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Anaemia, iron status and vitamin A deficiency among adolescent refugees in Kenya and Nepal

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Abstract

Objective: To investigate the prevalence of anaemia (haemoglobin < 11.0 to 13.0 $g\,dl^{-1}$ depending on age and sex group), iron deficiency (transferrin receptor concentration > 8.3 $\mu g\,ml^{-1}$) and vitamin A deficiency (serum retinol < 0.7 $\mu mol\,l^{-1}$) in adolescent refugees.

Design: Cross-sectional surveys.

Setting: Kakuma refugee camp in Kenya and seven refugee camps in Nepal.

Subjects: Adolescent refugee residents in these camps.

Results: Anaemia was present in 46% (95% confidence interval (CI): 42–51) of adolescents in Kenya and in 24% (95% CI: 20–28) of adolescents in Nepal. The sensitivity of palmar pallor in detecting anaemia was 21%. In addition, 43% (95% CI: 36–50) and 53% (95% CI: 46–61) of adolescents in Kenya and Nepal, respectively, had iron deficiency. In both surveys, anaemia occurred more commonly among adolescents with iron deficiency. Vitamin A deficiency was found in 15% (95% CI: 10–20) of adolescents in Kenya and 30% (95% CI: 24–37) of adolescents in Nepal. Night blindness was not more common in adolescents with vitamin A deficiency than in those without vitamin A deficiency. In Kenya, one of the seven adolescents with Bitot's spots had vitamin A deficiency.

Conclusions: Anaemia, iron deficiency and vitamin A deficiency are common among adolescents in refugee populations. Such adolescents need to increase intakes of these nutrients; however, the lack of routine access makes programmes targeting adolescents difficult. Adolescent refugees should be considered for assessment along with other at-risk groups in displaced populations.

Keywords
Adolescents
Dietary iron
Anaemia
Vitamin A deficiency
Micronutrients
Refugees

Population-based assessments of nutritional status do not often include adolescents, who are thought to be less vulnerable to nutritional deprivation than other groups, such as young children and pregnant and lactating women. In addition, methods to assess nutritional status in adolescents are not as standardised as the methods for assessing young children, and public health staff working in emergencies have less experience with such methods[1]. However, adolescents may in fact be vulnerable to deficiencies of iron, vitamin A and other micronutrients. Iron deficiency, the most common micronutrient deficiency in the world[2], frequently affects adolescent girls. Moreover, some studies demonstrate that iron deficiency can have detrimental effects on learning, memory and attentional processes in preadolescents and adolescents[3]. The presence of vitamin A deficiency has recently been described in population subgroups, such as adolescents, who are too old to benefit from supplementation programmes targeted to pre-school children[4–6]. Vitamin A deficiency in pregnancy increases mortality among pregnant women and their newborn infants[7–9]. Vitamin A supplementation recently was recommended for women of childbearing age (15–49 years), which includes late adolescence[10].

Refugee and displaced populations are especially vulnerable to deficiencies of many micronutrients,

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including iron and vitamin A. Anaemia and iron deficiency result in severe health problems in such populations and account for a substantial proportion of deaths among young children and women of childbearing age[11]. In addition, vitamin A deficiency has been seen in refugee, displaced and other populations whose usual food source has been disrupted[12]. Persons in these populations often suffer from insufficient food availability, and the food supplied by host governments and the humanitarian relief community frequently lacks sufficient quantities of many essential micronutrients[13]. As a result, outbreaks of various micronutrient deficiency conditions occur in many displaced populations who are dependent on food supplied by humanitarian agencies[13,14].

In both displaced populations and more stable situations, providing adolescents with additional iron and vitamin A may be difficult. Adolescents often have little contact with health or nutrition programmes used to distribute micronutrient supplementation to other groups, such as young children and pregnant and lactating women. Moreover, a separate programme targeting adolescents would require substantial resources because adolescents often make up a large proportion of the population. Therefore, the need for new, potentially expensive, programmes specifically addressing adolescents must be determined on the basis of data from adolescents. The present paper describes the prevalence of anaemia, iron deficiency and vitamin A deficiency among adolescents in two refugee populations.

Background

Kakuma Camp was established in August 1992 near the border town of Lockichokio in the Turkana District of northwest Kenya for refugees fleeing fighting in the Sudanese civil war. Since that time, Kenyan authorities have settled refugees from at least nine other countries in Kakuma Camp. More than two-thirds of its population is from southern Sudan or Somalia, and most have been refugees for many years. In 1997, a survey of school-aged children and adolescents found a high prevalence of protein–energy malnutrition as defined by body mass index (BMI) less than the 5th centile of matching age- and sex-specific groups in a reference population, as recommended by the World Health Organization (WHO)[15,16]; however, the methods used to obtain these results were later questioned[17,18]. In addition, the survey found a high prevalence of anaemia. In response to these findings, camp authorities implemented a school-based supplementary feeding programme with a blended, micronutrient-fortified food; this programme was ongoing at the time of the survey reported herein. In November 1998, 18 months after this intervention, the Centers for Disease Control and Prevention (CDC) was asked to repeat a nutrition assessment survey of adolescents (10–19 years of age) to determine the prevalence of protein–energy and micronutrient malnutrition, including the prevalence of anaemia and vitamin A deficiency.

The Nepal refugee camps were established in early 1990 in the Jhapa and Morang Districts in southeast Nepal for ethnic Nepalese who fled the Government of Bhutan's enforcement of new citizenship policies. In February and March 1999, the rate of cases of angular stomatitis, a potential sign of riboflavin deficiency, reported in the routine health information system increased six-fold from the prior baseline, with the greatest number of cases occurring in children and adolescents. In September 1999, organisations working in these camps asked CDC to conduct a nutrition survey of adolescent refugees to determine the prevalence of protein–energy and micronutrient malnutrition, including anaemia and deficiencies of B vitamins and vitamin A. The investigation of angular stomatitis and B-vitamin deficiency demonstrated that most adolescents had subnormal serum concentrations of riboflavin[19].

The anthropometric results from both assessments have been presented elsewhere[20]. The present article describes the results of measurement of the prevalence of anaemia, iron deficiency and vitamin A deficiency from the surveys in Kenya and Nepal.

Subjects and methods

Study design and subjects

CDC and the United Nations High Commissioner for Refugees (UNHCR) conducted cross-sectional surveys in November 1998 in Kakuma Camp, and in October 1999 in refugee camps in Nepal. According to camp registry data kept by UNHCR, in May 1998, 66 171 persons, including 16 846 (25%) adolescents, resided in Kakuma Camp. According to UNHCR camp registries, in September 1999, 99 044 persons, including 26 235 (27%) adolescents, resided in the seven refugee camps in Nepal.

In the Kenya survey, sample size calculations were done assuming 50% prevalence of anaemia. In the Nepal survey, sample size calculations were done assuming a 50% prevalence of anaemia and a 30% prevalence of vitamin A deficiency and angular stomatitis. The largest sample size required was for the estimate of the prevalence of anaemia; a minimum sample size of 385 adolescents was needed in each survey to achieve the desired precision of ± 5 percentage points around this estimate. This sample size would provide a precision of about ± 4.6 percentage points around the estimates of vitamin A deficiency and angular stomatitis in the Nepal survey. To account for potential non-response, 455 adolescents were selected in Kakuma Camp and 495 adolescents were selected in the Nepal camps. Both samples were selected from the computerised registry data by systematic random sampling. Selected adolescents who could not be traced, who were ineligible because their age was incorrect in the registry data, or who had died, were not replaced.

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In Kakuma Camp, the families of many adolescents selected for the original sample had permanently left the camp. In order to achieve the necessary sample size, an adolescent of the same sex in the household nearest the place of residence of the missing adolescent replaced each such missing adolescent. In the Nepal camps, a much smaller proportion of selected adolescents was missing. Pregnant adolescents were excluded from all analyses.

Data collection

Data collection forms for both surveys, including interview questions, were originally created in English. Refugee personnel translated the forms into the main languages spoken by the camp populations (Somali, Dinka and Nuer in Kakuma Camp; Nepali in the Nepal camps). Different translators translated the forms back into English. Survey managers and translators then resolved the discrepancies between the original English and the back-translated English version.

Community health workers went to the residence of each selected adolescent to ask him or her to report to a central survey site on a given date. Adolescents younger than 15 years were encouraged to bring a parent or guardian. If a specific adolescent was not at home at the time of the first visit, survey workers returned to the house on two subsequent days and asked neighbours about the whereabouts of the family and the adolescent.

Survey teams consisted of: (1) a clerk to register prospective participants and confirm their eligibility, (2) two interviewers to administer the questionnaire, (3) two anthropometrists to take weight and height measurements, (4) a medical officer or assistant to examine each participant and (5) a laboratory technician to obtain biological specimens. Survey personnel had prior experience in the activity they performed during data collection and received refresher training for the surveys.

Upon reporting to the central survey site, adolescents and accompanying parents received an explanation of the survey objectives and procedures and were asked for consent to participate in the survey. Adolescents 18 or 19 years of age who gave consent and adolescents less than 18 years of age who assented and whose accompanying parent gave consent were asked about various socio-economic characteristics. Girls were asked about age at menarche and current pregnancy. In Kakuma Camp, every second survey participant was questioned about night blindness and examined for conjunctiva pallor, palmar pallor and Bitot's spots. In the Nepal camps, these data were gathered on all participants. Each adolescent was weighed to the nearest 100 g while wearing one layer of light clothing using a bathroom type scale. Standing height was measured without shoes to the nearest 0.1 cm using a 2-m height board similar to that used for children less than 5 years of age. Blood specimens were obtained by fingerprick for haemoglobin assessment. Every second survey participant underwent venepuncture to determine the serum concentrations of retinol and transferrin receptors. C-reactive protein was measured only on adolescents in Kakuma Camp.

Biochemical assessment

The haemoglobin concentration in the fingerprick blood sample was measured using a HemoCue haemoglobinometer (HemoCue AB, Ångelholm, Sweden) according to the manufacturer's recommendations. The haemoglobinometers were checked each morning using the standard included by the manufacturer with each machine. Non-fasting blood was collected by venepuncture into glass tubes without anticoagulant. Blood specimens were kept in a cold box and protected from light for 1–8 h in the field until processing each evening. During processing, clotted blood was centrifuged, the serum removed by pipette and placed in cryovials, which were immediately stored in a dark freezer at −20°C for 1–4 weeks. Shipment to CDC (Atlanta, GA, USA) by commercial airliner lasted no more than 36 h, at the end of which the specimens were refrozen and kept at −70°C for 2–3 months until analysis. The serum concentration of vitamin A was measured as retinol using high-performance liquid chromatography[21]. The serum transferrin receptor concentration was measured using a commercially available enzyme-linked immunosorbent assay (Bio-Rad Laboratories, Hercules, CA, USA). C-reactive protein was measured using a Hitachi 912 analyser and a commercial kit (Roche Diagnostics, Basel, Switzerland).

Definition of outcomes

Anaemia was defined using the WHO-recommended age- and sex-specific cut-off points[22]: for both sexes 10–11 years of age, 11.5 g dl^{-1}; for both sexes 12–14 years of age, 12.0 g dl^{-1}; for girls >15 years of age, 12.0 g dl^{-1}; and for boys >15 years of age, 13.0 g dl^{-1}. Severe anaemia was defined as haemoglobin <7.0 g dl^{-1}. Transferrin receptor concentration >8.3 μg ml^{-1} defined adolescents with low iron tissue stores, as recommended by the manufacturer of the laboratory testing kit. Night blindness was self-reported by answering a question about its presence. During translation of the data collection form, words in Dinka, Nuer, Somali and Nepali were identified for night blindness. Serum vitamin A concentration < 0.7 μmol l^{-1} defined vitamin A deficiency[23]. A survey participant was considered to have active inflammation if the serum C-reactive protein concentration exceeded 0.5 mg dl^{-1}. BMI was calculated from weight and height according to the formula: BMI = [weight (in kg)]/[height (in m)]^2. The prevalence of low BMI was determined by using the age- and sex-specific BMI cut-off points recommended by WHO[15]. These cut-off points were defined by using the 5th centile of a reference population of US adolescents.

Statistical analysis

Data were entered and analysed with Epi Info version 6.04b[24]. The precision around point estimates of

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prevalence rates is indicated by the 95% confidence interval (CI). The chi-square test was used to compare categorical data. A P-value < 0.05 was considered statistically significant for all tests of association.

Results

Survey sample

Of the 455 selected adolescents in Kakuma Camp, 54 (11.9%) could not be traced, seven (1.5%) refused participation, two (0.4%) were ineligible because they reported their age as <10 years or >19 years, and one (0.2%) had died. An additional 111 adolescents in the original sample had permanently moved out of the camp, all of whom were replaced. This final survey sample in Kenya comprised 391 adolescents (85.9% of the number originally selected). No adolescents reported pregnancy at the time of the survey. Of the 495 selected adolescents in Nepal, one (0.2%) could not be traced, two (0.4%) refused participation, 13 (2.6%) were ineligible because they reported their age as <10 years or> 19 years, one (0.2%) had died, and 14 (2.8%) resided outside the camp. The final survey sample in Nepal comprised 464 adolescents (93.7% of the original sample). Because two adolescents reported pregnancy, 462 were included in the analysis.

Duration of residence in the camp for the adolescents in Kakuma Camp ranged from 1 month to 6 years; the median duration of stay was 3 years. In the survey population, 318 (81.3%) adolescents lived with relatives, 41 (10.5%) lived in the minor community, seven (1.8%) lived with foster or adoptive families, and 25 (6.4%) lived alone or in other situations. More than two-thirds of the Kakuma Camp sample was male, and most were 15–19 years of age (Table 1). Most adolescents were from Sudan. No statistically significant differences existed in the distribution of sex, age or country of origin between adolescents in the total population of Kakuma Camp and adolescents in the final survey sample (data not shown). The sample of adolescents from Nepal was more equally distributed by sex and age (Table 1). Adolescents in the final survey sample were slightly older than adolescents in the total adolescent population in the Nepal camps (54.7% vs. 47.0% 15–19 years of age, respectively; $P < 0.01$, chi-square test). All adolescents in Nepal were from Bhutan. Although the Nepal survey questionnaire did not specifically ask survey respondents how long they had lived in the camps, most of the population of the camps at the time of the survey had arrived *en masse* in 1991.

Table 1 Number (%) of adolescents included in surveys, by age, sex and (for Kakuma only) country of origin; Kakuma Camp, 1998 and Nepal camps, 1999

Characteristic	Kakuma	Nepal
Sex		
Male	266 (68)	225 (49)
Female	125 (32)	237 (51)
Age		
10–14 years	155 (40)	210 (45)
15–19 years	234 (60)	252 (55)
Unknown	2 (0.5)	0
Country of origin		
Sudan	260 (66)	
Somalia	120 (31)	
Ethiopia	7 (2)	
Uganda	3 (0.8)	
Burundi	1 (0.3)	

Anaemia and iron deficiency

Anaemia was common in adolescents in both surveys. In Kakuma Camp, 178 (45.9%; 95% CI: 40.9–51.0) of 388 adolescents were anaemic. In Nepal, 110 (23.8%; 95% CI: 20.1–28.0) of 462 adolescents were anaemic. Seven (1.8%) adolescents in Kakuma Camp and one (0.2%) adolescent in Nepal had severe anaemia. The prevalence of anaemia was the same for boys and girls in Kakuma Camp, but was greater in girls than in boys in Nepal (Table 2). Anaemia was more common in postmenarcheal than premenarcheal girls in both surveys; however, this difference was statistically significant only in Nepal. More of the older adolescents were anaemic in both surveys. To control for the presence of more postmenarcheal girls in the older age group than in the younger age group, the association between age and anaemia was analysed only among boys. The effect of age largely disappeared in Nepal, and although anaemia was more common among older than younger boys in Kakuma Camp, the association was no longer statistically significant. No statistically significant difference existed in the prevalence of anaemia among adolescents with normal and low BMI.

Iron deficiency also was common in both adolescent populations. In Kakuma Camp, 83 (43.0%; 95% CI: 35.9–50.3) of 193 adolescents and in Nepal 103 (53.4%; 95% CI: 46.1–60.6) of 193 adolescents had transferrin receptor concentrations indicating iron deficiency. The prevalence of iron deficiency did not differ substantially between boys and girls (Table 3). Although the prevalence of iron deficiency was higher in postmenarcheal girls than in premenarcheal girls in both surveys, the differences were not statistically significant. The prevalence of iron deficiency in older boys was not consistently higher than in younger boys. Iron deficiency prevalence and BMI were not clearly associated.

In both surveys, anaemic adolescents were much more likely than non-anaemic adolescents to have iron deficiency. In Kakuma Camp, among the 88 anaemic adolescents who underwent testing for transferrin receptor concentration, 55 (62.5%) had iron deficiency; among the 105 non-anaemic adolescents, 28 (26.7%) had iron deficiency ($P < 0.001$, chi-square test). In Nepal, among the 44 anaemic adolescents who underwent testing for transferrin receptor concentration, 32 (72.7%) had iron deficiency; among the 149 non-anaemic adolescents, 71 (47.7%) had iron deficiency ($P < 0.01$, chi-square test).

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Table 2 Number (%) of adolescents with anaemia, by sex, age and body mass index (BMI); Kakuma Camp, 1998 and Nepal camps, 1999

	Kakuma			Nepal		
Characteristic	No. measured	No. (%) with anaemia*	*P*-value (χ^2)	No. measured	No. (%) with anaemia*	*P*-value (χ^2)
Sex						
Male	264	121 (46)	NS	225	42 (19)	<0.05
Female	124	57 (46)		237	68 (29)	
Menarche†						
Post	22	12 (55)	NS	138	51 (37)	<0.001
Pre	42	15 (36)		99	17 (17)	
Age						
10–14 years	154	61 (40)	<0.05	210	40 (19)	<0.05
15–19 years	234	117 (50)		252	70 (28)	
Age (males only)						
10–14 years	85	34 (40)	NS	97	17 (18)	NS
15–19 years	179	87 (49)		128	25 (20)	
BMI						
Normal	165	70 (42)	NS	292	73 (25)	NS
Low*	223	108 (48)		170	37 (22)	

NS – not significant ($P > 0.05$).
* Definition in text.
† In Kakuma, data on menarcheal status available only from girls undergoing venepuncture.

Because the association between clinical signs of deficiency and biochemical measures of anaemia and vitamin A was similar in the two surveys, the two surveys' results were combined to evaluate the utility of using clinical examination to identify adolescents with anaemia and vitamin A deficiency. Of the 57 adolescents with conjunctival pallor, 31 (54.4%) had anaemia; of the 599 adolescents without conjunctival pallor, 168 (28.0%) had anaemia ($P < 0.001$, chi-square test). Although the prevalence of anaemia was significantly higher in adolescents with conjunctival pallor, the sensitivity of this sign was only 16%, the specificity was 94%, and the positive predictive value was 54%. Of the 92 adolescents with palmar pallor, 43 (46.7%) had anaemia. Of the 564 adolescents without palmar pallor, 156 (27.7%) had anaemia ($P < 0.001$, chi-square test). The sensitivity of this sign was 22%, the specificity was 89%, and the positive predictive value was 47%.

Vitamin A deficiency

In Kakuma Camp, 28 (14.5%; 95% CI: 9.9–20.3) of the 193 adolescents tested, and in Nepal 57 (29.8%; 95% CI: 23.5–36.9) of the 191 adolescents tested, had vitamin A deficiency. Vitamin A concentrations $< 0.35\ \mu mol\ l^{-1}$ were found in three (1.6%) adolescents in Kakuma Camp and two (1.0%) adolescents in Nepal. The prevalence of vitamin A deficiency did not differ significantly by sex or age (Table 4). In Kakuma Camp,

Table 3 Number (%) of adolescents with iron deficiency, by sex, age and body mass index (BMI); Kakuma Camp, 1998 and Nepal camps, 1999

	Kakuma			Nepal		
Characteristic	No. measured	No. (%) with iron deficiency*	*P*-value (χ^2)	No. measured	No. (%) with iron deficiency*	*P*-value (χ^2)
Sex						
Male	127	55 (43)	NS	95	48 (51)	NS
Female	66	28 (42)		98	55 (56)	
Menarche†						
Post	22	13 (59)	0.07	65	40 (62)	NS
Pre	42	15 (36)		33	15 (46)	
Age						
10–14 years	80	31 (39)	NS	77	36 (47)	NS
15–19 years	113	52 (46)		116	67 (59)	
Age (males only)						
10–14 years	43	20 (47)	NS	36	17 (47)	NS
15–19 years	84	35 (42)		59	31 (53)	
BMI						
Normal	82	33 (40)	NS	128	69 (54)	NS
Low*	111	50 (45)		65	34 (52)	

NS – not significant ($P > 0.05$).
* Definition in text.
† In Kakuma, data on menarcheal status available only from girls undergoing venepuncture.

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Table 4 Number (%) of adolescents with low vitamin A concentration, by sex, age and body mass index (BMI); Kakuma Camp, 1998 and Nepal camps, 1999

	Kakuma			Nepal		
Characteristic	No. measured	No. (%) with low vitamin A concentration*	*P*-value (χ^2)	No. measured	No. (%) with low vitamin A concentration*	*P*-value (χ^2)
Sex						
Male	127	21 (17)	NS	94	31 (33)	NS
Female	66	7 (11)		97	26 (27)	
Age						
10–14 years	80	16 (20)	NS	76	20 (26)	NS
15–19 years	113	12 (11)		115	37 (32)	
BMI						
Normal	82	6 (7)	<0.05	127	35 (28)	NS
Low*	111	22 (20)		64	22 (34)	

NS – not significant ($P > 0.05$).
* Definition in text.

adolescents with low BMI were more likely than adolescents with normal BMI to have vitamin A deficiency. Of the 125 adolescents in Kakuma Camp with sufficient serum to test for C-reactive protein, 19 (15.2%; 95% CI: 9.4–22.7) had acute inflammation. Of these 19, five (26.3%) had vitamin A deficiency.

In Kakuma Camp, 47 (24.0%) of 196 adolescents reported night blindness, as did 135 (29.2%) of 462 adolescents in the Nepal camps. Of the 109 adolescents in both surveys who reported night blindness and had serum retinol concentrations measured, 25 (22.9%) had vitamin A deficiency. Among the 275 adolescents without night blindness, 60 (21.8%) had vitamin A deficiency. The sensitivity of reported night blindness to detect vitamin A deficiency was 29%; the specificity, 72%; and the positive predictive value, 23%. Bitot's spots were observed in seven adolescents in Kakuma Camp and in no adolescent in Nepal. Of these seven, one (14.3%) had vitamin A deficiency. Among 185 adolescents in Kakuma Camp without Bitot's spots, 27 (14.6%) had vitamin A deficiency. The sensitivity of Bitot's spots in detecting vitamin A deficiency was 4%; the specificity, 96%; and the positive predictive value, 14%.

Discussion

The two surveys presented in this report found high prevalence rates of anaemia, iron deficiency and vitamin A deficiency among adolescent refugees in Kakuma Camp, Kenya and refugee camps in Nepal. The prevalence rates of anaemia in these two populations define anaemia as a public health problem of high significance in adolescents[2]. Although no comparable prevalence benchmarks exist for vitamin A deficiency in adolescents, for children 24–71 months of age, a prevalence of low serum retinol of 10–19% defines a moderate public health problem and a prevalence of 20% or greater defines a severe public health problem[2].

Because our surveys did not include other population subgroups, the results cannot be used to determine whether adolescents are at higher risk than other groups for these deficiencies, or if the high prevalence rates in adolescents reflect deficiencies distributed throughout the entire population. Consistent with the former possibility, rapid growth in stature, muscle mass and fat mass during adolescence results in greater daily requirement for iron and vitamin A than among persons of other age groups[25]. In populations dependent on relief food, the limited dietary supply of these nutrients in relief food may not be able to meet this greater demand. Moreover, as our results indicate, because of the adolescent growth spurt and menarche, older girls have an especially high requirement for iron even if they are not pregnant.

On the other hand, micronutrient deficiencies in adolescents may reflect micronutrient deficiencies in the entire population. Although the surveys reported here did not include other age groups, a survey of children 6–59 months of age in Kakuma Camp was done in March 2001, slightly more than 2 years after the adolescent survey reported herein. Using methods similar to those used in our surveys, the 2001 survey found anaemia in 61% of children, iron deficiency in 60%, and vitamin A deficiency in 47%[26]. Moreover, several studies in stable but poor populations have shown that vitamin A deficiency is common in both adolescents and other age groups[6,27,28]. Given the deficient food supply and changes in diet that often occur with population displacement, one might expect exacerbation of micronutrient deficiencies during and after humanitarian emergencies in many population subgroups. Surveys simultaneously including multiple groups, such as adolescents, young children and adult women, are needed to estimate adolescents' vulnerability to both iron and vitamin A deficiency relative to other population groups.

Targeting adolescents for micronutrient interventions may be difficult because adolescents lack recommended preventive health visits and may not seek health care as frequently as other groups. School-based nutrition programmes can take advantage of adolescents' congregation in schools. However, schools are rarely open

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early in humanitarian emergencies when the need may be greatest. Moreover, school enrolment must include nearly all adolescents if school-based programmes are to reach most of this age group, and school enrolment is often lower for older girls at greatest risk of anaemia and iron deficiency. In Kakuma Camp, school attendance at the time of the survey for boys aged 10–14 years was 62.5%; for boys 15–19 years, 94.6%; for girls 10–14 years, 57.9%; and for girls 15–19 years, 34.1%. Hence, the school-based supplementary feeding programme in Kakuma Camp that provided fortified cereal blend to students each morning upon their arrival at school missed almost two-thirds of older girls. If a nutritional intervention aims to reach all adolescents, an innovative approach to reaching these beneficiaries needs to be developed.

Distribution of fortified food in the general ration would better address nutrition problems in the entire population, including adolescents. Many food-dependent emergency-affected populations have suffered widespread micronutrient deficiency outbreaks, including outbreaks of scurvy, pellagra and beriberi, because relief food often is deficient in many micronutrients[13]. However, fortified, blended food is substantially more expensive than bulk unfortified or unmilled cereal. When resources are limited for programmes in long-standing refugee populations, fortified food is often among the first commodities to be cut. The Nepal survey was prompted by the appearance of many cases of angular stomatitis, a suspected manifestation of riboflavin deficiency, which appeared shortly after distribution of fortified cereal was stopped[19].

These surveys also demonstrate the difficulty of clinical identification of iron and vitamin A deficiency in adolescents. In several recent studies, clinical examination for pallor did not reliably identify persons with mild and moderate anaemia[29–31]. However, few of these studies have included boys or younger girls. None the less, little reason exists to believe that clinical examination would have greater utility in adolescents than in other groups. As with surveys in other age groups, haemoglobin measurement probably is necessary to obtain reasonably precise estimates of the prevalence and severity of anaemia in adolescents.

The ability of clinical examination of adolescents to detect vitamin A deficiency is largely unknown. Other studies have correlated night blindness with vitamin A deficiency in both adults and children[32–34]. The survey in Kakuma Camp failed to demonstrate this correlation among adolescents. The accuracy of interview responses regarding night blindness obviously depends on the ability of interview respondents to recognise this symptom. Although interviewers, translators and other survey workers identified a specific word for night blindness in the major languages in which the survey interviews were conducted, this word may not be as well known by adolescents as by mothers of young children. Thus, detecting night blindness through direct questions to adolescents may be more difficult than detecting night blindness among young children by asking their mothers.

Several reasons may account for the observed lack of correlation between Bitot's spots and vitamin A deficiency. First, because only seven adolescents had Bitot's spots in one survey, our analysis lacked statistical power. Second, although Bitot's spots have been noted in adolescents for many years[35], their presence may not indicate vitamin A deficiency as accurately as it does in young children. Because Bitot's spots in older children and adolescents do not resolve as frequently with vitamin A treatment[36], positive examinations may include adolescents with past, but resolved, vitamin A deficiency.

These surveys and their results have some limitations. First, because the data collected did not include health outcomes, the clinical consequences of iron and vitamin A deficiency in adolescents cannot be determined. Additional studies should explore these outcomes. Second, communicable diseases and other sources of inflammation are often more common in emergency-affected populations and may result in spuriously depressed serum retinol concentrations[37]. As a result, these surveys may have overestimated the prevalence of vitamin A deficiency. However, surveillance data from the camps showed no increase in the background rates of communicable diseases in the year prior to the surveys. Moreover, if all five adolescents in Kakuma Camp who had vitamin A deficiency and elevated C-reactive protein concentrations had normal serum retinol concentrations before their acute inflammation, the prevalence of vitamin A deficiency in this population would still have been about 8%. Therefore, depression of serum retinol concentrations by inflammation would not eliminate the apparent vitamin A deficiency demonstrated in Kakuma Camp.

Overall, the results of these two surveys indicate that, in at least some displaced populations dependent on relief food, adolescents have elevated prevalence rates of anaemia, iron deficiency and vitamin A deficiency, and should increase their intakes of iron and vitamin A. Additional research needs to determine the vulnerability of adolescents relative to other population subgroups, to test the validity of clinical indicators of iron and vitamin A deficiency in adolescents, and to evaluate innovative approaches to targeting adolescents for micronutrient supplementation.

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