



Detection of malaria in relation to fever and grade of malnutrition among malnourished children in Ethiopia

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<http://dx.doi.org/10.5588/pha.11.0008>

Setting: Forty-eight nutritional rehabilitation centres in southern Ethiopia.

Objective: To determine 1) the frequency of temperature recording under programme conditions, 2) the proportion of malnourished children with and without fever who had falciparum malaria and 3) the association between malaria and grade of malnutrition.

Design: This was a retrospective analysis of routine programme data.

Results: Of 19 200 malnourished children, 16 716 (mean age 4.4 years, 7412 males) underwent a rapid malaria diagnostic test (Paracheck *Pf*®). Malnutrition was graded as severe (38%), moderate (35%) and mild (27%). Temperature was not recorded in 15 248 (91%) children. Malaria was diagnosed in 57 (28%) children with fever ($n = 206$) and 122 (10%) children with no fever ($n = 1262$). The prevalence of falciparum malaria was 9%. Malaria prevalence was significantly associated with grade of malnutrition: Paracheck *Pf* was positive in respectively 5%, 8% and 10% of children with mild, moderate and severe malnutrition (χ^2 for trend 78, $P < 0.001$).

Conclusions: This study shows the value of routine malaria screening in malnourished children, especially those with more severe grades of malnutrition, irrespective of fever. Operational shortcomings are highlighted and ways forward to address these problems are discussed.

Malaria kills more than 800 000 people annually worldwide, of whom 91% reside in sub-Saharan Africa and 85% are children aged <5 years.¹ In half of all childhood deaths, undernutrition is an underlying problem.² In Ethiopia, both malnutrition and malaria are major health concerns in children, as these are both important contributors to childhood morbidity and mortality.^{1,3}

Children in malaria-endemic areas with malaria parasitaemia may or may not present with fever, defined as body temperature of $>37.5^{\circ}\text{C}$.⁴ In malnourished children, any malarial parasitaemia is considered important and should be treated due to compromised immunity and the potential threat to life. Such immunocompromised children have a high risk of developing severe malaria and possible death.⁵ The current Ethiopian recommendations for malaria testing among malnourished children are to restrict testing to those who present with fever.⁶ It is thus possible that malnourished children who do not have fever, but

who do have malaria parasitaemia, might be missed and therefore be deprived of anti-malarial treatment.

In Médecins Sans Frontières (MSF) supported nutritional centres in southern Ethiopia, all children, irrespective of presence or absence of fever, were systematically tested for malaria using Paracheck *Pf*® (Orchid Biomedical Systems, Bambolim, India), a rapid diagnostic test (RDT) for malaria. Such an approach was felt relevant to rationalise the use of the newer artemisinin-based anti-malarial treatment.⁵ We hypothesised that malnourished children who present without fever might actually have malarial parasitaemia and might be missed and go untreated under the current national guidelines. However, not all children with fever have malaria. It should be standard procedure in all nutritional units to measure and record body temperature. If a child has fever and is Paracheck-negative, this should prompt the clinician to search for underlying conditions other than malaria.

Using routine data from MSF nutritional centres, we conducted the present study to determine 1) the frequency of temperature recording under routine programme conditions, 2) the proportion of malnourished children with and without fever who had falciparum malaria, and 3) the association between malaria and grades of malnutrition.

METHODS

Design

This was a retrospective analysis of routine programme data.

Study setting and population

The study was conducted in 48 MSF nutritional rehabilitation centres, established in collaboration with the Southern Nation Nationalities and Peoples' Regional Health Bureau in southern Ethiopia. All malnourished children aged <15 years admitted to nutritional centres between June and November 2008 were included.

Nutritional rehabilitation was offered through two kinds of nutritional centres: the so-called 'stabilisation centres', located close to established health facilities and used to manage severely malnourished children with medical complications, and 'ambulatory centres' catering to moderate to severely malnourished children without medical complications. Individuals were assessed for malnutrition in health facilities using internationally recognised standard criteria,^{7,8} and admitted to one of the two centres mentioned above.

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ACKNOWLEDGEMENTS

The authors thank the Médecins Sans Frontières (MSF) Operational Centre Brussels field team, and in particular the data encoders. They also thank the Ethiopian Health and Nutritional Research Institute and Southern Nation Nationalities and Peoples' Regional Health Bureau for their collaboration. This research was supported by an operational research course jointly developed and run by the Centre for Operational Research, International Union Against Tuberculosis and Lung Disease, France, and the Operational Research Unit, MSF, Brussels. The study was funded by the MSF Operational Centre Brussels.

KEY WORDS

Ethiopia; malaria; malnutrition; temperature; rapid diagnostic test

Received 9 June 2011

Accepted 22 August 2011

Malnutrition was graded as mild, moderate or severe.^{9,10} On admission, all children were assessed clinically and their temperatures recorded using a standard mercury thermometer. They were then offered an empirical package, including a single course of a broad-spectrum antibiotic, a single dose of vitamin A, vaccination for measles, a course of de-worming and folic acid prophylaxis. Systematic screening for *Plasmodium falciparum* malaria was performed for all children on entry into the nutritional programme using an RDT (Paracheck). Children with a positive RDT were treated with artemisinin-based combination anti-malarial treatment (artemether-lumefantrine combination, Coartem®, Novartis, Basel, Switzerland) for 3 days.

Data collection and statistical analysis

Data from treatment cards were collected between September 2010 and March 2011, and entered into a Microsoft Excel spreadsheet (Microsoft, Redwoods, WA, USA). Data included the variables age, sex, grade of malnutrition, whether body temperature was measured and recorded on admission and Paracheck *Pf* results. Data were analysed using EpiData 3.1 software (EpiData Association, Odense, Denmark). The χ^2 test for trend was used to test for linear relationships.

Ethics approval

Formal approval for this study was obtained from the Scientific and Ethical Review Committee of the Ethiopian Health and Nutrition Research Institute, the MSF Ethical Review Board and the Ethics Advisory Group of the International Union Against Tuberculosis and Lung Disease.

RESULTS

A total of 19 200 malnourished children were admitted into the nutritional programme, of whom 2484 (13%) were excluded as they did not have a recorded Paracheck result. Of the remaining 16 716 children included in the study, 7412 (44%) were male; the mean age of all admitted children was 4.4 years. Of the children included in the study, 38% were severely malnourished, 35% were moderately malnourished and 27% had mild malnutrition with medical complications.

Of the 16 716 children admitted to the nutritional centres, body temperature was not recorded in 15 248 (91%) of cases. The relation between Paracheck results and presence or absence of fever is shown in Table 1. Among those with fever, 28% were positive for malaria, while 10% of those with no fever were positive for malaria. There was a highly significant linear association between malaria prevalence and increasing grades of malnutrition (χ^2 for linear trend 78, $P < 0.001$; Table 2).

TABLE 1 Relation between recorded body temperature and malaria among malnourished children in nutritional centres, southern Ethiopia

Temperature >37.5°C	Malaria* n (%)	Total
Yes	57 (28)	206
No	122 (10)	1 262
Unrecorded	1174 (8)	15 248
Total	1353 (9)	16 716

*Paracheck *Pf*-positive.

TABLE 2 Relation between grades of malnutrition and malaria prevalence in southern Ethiopia

Malnutrition	Total n	Malaria*† n (%)
Mild	3767	184 (5)
Moderate	5986	480 (8)
Severe	6399	632 (10)

*Paracheck *Pf*-positive.

† χ^2 for linear trend 78, $P < 0.001$.

DISCUSSION

This study showed that although noting body temperature should be an essential part of standard admission procedures in nutritional centres, in practice this vital sign was not recorded for the great majority of children in our programme. The study also confirms the value of universal malaria RDT screening for malnourished children, especially those with higher degrees of malnutrition, in this setting of relatively high falciparum malaria prevalence.

The strengths of the study include 1) the large study size, 2) data from a programme setting—the findings are thus likely to reflect the operational reality on the ground, and 3) the fact that this is one of the first studies to look at temperature recording in a setting that offered systematic RDT screening for malaria. We also adhered to the STROBE (strengthening the reporting of observational studies in epidemiology) guidelines.¹¹

This study highlights a number of important operational findings. First, the great majority (72%) of malnourished children with fever did not have malaria on screening. It is common clinical practice in malaria-endemic areas to prescribe an empirical course of antimalarial treatment for all individuals who present with fever.¹² This is based on the simple assumption that the most common cause of fever is malaria and thus antimalarial treatment might be justified. The findings of this study provide evidence to the contrary, and in particular that the empirical use of artemisinin-based combination antimalarial treatment is irrational, a waste of resources and a likely contributor to the development of drug resistance.

Second, a malaria RDT that is negative in a child with fever is a 'red flag' sign that should alert the clinician to other underlying causes. In this regard, the fact that the great majority of children in the programme setting did not have their temperatures recorded is an important shortcoming in clinical practice. It is possible that clinical and nursing staff assume that malaria screening using an RDT makes the task of measuring temperature unnecessary. This perception needs to be revised through better training, education, communication and supervision so that routine monitoring and recording of temperature in all malnutrition cases become standard practice. The use of mercury thermometers, which are difficult to read and are time consuming to use, is inappropriate in busy nutritional centres, and this might also have contributed to a failure in measuring and recording temperature. The change to rapid, user-friendly digital thermometers should help alleviate this problem; this has already taken place in the programme setting.

Third, 10% of the children without fever actually had malaria. In the absence of an RDT, such children will not receive antimalarial treatment. Under current Ethiopian national guidelines, which recommend the use of RDTs only for children with fever, such children would be missed. In our study setting of about 20 000 children, this implies that nearly 2000 children with malaria would

not receive treatment. The lack of antimalarial treatment in such children could result in progression to severe malaria and potentially lead to death. The association demonstrated between increasing grades of malnutrition and malaria prevalence is very likely related to increased malarial susceptibility in the more malnourished groups due to compromised immunity.^{2,13} In children with severe malnutrition, the need to administer a malarial RDT is thus even more important.

The limitations of this study include the reliance on Paracheck as an RDT, which detects primarily *P. falciparum*,¹⁴ and malaria due to other malarial parasites might thus have been missed. Furthermore, our analysis of the relation between fever and malaria meant the exclusion of a large proportion of children without temperature recordings. Despite these limitations, this study highlights a number of important operational shortcomings, and measures have been taken to correct these.

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Contexte : Quarante-huit centres de réhabilitation nutritionnelle dans le Sud de l’Ethiopie.

Objectif : Déterminer 1) la fréquence de l’enregistrement de la température dans les conditions du programme, 2) la proportion d’enfants en état de malnutrition avec ou sans température et atteints de malaria due à *Plasmodium falciparum* et 3) l’association entre la malaria et le degré de malnutrition.

Schéma : Analyse rétrospective de données de routine du programme.

Résultats : Au total, il y a eu 19 200 enfants en état de malnutrition parmi lesquels 16 716 (âge moyen 4,4 ans, 7412 de sexe masculin) ont subi un test rapide de diagnostic de la malaria (Paracheck Pf®). Parmi ceux-ci, la malnutrition a été classée comme grave (38%), modérée (35%) et légère (27%). La température n’a pas été enregistrée

Marco de referencia: Se estudiaron 48 centros de rehabilitación nutricional en el sur de Etiopía.

Objetivo: Determinar: 1) la frecuencia de registro de la temperatura en las condiciones del programa nutricional; 2) la proporción de niños desnutridos que presentaban fiebre o sin ella y que sufrían de paludismo por *Plasmodium falciparum*; y 3) la correlación entre el paludismo y el grado de desnutrición.

Métodos: Fue este un análisis retrospectivo de los datos corrientes del programa nutricional.

Resultados: Se encontraron 19 200 niños desnutridos (el promedio de la edad fue 4,4 años y 7 412 niños eran de sexo masculino) y 16 716 de ellos contaban con una prueba rápida de diagnóstico de paludismo (Paracheck Pf®). La desnutrición de estos niños se clasificó como grave en 38%, moderada en 35% y leve en 27% de ellos. No

chez 15 248 enfants (91%). La prévalence de la malaria due à *P. falciparum* a été de 9%. La malaria a été diagnostiquée chez 57 enfants (28%) souffrant de fièvre ($n = 206$) et chez 122 enfants (10%) non fébriles ($n = 1262$). On a noté une association significative entre la prévalence de la malaria et la gravité de la malnutrition : le test Paracheck Pf a été positif respectivement chez 5%, 8% et 10% des enfants atteints de malnutrition légère, modérée ou grave (χ^2 pour la tendance 78 ; $P < 0,001$).

Conclusions : Cette étude démontre la valeur d’un dépistage de la malaria en routine chez les enfants en état de malnutrition, particulièrement chez ceux où la malnutrition est grave, qu’il y ait fièvre ou non. Les déficiences opérationnelles sont soulignées et les façons d’y répondre à l’avenir font l’objet de la discussion.

se consignó la temperatura de 15 248 niños (91%). Se estableció el diagnóstico de paludismo en 57 de los niños con fiebre ($n = 206$, 28%); y en 122 niños que no presentaban fiebre ($n = 1262$, 10%). La prevalencia de paludismo causado por *P. falciparum* fue 9%. Se observó una correlación estadísticamente significativa entre la prevalencia de paludismo y el grado de desnutrición: la prueba Paracheck Pf fue positiva en 5% de los niños con desnutrición leve y en 10% de los niños con desnutrición grave (χ^2 de la tendencia lineal 78; $P < 0,001$).

Conclusión: El presente estudio pone en evidencia la utilidad de la detección sistemática del paludismo en los niños desnutridos, sobre todo en los niños con los grados más graves de desnutrición, independientemente de la presencia de fiebre. Se señalan las deficiencias en el manejo y se proponen las formas de dar respuesta a estos problemas.