>
<td>89 (40)</td>
</tr>
<tr>
<td>6–11 months</td>
<td>226 (11.4)</td>
<td>7.6; 0.16</td>
<td>133 (59)</td>
</tr>
<tr>
<td>1 year</td>
<td>403 (20.4)</td>
<td>8.0; 0.14</td>
<td>207 (51)</td>
</tr>
<tr>
<td>2 years</td>
<td>377 (19.1)</td>
<td>8.3; 0.13</td>
<td>157 (42)</td>
</tr>
<tr>
<td>3 years</td>
<td>389 (19.7)</td>
<td>9.0; 0.13</td>
<td>112 (29)</td>
</tr>
<tr>
<td>4 years</td>
<td>322 (16.3)</td>
<td>9.2; 0.11</td>
<td>75 (23)</td>
</tr>
<tr>
<td><strong>Time taken to travel from home to health facility (n=1860)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90 minutes</td>
<td>1437 (77)</td>
<td>8.6; 0.09</td>
<td>569 (40)</td>
</tr>
<tr>
<td>&gt;90 minutes</td>
<td>423 (23)</td>
<td>8.6; 0.17</td>
<td>166 (29)</td>
</tr>
<tr>
<td><strong>Fully vaccinated (n=401)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>328 (82)</td>
<td>7.9; 0.14</td>
<td>172 (52)</td>
</tr>
<tr>
<td>No</td>
<td>73 (18)</td>
<td>8.1; 0.27</td>
<td>35 (48)</td>
</tr>
<tr>
<td><strong>Socioeconomic score (n=1928)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Most poor</td>
<td>386 (20)</td>
<td>8.4; 0.14</td>
<td>165 (45)</td>
</tr>
<tr>
<td>Very poor</td>
<td>383 (20)</td>
<td>8.4; 0.14</td>
<td>153 (42)</td>
</tr>
<tr>
<td>Poor</td>
<td>386 (20)</td>
<td>8.6; 0.18</td>
<td>132 (38)</td>
</tr>
<tr>
<td>Less poor</td>
<td>385 (20)</td>
<td>8.7; 0.15</td>
<td>136 (37)</td>
</tr>
<tr>
<td>Least poor</td>
<td>388 (20)</td>
<td>8.6; 0.16</td>
<td>126 (37)</td>
</tr>
<tr>
<td><strong>HAZ^e tertile (n=1873)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top</td>
<td>613 (33)</td>
<td>8.8; 0.12</td>
<td>212 (35)</td>
</tr>
<tr>
<td>Middle</td>
<td>639 (34)</td>
<td>8.5; 0.10</td>
<td>263 (41)</td>
</tr>
<tr>
<td>Bottom</td>
<td>621 (33)</td>
<td>8.4; 0.11</td>
<td>256 (41)</td>
</tr>
<tr>
<td><strong>WAZ^f tertile (n=1947)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top</td>
<td>639 (33)</td>
<td>8.9; 0.11</td>
<td>203 (32)</td>
</tr>
<tr>
<td>Middle</td>
<td>658 (34)</td>
<td>8.6; 0.12</td>
<td>255 (39)</td>
</tr>
<tr>
<td>Bottom</td>
<td>650 (33)</td>
<td>8.2; 0.11</td>
<td>301 (46)</td>
</tr>
<tr>
<td><strong>WHZ^g tertile (n=1893)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top</td>
<td>623 (33)</td>
<td>8.6; 0.12</td>
<td>224 (36)</td>
</tr>
<tr>
<td>Middle</td>
<td>644 (34)</td>
<td>8.7; 0.11</td>
<td>238 (37)</td>
</tr>
<tr>
<td>Bottom</td>
<td>626 (33)</td>
<td>8.3; 0.11</td>
<td>282 (45)</td>
</tr>
<tr>
<td><strong>Mosquito net (n=1970)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treated</td>
<td>237 (12)</td>
<td>8.8; 0.17</td>
<td>71 (30)</td>
</tr>
<tr>
<td>Untreated</td>
<td>421 (21)</td>
<td>8.7; 0.15</td>
<td>150 (36)</td>
</tr>
<tr>
<td>None</td>
<td>1312 (67)</td>
<td>8.5; 0.10</td>
<td>551 (42)</td>
</tr>
<tr>
<td><strong>Altitude (n=1979)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1000 m</td>
<td>1791 (91)</td>
<td>8.5; 0.09</td>
<td>719 (40)</td>
</tr>
<tr>
<td>≥1000 m</td>
<td>188 (9)</td>
<td>9.1; 0.28</td>
<td>56 (30)</td>
</tr>
<tr>
<td><strong>Distance to transfusion centre (n=1979)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10 km</td>
<td>359/1979 (18)</td>
<td>9.0; 0.18</td>
<td>101 (28)</td>
</tr>
<tr>
<td>10–49 km</td>
<td>1340 (68)</td>
<td>8.5; 0.11</td>
<td>547 (41)</td>
</tr>
<tr>
<td>≥50 km</td>
<td>280 (14)</td>
<td>8.3; 0.25</td>
<td>127 (45)</td>
</tr>
</tbody>
</table>

Note: P-values are from tests of the association between prevalence of anaemia of different levels or mean haemoglobin and each of the variables in the table. All tests are adjusted for the clustered nature of the data.

a Hb = haemoglobin concentration.

b Figures in parentheses are percentages.
c Figures in italics are standard errors.
d P-values are from tests of the association between prevalence of anaemia of different levels or mean haemoglobin and each of the variables in the table. All tests are adjusted for the clustered nature of the data.

e HAZ = height-for-age Z-score.
f WAZ = weight-for-age Z-score.
g WHZ = weight-for-height Z-score.
Research

Table 2. Frequency and pattern of morbidity by level of anaemia in Tanzanian children aged <5 years

<table>
<thead>
<tr>
<th>Haemoglobin concentration (g/dl)</th>
<th>Sick in past 2 weeks</th>
<th>Help sought outside the home</th>
<th>Symptomatic at interview</th>
<th>Symptom profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥11.0</td>
<td>111/257 (43)</td>
<td>67/109 (61)</td>
<td>62/257 (24)</td>
<td>Fever 28 (47)</td>
</tr>
<tr>
<td>8–10.9</td>
<td>477/941 (51)</td>
<td>353/469 (75)</td>
<td>224/941 (24)</td>
<td>Cough 35 (58)</td>
</tr>
<tr>
<td>5–7.9</td>
<td>411/707 (58)</td>
<td>300/409 (73)</td>
<td>227/706 (32)</td>
<td>Fast breathing 3 (5)</td>
</tr>
<tr>
<td>&lt;5.0</td>
<td>44/66 (69)</td>
<td>32/43 (74)</td>
<td>29/64 (45)</td>
<td>Very sleepy 2 (3)</td>
</tr>
<tr>
<td>Overall</td>
<td>1043/1969 (53)</td>
<td>751/1029 (73)</td>
<td>542/1968 (28)</td>
<td>Vomiting every-thing 3 (5)</td>
</tr>
</tbody>
</table>

Test of statistical association:

- Symptomatic: F = 25.6, P < 0.0001
- Help sought: F = 1.7, P = 0.2
- Sick in past 2 weeks: F = 17.1, P = 0.0001
- Denominator = 142; 6%.

Overall: 1043/1969 (53) 751/1029 (73) 542/1968 (28)

Denominator = 527.

a Numbers in parentheses are percentages. The row percentages exceed 100% as each child may experience more than one symptom.

b Unless otherwise stated.

c Denominator = 216.
d Denominator = 213.
e Denominator = 527.
f All tests were design-based F-tests for trend.
g Anaemic versus non-anaemic: design-based F,123=8.1; P=0.0051.

Results

A total of 2417 households were selected from the 125 clusters. A small number of households declined to take part (n = 25; 1%) or were unavailable for interview (n = 142; 6%). 2131 children <5 years old were identified in 1405 households, and haemoglobin results were available for 1979 (93%) of them. Half of the children (996) were male (Table 1) and the sample was broadly representative of the population with regard to age and sex of the children included (data not shown).

Table 1 summarizes basic descriptive information and the factors significantly associated with an Hb <11 g/dl. Haemoglobin concentrations ranged from 1.7 to 18.6 g/dl, with the highest Hb recorded in a neonate and the lowest recorded in a child of 2 months. Overall, 87% (1722/1979) of children had some degree of anaemia (Hb <11 g/dl), 39% (775) had an Hb <8 g/dl, and 3% (65) had an Hb <5 g/dl. Fig. 1 shows that the prevalence of all levels of anaemia rose dramatically between 1 and 5 months of age before peaking in children aged 6–11 months. The prevalence of anaemia climbed from 85% (187/221) in the first 6 months of life to 96% (216/226) in the second half of infancy. Of note: 10%
of their nearest health facility. Overall, 11% (211/1963) of children had been admitted to hospital at least once in the previous year and anaemic children were not more likely to have been admitted than non-anaemic children (23/255 (9%) versus 188/1708 (11%), \( F = 0.84, P = 0.36 \)). Compliance with the full diphtheria-pertussis-tetanus (DPT) and measles vaccination regimen was 82% (327/400) and not associated with risk of anaemia.

The risk of severe anaemia (Hb <8 g/dl) increased as the socioeconomic score decreased, the poorest children being 1.23 times as likely as the least poor to have severe anaemia \( (F = 4.94, P = 0.028) \). Low HAZ, WHZ, and WAZ scores were all associated with an increased risk of anaemia. Only 1 of the 188 children (0.5%) living above 1000 m had an Hb <8 g/dl, compared with 64 of the 1791 (3.5%) children living at lower altitudes \( (F_{1,1124} = 5.71, P = 0.02) \). Although 86% of children lived within 50 km (approximately one day travelling) of the nearest health facility capable of giving blood transfusions, those living more than 50 km from such a facility were more likely to be anaemic, and this trend was significant (Table 1). Children who spent the night before the survey under a mosquito net, particularly a net treated with insecticide, were up to 29% (95% confidence interval (CI) 7 to 45) less likely to be anaemic than children who had not slept under a net (Table 1).

Table 2 summarizes the frequency and type of symptoms, and pattern of health-seeking behaviour, by level of anaemia. More than half of the children had been unwell during the two weeks preceding, or on the day of, the interview. Children with a history of recent illness were more likely to be anaemic than children with no reported illness, the relative risk being 1.28 (95% CI=1.14 to 1.42) and 1.99 (95% CI=1.17 to 3.40) for Hb <8 g/dl and Hb <5 g/dl, respectively. Increasing severity of anaemia was significantly associated with symptoms at the time of interview, but between half and three-quarters of all anaemic children were asymptomatic. Only 4 of the 762 children (0.5%) with any degree of anaemia and who had not been unwell in the preceding two weeks were symptomatic on the day of the interview.

The minority of anaemic children who were unwell when interviewed had nonspecific symptoms. Fever, cough, fast breathing, being very sleepy, vomiting everything, and being unable to drink/breastfeed as normal were all more frequently reported in children with anaemia than in children without anaemia. Diarrhoea, difficult breathing, and convulsions were reported with similar frequencies for anaemic and non-anaemic children. Increasing anaemia was associated with perceived severity of the episode among children reported to have been ill in the past two weeks. However, 67% (29/43) of mothers of symptomatic children with an Hb <5 g/dl, and 81% (365/451) of mothers of symptomatic children with an Hb <8 g/dl, did not think the illness was severe (Fig. 2). Mothers of anaemic children were more likely to seek health care outside the home than mothers of children with no anaemia (Table 2). No assistance was sought for approximately 26% (237/923) of children in each category of anaemia, despite the fact that only 31% (70/225) of these children lived more than 90 minutes away from the nearest health facility.

Table 3 shows that more anaemic children used antimalarial drugs in the two weeks preceding the interview than non-anaemic children. However, only 19% (320/1720) of anaemic children had received antimalarial treatment and less than 1% had received iron in the preceding fortnight. Only 12% (51/425) of attendances to a formal health provider were to a hospital, including one of the 24 children with an Hb <5 g/dl. None of the remaining 23 children had been referred for hospital care.

Discussion

Overall, 87% of children under 5 years of age had some level of anaemia (Hb <11 g/dl). We found surprisingly few differences between anaemic and non-anaemic children (apart from anaemia affecting relatively poor and malnourished children), making it hard to identify them as a group for targeted interventions. The most striking observation was the marked age-dependence within the community, the prevalence of anaemia increasing dramatically during the first 6 months of life and reaching maximal levels in the second half of infancy. This pattern was seen for all levels of anaemia and may reflect inadequate fetal iron stores, secondary to maternal anaemia and iron deficiency, which are then compounded by additional insults (14–19). Concerns about the high prevalence of anaemia are heightened by the fact that most...
Research

Table 3. Reported use of antimalarial drugs and iron in the previous 2 weeks in Tanzanian children aged <5 years

<table>
<thead>
<tr>
<th>Haemoglobin concentration (g/dl)</th>
<th>Antimalarial drugs</th>
<th>Irona</th>
<th>Obtained from formal health sector</th>
<th>Obtained outside formal health sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥11 (n=257)</td>
<td>11 (4)b</td>
<td>12 (5)b</td>
<td>1 (0.4)b</td>
<td></td>
</tr>
<tr>
<td>8.0–10.9 (n=946)</td>
<td>100 (11)</td>
<td>50 (5)</td>
<td>4 (0.4)</td>
<td></td>
</tr>
<tr>
<td>5.0–7.9 (n=710)</td>
<td>112 (16)</td>
<td>40 (6)</td>
<td>6 (0.8)</td>
<td></td>
</tr>
<tr>
<td>&lt;5.0 (n=64)</td>
<td>14 (22)</td>
<td>4 (6)</td>
<td>2 (3)</td>
<td></td>
</tr>
<tr>
<td>Total (n=1977)</td>
<td>237 (12)</td>
<td>106 (5)</td>
<td>12 (0.6)</td>
<td></td>
</tr>
<tr>
<td>Test of significanceb</td>
<td>F=32.7</td>
<td>F=0.43</td>
<td>F=3.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P&lt;0.000001</td>
<td>P=0.5</td>
<td>P=0.08</td>
<td></td>
</tr>
</tbody>
</table>

a Only one child (with a haemoglobin concentration <5 g/dl) obtained iron outside the formal health sector.

b Figures in parentheses are percentages.

c Design-based F–test on 1124 degrees of freedom.

Treatment with antimalarials and iron

Difficulty in diagnosing anaemia or inadequate knowledge of treatment guidelines may account for the low antimalarial (13%) and very low iron (1%) treatment rates in anaemic children. Both types of drug are recommended by IMCI for the treatment of anaemia in such settings (39). Although problems of drug prescription, availability, and cost may also account for the low prescription rates, the fact that none of the 23 children with an Hb <5 g/dl who presented to a peripheral health facility was referred to hospital also suggests a problem at an earlier stage in the management pathway. Key areas for improving case management are thus likely to be enhanced diagnosis and improved treatment of cases. IMCI has the potential to improve this by increasing the number of children identified as anaemic, ensuring drug treatment guidelines are clear, and encouraging appropriate referral practices.

Access to transfusion centres

The assessment of access to transfusion centres suggested that only 19% of children lived within 10 km (approximately 2 hours travelling) of their nearest transfusion centre. Blood transfusion is recommended for children with life-threatening anaemia (Hb <4 g/dl) or less severe anaemia with signs of physiological compromise (40, 41). Transfusion was found to be necessary in 13–20% of general paediatric admissions (10, 42) and almost half the malaria admissions in children aged 1–4 months in one hospital-based study (7). However, such hospital-based data tell us little about the number of child deaths that may be averted by timely blood transfusion, as the majority of child deaths occur in the community (34). Clearly, extended journey times with a child in urgent need of transfusion are likely to increase the risk of an adverse outcome. The increased prevalence of anaemia with increasing distance from transfusion centres was therefore particularly disturbing. Although the reason for this association is not clear, one can speculate confounding associations between socioeconomic status and proximity to malaria-vector breeding sites with increasing distance from transfusion centres, which are typically located in more urban settings.

Approaches to the prevention of anaemia

There is good evidence that the anaemia seen in this and similar settings is caused largely by malaria or by iron deficiency, or both (18, 19), and hence improved malaria control and iron supplementation programmes could have dramatic anti-anaemia effects

Anaemia control in mothers

One approach to preventing anaemia in children is by reducing anaemia and improving iron status in pregnancy and pre-pregnancy. Iron supplementation and intermittent preventive malaria treatment are recommended for women attending antenatal clinics (33, 43), although the transient nature of pregnancy may result in incomplete correction of anaemia or iron deficiency before delivery. Furthermore, women tend to present to clinic relatively late in pregnancy and there is evidence that anaemia in the first trimester reduces fetal growth and birth weight (44). Novel attempts to improve the health of prepregnant women — for exam-
ple, by accessing newlyweds at marriage registries (45) — have shown promise in some settings.

**Iron supplementation in children**

The global guidelines for iron supplementation in childhood may need to be refined if the benefits from iron prophylaxis are to be optimized. With the exception of children of low birth weight, for whom iron supplements are recommended from 2 months of age, WHO/UNICEF/INACG recommend that supplementation should commence only at 6 months; however, by this age anaemia has already affected a large proportion of children. A study from the same area as our survey delivered iron supplements to children aged 2–6 months and showed a 29% reduction in the incidence of severe anaemia (packed cell volume <25% (Hb <8 g/dl)) in the first year of life (18). This supplementation regimen also reduced the prevalence of iron deficiency measured at 12 months of age and the prevalence of anaemia at 4 years of age (C. Menendez, D. Schellenberg, L. Quinto, E. Kahigwa, L. Alvarez, J. J. Aponte, et al., unpublished data).

**Malaria prevention in children**

Anaemia was less of a problem at altitudes greater than 1,000 m, which probably reflects the reduced burden of malaria at such heights. Interestingly, this effect was more marked for life-threatening anaemia than for less severe anaemia. This suggests that malaria may be a relatively important cause of the most severe anaemia but that other causes of less severe anaemia, such as iron deficiency, are still prevalent at altitude. An element of altitude-induced secondary polycythaemia may also be present, although this is unlikely at the altitudes studied. Children sleeping under mosquito nets, especially nets treated with insecticide, had a reduced risk of anaemia, which is a further indication that malaria may be important in causing anaemia. This is in keeping with the results of several randomized studies that showed a mean increase in packed cell volume of 1.4% in children sleeping under an ITN (31). A major challenge is to develop and expand sustainable approaches to the provision of mosquito nets — and net treatment — in endemic settings, and progress in this respect is being made (46). Malaria vector control by residual house-spraying has also been shown to reduce the prevalence of anaemia (47); however, the benefits of this approach over ITN are not clear, especially considering the logistic complexity and expense of house-spraying. Similarly, malaria chemoprophylaxis has been shown to reduce the risk of anaemia by up to 60% (18) but the logistic complexity, expense, concerns over drug resistance, and a rebound increase in malaria and anaemia on stopping chemoprophylaxis render this an impractical public health approach to controlling anaemia.

**Expanded Programme on Immunization**

There is an established channel capable of delivering effective anti-anaemia interventions to the target group. The Expanded Programme on Immunization (EPI) routinely delivers DPT and oral polio vaccines to children aged 1, 2, and 3 months, and measles vaccinations and vitamin A supplements to children aged 9 months. Children with the most severe anaemia were just as likely as others to receive routine EPI vaccinations and overall compliance with the full DPT and measles vaccination regimen was high (82%). This existing infrastructure already delivers vaccines and micronutrients to the target group for anaemia control. In particular, it has contact with children during the first 6 months of life, when the prevalence of anaemia is rising sharply and may therefore be most amenable to intervention. This principle was confirmed by a study investigating the effects of intermittent malaria treatment delivered at 2, 3, and 9 months of age, in which the incidence of anaemia (Hb <8 g/dl) was reduced by 50% in the first year of life (48). This study also monitored compliance to ferrous sulfate supplements, made available at the time of routine health visits between 2 and 6 months of age, which may be another feasible approach to anaemia control.

**Study limitations**

This study was subject to the limitations of any retrospective study, such as the reliance on a history of illness and its inherent biases. We related a history of illness and treatments in the two weeks preceding interview to the haemoglobin concentration at the time of the survey. Haemoglobin levels could have fluctuated during the intervening period, thereby crossing the thresholds defining “any”, “severe” and “life-threatening” anaemia in either direction. However, the extremely high prevalence of anaemia at all levels, despite the large number of contacts with the health services (Table 2), suggests that the effects of such misclassifications are likely to be relatively small and that there is considerable scope for improvements in anaemia control. Another limitation of this study is that it was performed over a period of only 2 months in the early dry season, and hence seasonal variations in the pattern of anaemia could not be discerned.

**Conclusion**

In conclusion, we have documented a very high point prevalence of anaemia in children under 5 years and showed that children less than 6 months of age are already severely affected. Anaemia was usually asymptomatic and when symptoms arose they were nonspecific. Few anaemia cases were managed optimally, despite many children having attended a health facility, and the very high burden of anaemia warrants a concerted approach to its control. Improved availability of diagnostic tests and wider implementation of standard treatment guidelines, including appropriate referral practices and optimizing compliance, are important. However, given the insidious and often undetected nature of anaemia, the difficulties accessing appropriate health care, and the dangers of blood transfusion, increased emphasis on preventive measures is required. The system of EPI contacts may be a suitable means of raising awareness about anaemia and delivering effective anaemia control interventions.

**Acknowledgements**

The authors are grateful for the participation of all those interviewed and the field and data room staff of IHRDC and Dr Hassan Mshinda, IHRDC Director. The support of the District Medical Officers and their teams in Kilombero, Morogoro Rural, Rufiji, and Ulanga districts was essential, as was the cooperation of the Tanzanian Ministry of Health.
La anemia silenciosa entre los niños de Tanzanía: un estudio comunitario

Objetivo Documentar la prevalencia, la distribución por edades y los factores de riesgo de anemia entre los niños tanzanos menores de 5 años, en el objetivo de ayudar a formular estrategias eficaces de acción contra la anemia.

Métodos Se identificaron aleatoriamente en el sureste de Tanzania, 2131 niños menores de 5 años, para un muestreo por conglomerados. Se tomó el hemoglobina (Hb) en sangre en el frente de la población y se analizaron datos referentes a diversas variables sociodemográficas y clínicas.

Resultados Se obtuvieron los niveles de hemoglobina (Hb) de 1979 (93%) de los 2131 niños identificados, con valores de entre 1,7 g/dl y 18,6 g/dl. En términos globales, el 87% (1722) de los niños menores de 5 años presentaron un nivel de hemoglobina <11 g/dl, 39% (775) un nivel <8 g/dl y 3% (65) un nivel <5 g/dl. Para estos tres grados de anemia, la prevalencia más alta fue encontrada en los niños de 6 a 11 meses, con un 10% (22/226) de esos niños presentando niveles de hemoglobina <5 g/dl. La anemia era en general asintomática, y en los casos en que había síntomas, eran no específicos y raramente se asociaron a una patología grave por el dispensador de atención. Poco o nada se asoció a un riesgo de anemia.

Conclusion La anemia es un problema muy común en el sureste de Tanzania, incluso entre los lactantes de muy corta edad. Una más extensa aplicación del algoritmo de la atención integrada a la salud de los niños de la infancia debería reducir el manejo de los casos de anemia. No obstante, el carácter asintomático de la mayoría de los episodios de anemia destaca la necesidad de aplicar estrategias preventivas. El PAI, con una buena cobertura de la población destinatario, podría ser un mecanismo apropiado para suministrar los medios necesarios para controlar la anemia y la malaria.
References


