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Anaemia and malnutrition in children aged 0–59 months on the Bijagós Archipelago, Guinea-Bissau, West Africa: a cross-sectional, population-based study

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Abstract

Background—Childhood malnutrition is the leading risk factor for the global burden of disease. Guinea-Bissau is a politically unstable country with high levels of childhood malnutrition and mortality.

Aim—To determine the nutritional status of children on three remote islands of the Bijagós Archipelago, Bubaque, Rubane and Soga, and to identify factors associated with malnutrition and anaemia in this population in order to provide a baseline for future public health interventions.

Methods—A cross-sectional, population-based, door-to-door household survey of randomly selected households was undertaken to collect data on children aged 0–59 months (n=872). Dietary information was collected using a validated questionnaire. Anthropometric measurements were collected using World Health Organization techniques. Capillary blood samples were analysed using a Hemocue®, with anaemia defined as Hb<11 g/dl.

Results—The prevalences of stunted, wasted and underweight children were 21.8%, 9.4% and 3.7%, respectively. These figures indicate moderate chronic malnutrition. The significant predictor variables for stunting were: age in months (OR 1.03), rural residence (OR 2.32), anaemia (OR 3.55) and residence on Soga island (OR 0.44). Stunting was more prevalent in males (25.4%) than in females (18.6%) (P=0.03). The prevalence of anaemia was 80.2%. Age (OR 0.96), male gender (OR 1.81) and stunting (OR 2.87) were significant predictors. The Minimum Acceptable Diet was achieved by only 8.7% of children.

Conclusion—The prevalence of malnutrition on the Bijagós Archipelago is less than half that on the mainland. This study is the first to determine the prevalence of anaemia in Guinea-Bissau, which, at 80.2%, is of severe public health concern. Future research should focus on the aetiology

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of stunting and anaemia, especially the contribution of infectious diseases and mother–child interaction. Iron supplementation should be strongly considered in this population.

Keywords

Child nutrition; Malnutrition; Nutritional status; anaemia; Guinea-Bissau; Bijago´s Archipelago

Introduction

Childhood malnutrition is an important indicator of the health of a population. A worldwide analysis recently identified childhood malnutrition as the leading risk factor for the global burden of disease.[1] The United Nations (UN) highlight this burden in the Millennium Development Goals which aim to halve the number of malnourished children by 2015.[2] It is estimated that 56% of childhood deaths worldwide are attributable to the potentiating effects of malnutrition, with 83% of these arising from the mild-to-moderate form rather than the severe form.[3]

Childhood malnutrition can have long-term physical and cognitive repercussions. The literature indicates that both fetal and childhood malnutrition have a marked effect on adult anthropometric outcomes.[4] Furthermore, malnourished children display a reduced immune response compared with their well nourished counterparts.[5] This increases susceptibility to and mortality from communicable diseases such as malaria, human immunodeficiency virus (HIV) and helminth infections.[6–10] Conversely, such communicable diseases can also precipitate childhood malnutrition.[6,7] The manifestation of malnutrition can be witnessed in terms of micronutrient deficiencies, anaemia and anthropometric measurements.

Childhood malnutrition also has significant economic repercussions. Evidence suggests that productivity is decreased in individuals who have experienced childhood malnutrition.[11] A Zimbabwean study demonstrated a causal relationship between suboptimal pre-school nutritional status and an estimated loss of lifetime earnings of at least 7–12%.[12] Childhood malnutrition is perhaps the greatest public health concern in Africa, with 60 million pre-school children displaying stunted growth, a figure which is set to rise to 64 million by 2020.[13] Consequently, there is a pressing need to identify children at risk of malnutrition and institute effective nutritional supplementation programmes.

Guinea-Bissau is a small West African country with a history of civil war and political instability. As a result, there is a paucity of epidemiological data on the nutritional status of children. A MEDLINE search identified five studies which included anaemia in Guinea-Bissau (search terms: anaemia and Guinea-Bissau). These studies highlight the fact that anaemia increases mortality after discharge from hospital[14] and is associated with malaria,[15] tuberculosis[16] and maternal mortality.[17] The findings of another study indicate a low prevalence of haemoglobinopathies in this population.[18] At the time of writing, no studies have investigated the prevalence of childhood anaemia in Guinea-Bissau. Current prevalence estimates are based on the WHO Global Database on Anaemia in which a regression model estimates the prevalence to be 74.9% (95% CI 40.3–93.0).[19]

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The majority of recent anthropometric data from Guinea-Bissau arise from two Multiple Indicator Cluster Surveys (MICS) carried out by UNICEF in 2000[20] and 2006.[21] These surveys include a nation-wide assessment of the nutritional status of children under 5 years of age. The 2006 results indicate that 48% of children are stunted, 17% are underweight and 9% are wasted.[21] These high figures are even more marked in rural areas.[21] Wasting and stunting are validated markers of acute and chronic malnutrition, respectively.[22] The MICS 2000 sample population contained anthropometric data on 5856 children under the age of 5.[20] Only 176 of these children were from the remote islands of the Bijagós Archipelago.[20] For social, ethnic and cultural reasons related primarily to geographical isolation, the population of these 21 islands is distinct from that of the mainland. The MICS were not sufficiently powered to identify differences in the nutritional status of children between individual villages on the islands, or indeed between whole islands. This cross-sectional study on the three islands of Bubaque, Rubane and Soga aimed to address this scarcity of information.

Methods

Guinea-Bissau has a Human Development Index (HDI) of 0.353 and is ranked 176/187 countries worldwide.[23] The under-5 mortality rate is 203/1000 live births and it is estimated that almost 50% of the population is under 15.[24] The Bijagós Archipelago has a population of 32,424 and the inhabitants are predominantly hunter-gatherers and fishermen. The central islands of Bubaque (6427), Soga (842) and Rubane (165) have a combined population of 7434 distributed across 21 rural villages and in Praça (a semi-urban area of Bubaque divided into six areas). Owing to the extreme remoteness of the other islands, this research was focused on these three islands.

The study population was children aged 0–59 months. This age range was used in the WHO Multicentre Growth Reference Study (MRGS) on which the Child Growth Standards are based.[25] Furthermore, children under 5 years of age are particularly vulnerable to the adverse effects of malnutrition.[26] Premature children were analysed according to postnatal rather than gestational age as the latter was largely unknown by mothers owing to limited access to medical care during pregnancy.

Sampling strategy

The nationwide prevalence of stunting (48%) was used to determine the required sample size.[21] A sample of 384 children was required to enable estimation of the proportion of children who were stunted with 5% precision at the 95% confidence level. Allowing for a 5% refusal rate, the total required sample size was 404 children. The 2009 census identified 1021 children aged 0–59 months on Bubaque, Rubane and Soga.

A household list generated through a concomitant population-based trachoma survey being conducted in the same population was used to identify house-holds within each village. The locally accepted definition of a household as ‘individuals who are fed from the same cooking pot’ was used. This definition has been used by other epidemiological surveys in the region and assumes shared activities as a unit.[27] Sixty per cent of households were selected

using a random number generator to satisfy the sample size calculation and ensure geographical representation of smaller villages.

Household exclusion criteria were: (i) households with no children aged 0–59 months, and (ii) house-holds in which the mother/primary caregiver was absent on three separate visits; the child exclusion criterion was children whose year of birth was unknown (n=7).

A randomly generated reserve household list was used in these instances. Participants were recruited by door-to-door visits between January and March 2012. Because of poor infrastructure and high levels of illiteracy, this was the most appropriate and acceptable method of data collection.

Data collection

Dietary information—This was obtained through a validated questionnaire, translated into Portuguese and administered in the local language (either Kriolu or Bijagó s). This questionnaire had been used in previous demographic health surveys in Guinea-Bissau.[28] The dietary questions provided information on the minimum acceptable diet (Fig. 1). This is a validated indicator that provides essential baseline information before the implementation of a nutritional programme[28,29] which might have special importance on the Bijagós Archipelago owing to the impact of geographical isolation on food availability and diversity.

Anthropometric measurements—For children <2 years of age, length was measured with the child supine on a length board (range 30–110 cm). The height of children >2 years of age was measured using a Leicester Height Measure (range 20–207 cm). Length/height was measured to the nearest 0.1 cm. Weight was measured to the nearest 0.1 kg using portable electronic scales (Seca 803, Hamburg, Germany). For children who were unable to stand unsupported, the Tared weighing procedure was used: the mother was weighed, the scales zeroed and the infant was handed to her.[30] Children wore only light clothes and no shoes. These were the methods used in the MICS, rendering the results directly comparable with those on the mainland. They are more sensitive and specific in identifying malnutrition than mid-upper-arm circumference (MUAC).[22] All data collectors were trained by staff at the Medical Research Council in The Gambia and they were at all times observed by the study coordinators, ensuring methods were standardised throughout. Z-scores were calculated according to WHO Child Growth Standards' median height-for-age (HAZ), weight-for-age (WAZ), weight-for-height (WHZ) and BMI-for-age (BMIAZ) (Fig. 1).[31] Physical examination was also undertaken to identify signs of acute malnutrition (oedema, hair loss, hair/skin discolouration, nail signs).

Biological measurements—Capillary haemoglobin (Hb) concentration is the most reliable indicator of anaemia[19] and was measured in children aged 6–59 months using a Hemocue® 201+ (Hemocue®AB, Sweden). In this age group, anaemia is defined as a Hb concentration <11 g/dl.[19] There is no specified cut-off point for anaemia in children <6 months so they were excluded.[19] The Hemocue® has been validated by WHO as comparable to the cyanmetha-globin method and is highly suitable for use in the field owing to its compact size.[32] A paediatric lancet was used to obtain three drops of capillary blood from the middle finger. The first two drops were discarded and the third drop was used to fill

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the microcuvette. As the Bijagós Archipelago is at sea level, no adjustment was needed to account for the effects of altitude. For practical purposes, it was only possible to select three of six areas of Prac¸a for Hemocue testing. These were selected using a random number generator.

Data handling

Anthropometric data were entered into the WHO Anthro Software (WHO, Geneva, Switzerland) and Microsoft Excel (Microsoft, Redmond, Washington, USA). Data were transferred to SPSS 19 (IBM, New York, USA) for statistical analysis. Participant identifying details were made anonymous from the outset.

Statistical analysis

The distribution of haemoglobin values was non-normal (K-S, P=0.001); therefore, data were log-transformed and subsequently analysed using the independent t-test to determine differences between demographic groups. Univariate regression models were used to determine potential predictor variables of stunted growth and anaemia. Variables demonstrating significance at the $P<0.05$ level were entered into two separate forward logistic regression models. Owing to the small sample sizes in individual villages, statistical analyses of geographical differences were limited to rural/semi-urban residence and island of residence.

Results

Socio-demographics

A total of 545 households participated in the study. Within this sample, 958 children satisfied the inclusion criteria but 86 children were absent on all visits. A total of 872 children participated in the study, providing a response rate of 91%, and 415 (47.6%) were male (Table 1). The majority of participants resided on Bubaque (743, 85.2%), with 107 (12.3%) and 22 (2.5%) from Soga and Rubane, respectively. A total of 437 (50.1%) participants resided in Praça, with the remaining 435 (49.9%) distributed between the 21 rural villages. The mean (SD) age of participants was 27.8 (16.8) months.

Anthropometric measurements

The overall prevalence of malnutrition indicators were: wasting 3.7% (95% CI 2.4–5.1), underweight 9.4% (95% CI 7.4–11.4), stunting 21.8% (95% CI 19.0–24.7), and thinness 3.2% (95% CI 1.9–4) (Fig. 2). The prevalence of stunting was 6.2% (95% CI 5.5–11.7%) higher in males (25.4%) than in females (19.2%) (χ^2=4.65, P=0.03). In the rural villages the prevalence of stunting was 9.9% (95% CI 4.3–15.3) higher (27.1%) than that in semi-urban Praça (17.2%) (χ^2=12.06, P=0.001). Within individual villages, this ranged from 6.3% (1/16, 95% CI 0–21.2) in Ancamona to 100% (3/3, 95% CI 83.3–100) in Anhimango. The prevalence of stunting was 22.7% on Rubane (95% CI 10.1–33.4), 22.6% on Bubaque (95% CI 19.7–25.8) and 18.9% (95% CI 12.6–27.4) on Soga.

The prevalence of stunting increased from 8.8% (95% CI 2.4–15.2) at 0–5 months of age before peaking at 28.1% (95% CI 20.2–35.9) at 36–47 months of age, with a modest

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decrease to 24.1% (95% CI 16.7–31.5%) in the 48–59-month age bracket. This was significant (Linear-by-Linear χ^2=10.9, *P*=0.001). The prevalence of underweight children followed a similar age-related trend, although did not reach significance. It was lowest at 6–11 months at 6.2% (95% CI 0.9–11.5), increasing to 12.1% (95% CI 6.3–17.8) in the 48–59 month age range. The prevalence of wasting significantly decreased with age (Linear-by-Linear χ^2=5.7, *P*=0.012) from 7.6% (95% CI 1.6–13.6) at age 0–5 months to 1.1% (95% CI 0–2.8) between 24 and 35 months, with a minor increase to 2.9% (95% CI 0–6.0) between 36 and 47 months. The prevalence of thinness also decreased significantly with age (Linear-by-Linear χ^2=4.6, *P*=0.03) from 6.5% (95% CI 2.7–14.2) at 0–5 months to 2.8% (95% CI 0.9–7.6) at 48–59 months. This relationship with age is illustrated in Fig. 3 in those children aged 6—59 months who were also tested for anaemia.

The prevalence of physical signs of acute malnutrition was very low. Overall, five children demonstrated one or more signs (hair loss 3, skin discolouration 2, nail signs 1). No child displayed oedema.

Results of the univariate analyses shown in Table 2 indicate that male gender, age, rural residence and anaemia were associated with stunted growth. Three of these factors remained significant in the forward stepwise logistic regression displayed in Table 3. The significant predictor variables were: age in months (OR 1.03, 95% CI 1.01–1.04, *P*=0.001), rural residence (OR 2.32, 95% CI 1.42–3.80, *P*=0.001), anaemia (OR 3.55, 95% CI 1.78–7.08, *P*=0.001) and residence on the island of Soga (OR 0.44, 95% CI 0.22–0.90, *P*=0.023). The model could only account for 10.2% of variance in the outcome variable. Whilst male gender was associated with a 1.4-times greater risk of stunting by univariate analysis (*P*=0.031), because of the confounding effects of anaemia, it was not a statistically significant predictor of stunting by multivariate analysis.

Minimum acceptable diet

Only 8.7% (26/300, 95% CI 6.0–12.4) of children satisfied the criteria for the Minimum Acceptable Diet. The minimum dietary diversity was achieved by 13.7% of children (41/300, 95% CI 10.2–18.0) and the minimum dietary frequency by 34.0% of children (102/300, 95% CI 28.9–39.5). The most commonly consumed foods were bread, rice and grains (717/732, 98.0%, 95% CI 96.7–98.8); fish and shellfish (641/732, 87.6%, 95% CI 85.0–89.8); and others (431/732, 58.9%, 95% CI 55.3–62.4) (primarily palm nuts/oils); vitamin A-rich fruits (133/732, 18.2%, 95% CI 15.6–21.1); other fruits and vegetables (172/732, 23.5%, 95% CI 20.6–26.7) (mainly cashews, beans and other nuts (55/732, 7.5%, 95% CI 5.8–9.7); dark green leafy vegetables (50/732, 6.8%, 95% CI 5.2–8.9); and eggs (44/732, 6.0%, 95% CI 4.5–8.0).

Anaemia

Within the 24 villages/semi-urban areas selected, 626 children were eligible for Hemocue testing; parental consent was declined for 82 children. A total of 47 children were absent on all visits and the Hemocue was unavailable for 57 tests. Haemoglobin testing was therefore undertaken on 440 children, 353 of whom were anaemic (80.2%, 95% CI 76.3–83.7). The distribution of haemoglobin values was non-normal (Kolmogorov–Smirnov, *P*=0.001) with a

negative skew. The distribution of values stratified by age and gender is shown in Fig. 4. The median haemoglobin concentration was 9.9 g/dl (IQR 1.9, range 4.8–13.5 g/dl). Following log-transformation, haemoglobin concentrations were significantly lower in males (median 9.7 g/dl, IQR 1.9) than in females (median 10.1 g/dl, IQR 1.8) (t -2.93, P=0.003), with a respective anaemia prevalence of 84.7% (95% CI 79.2–88.9) and 76.0% (95% CI 70.0–81.1). Haemoglobin concentrations were lowest in the 6–11-months age-group (n=46, median 9.0 g/dl, IQR 1.8) and highest in the 48–59-months age-group (n=88, median 10.4 g/dl, IQR 2.1). This difference was significant (t 5.09, P<0.001). The corresponding prevalence of anaemia was 95.7% (95% CI 85.5–98.8) and 63.6% (95% CI 53.2–72.9), respectively. This temporal relationship is presented in Fig. 3. Of the 440 children tested, 87 (19.8%, 95% CI 16.3–23.8) were non-anaemic (Hb ≥ 11g/dl), 127 (28.9%, 95% CI 24.8–33.3) were mildly anaemic (Hb 10–10.9 g/dl), 213 (48.4%, 95% CI 43.8–53.1) were moderately anaemic (Hb 7–9.9 g/dl) and 13 (3.0%, 95% CI 1.7–5.0) were severely anaemic (Hb <7 g/dl).

Table 2 displays the results of the univariate analyses, indicating that male gender, age and stunting were all associated with anaemia. Each of these factors remained significant in the multivariate regression shown in Table 3. Age (OR 0.96, P<0.001), male gender (OR 1.81, P=0.022) and stunted growth (OR 2.87, P=0.002) accounted for 15% of the variability of anaemia.

Discussion

The rationale that underpinned this survey was aimed at identifying nutritional patterns and comparing them with those on the mainland. In this population, the prevalence of stunting was 21.8%, which is classified by WHO as a medium prevalence. The values for underweight and wasted children were 9.4% and 3.7%, respectively, both of which are considered low.[33] These results are substantially below the corresponding MICS estimated national prevalences for 2006 of 48%, 17% and 9%.[21] The minimal prevalence of wasting combined with the almost complete absence of physical signs of malnutrition indicates that acute severe malnutrition was not a problem in this population at the time of data collection. By contrast, mainland areas of Guinea-Bissau demonstrate prevalences ranging from 3.7 to 14.3%.[20] These results reinforce the hypothesis that the nutritional status of children on these islands is less severe than that on the mainland, and it is likely that dietary components are implicated, although future research is required to corroborate this. Fish and shellfish are one of the main dietary components on the islands and they are known to be protective against protein-energy malnutrition.[34] Instead, this population demonstrates an underlying burden of chronic malnutrition, represented by the 21.8% prevalence of stunting. The aetiological triad of nutrition, infection and mother–child interaction are the primary factors known to cause stunted growth.[35] The multi-factorial aetiology of stunting is illustrated in the logistic regression in Table 3, accounting for only 10.2% of the variability in stunting, implying that other factors are responsible. Future research should seek to identify the exact contribution of nutrition, infectious diseases and the mother–child interaction as aetiological factors for stunting in this population.

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The complex interplay between age and the various indicators of malnutrition warrants discussion. The tendency for the prevalence of stunted and underweight children to increase between 6 and 47 months of age is in keeping with the literature,[33] as this is when infants are highly vulnerable to poor linear growth.[36] The prevalence of anaemia appears to be inversely related to the prevalence of stunting (as shown in Fig. 3). It could be inferred, therefore, that low haemoglobin concentrations potentially contribute towards stunting in this population. The results of logistic regression consolidate this, anaemic children being 3.55 times more likely to display stunted growth than their non-anaemic counterparts. This hypothesis is reinforced by the literature which indicates that anaemia impairs the physical growth of children[37,38] and, indeed, that iron supplementation is effective in reducing stunting.[38,39] It is possible, however, that this trend in the prevalence of anaemia is one of the natural sequalae of a period of high growth velocity in infancy which also corresponds to a coincidental increase in the prevalence of stunting. The negatively skewed distribution of haemoglobin concentrations illustrated in Fig. 4[40] has been attributed to some severely low values. The trend for younger children to be more susceptible to anaemia has also been demonstrated previously.[41] The high prevalence at a young age is likely to reflect inadequate fetal iron stores secondary to maternal anaemia.[41] This merits further research because if there is indeed maternal iron deficiency, antenatal iron supplementation may be an effective and safe means of reducing the burden of childhood anaemia.

In this study, males were more susceptible to stunting than their female counterparts. This tendency is well recognised in the literature,[42–44] although it is interesting that this disparity was not seen in the nationwide data from the 2006 MICS.[21] There have been several speculations as to the cause of this disparity. In sub-Saharan Africa, these include historical social factors that lend females slight anthropometric advantages over males because of their potential for work in the agricultural sector.[45] Physiological explanations include males being more predisposed to symptomatic and asymptomatic morbidity, which ultimately results in stunting.[46] A further possible explanation is linked to the propensity of males to have lower haemoglobin concentrations than females (median Hb 9.7 g/dl *vs* 10.1 g/dl). Hence, male gender was not a significant predictor of stunting in this study once the confounding effects of anaemia were accounted for in the multivariate analysis. There are conflicting reports in the literature: a body of research corroborates this gender disparity[47–50] while others refute it.[41,51] It has been proposed that males display faster growth velocity accompanied by an increased demand for iron.[52] This, in turn, has the potential to exacerbate levels of anaemia and contribute to stunted growth. This study supports the idea that anaemia is more prevalent in males, although the implications for this population are negligible as the difference in haemoglobin concentrations is of biochemical but not clinical significance.

There was a surprising degree of variability between individual villages in this study. For example, the prevalence of stunting ranges from 6.3 to 100% and the prevalence of anaemia from 58.3 to 100%. These values demonstrate that some villages are more worthy of attention from healthcare services than others, although caution must be exercised when interpreting prevalence data from the small villages. The small sample sizes limit the efficacy of statistical tests in their ability to predict whether residence in a specific village is associated with poorer health outcomes. When villages were analysed collectively, a rural-

urban disparity was identified. These results reflect the findings of the previous MICS in this respect. It is likely that socio-economic factors are responsible, although a household-level risk factor survey is needed to corroborate this hypothesis. The implications in terms of nutritional supplementation programmes are that they will be more effective if implemented in rural communities in which the burden of malnutrition is greater. Particular attention should be paid to children in the smaller villages in which there is a greater prevalence of malnutrition. Prioritising healthcare interventions is of utmost importance in such a resource-constrained environment.

Although data from neighbouring West African countries suggest that this figure is not extraordinary for the region, the WHO considers the 80.2% prevalence of anaemia to be of severe public health concern.[33] The prevalence in nearby Guinea is 79.0% and because of a paucity of data from Guinea-Bissau, the national prevalence estimated from a regression model is 74.9% (95% CI 40.3–93.0).[19] In this population, anaemia is predominantly of mild–moderate severity. Whilst such anaemia may often be asymptomatic, the exact implications in terms of its contribution to the high child morbidity and mortality in Guinea-Bissau remain unidentified. Future research should focus on this, especially in view of the protracted developmental consequences of childhood anaemia which include delayed psychomotor development, irreversible impairment of cognitive performance, decreased lifetime earning potential and increased susceptibility to infection.[37] The literature indicates that malaria and iron deficiency are the major aetiological risk factors for anaemia in much of sub-Saharan Africa,[53] although in certain regions the contribution from helminth infections is also substantial.[10] In order to effectively reduce the burden of anaemia in this population, it is essential to determine the aetiological factors responsible and it is therefore important that the appropriate follow-up research be undertaken.

Dietary patterns in this population were largely better than those on the mainland. When compared with regional data from the most recent demographic health survey in 2008 (data in brackets), the proportion of children achieving the minimum dietary diversity and frequency was 13.7% (*vs* 6.7%) and 34.0% (*vs* 22.0%), respectively. The dietary information indicates that there is a deficiency of the frequency and diversity of foods consumed by infants during the period of life when they are most vulnerable to growth insults. A potentially sustainable approach to improving food availability and diversity is the introduction to the Bijago´s Archipelago of small-scale sustainable agricultural projects.[54] Indeed, there have been attempts to install such programmes on the island of Soga, which provides a potential explanation for the significantly lower prevalence of stunting (OR 0.44, 95% CI 0.22–0.90, P=0.023). Whilst the island of Rubane had the highest prevalence of stunting (22.7%, 95% CI 10.1–33.4), this did not reach significance because of the small size of the island. Owing to the high proportion of single person households on the island, the absolute number of households containing children was low and all such houses were able to be included in the sample.

With the baseline prevalence of childhood malnutrition and anaemia established, further public health interventions could be implemented specifically to target the burden of anaemia. When the prevalence of anaemia exceeds 30%, the WHO recommends universal iron supplementation for all children aged between 6 and 59 months, irrespective of a

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diagnosis of anaemia.[37] The basis for this is two-fold: firstly, if the prevalence of anaemia in the population is 80.2%, the underlying prevalence of iron deficiency is as high as 100%;[37] secondly, screening wastes valuable resources which could be better used for preventive measures. Iron supplementation can be achieved by food fortification, although, because of the negligible amount of processed food consumed on the Bijagós Archipelago, the success of such a programme might be limited. A multi-faceted approach is more appropriate in this population and should focus on malaria and helminth control with simultaneous iron supplementation. Current recommendations are that iron therapy be commenced at 6 months of age.[37] This study, supported by others,[41,55] indicates that by this early age the prevalence of anaemia is already very high. Previous studies propose that iron supplementation be incorporated alongside the WHO Extended Program for Immunisations (EPI),[41] although, to achieve this, the WHO global guidelines need to be readdressed. Currently, there is controversy about iron supplementation in young children as it has been shown to increase susceptibility to and morbidity from infectious diseases such as malaria.[56] This creates a conundrum as childhood anaemia also has such sequelae. The authors propose therefore that future research should seek to identify whether maternal anaemia contributes to childhood anaemia. This could be superseded by an antenatal iron supplementation programme coordinated by the Ministry of Health, thus avoiding the potential harm that might arise from childhood iron therapy.

Limitations

Although, because of the large sample size, the results of this study can be considered highly representative of the nutritional status of children on Bubaque, Rubane and Soga, the results might not be applicable to the rest of the Bijagós Archipelago as anecdotal reports from the more remote islands indicate that levels of malnutrition may be higher than those reported in this study.

The cross-sectional nature of the study is a limitation, particularly in relation to the prevalence and severity of anaemia in the study population. This study was undertaken in the dry season; however, seasonal variations in anaemia prevalence are reported to coincide with the malaria season. Although most anaemia described in this study was mild-to-moderate, the scale of the problem may be underestimated.

The cross-sectional design also limits to an extent the anthropometric data. Whilst minimal signs of acute malnutrition were detected in the study population during the period of data collection, it does not follow that participants were not subjected to or indeed were not at risk of future episodes of acute malnutrition. Equally, the overall prevalence of stunting was 21.8%, ranging from 8.8% at 0–5 months of age, before peaking between 36 and 47 months of age at 28.1%. The implications are that young children, who, at the time of data collection, were not stunted, might subsequently develop stunted growth as they age. Consequently, the proportion of children who will experience stunted growth at some stage during their development is underestimated in this population.

In spite of these limitations, this is the first study to identify the prevalence of anaemia in children aged 6–59 months in Guinea-Bissau.

The study was conducted according to universally accepted protocols, and provides valuable baseline data which could lay the foundation for future public health research in this under-researched remote population. Furthermore, the contained nature of the Bijagós Archipelago provides a useful means of assessing the impact of public health interventions on a small scale, potentially before undergoing more widespread implementation.

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Minimum acceptable diet*	WHO definitions of malnutrition	
Dietary diversity is present when four of the following food group are consumed: · Grains, roots and tubers; · Legumes and nuts; · Dairy products (milk, yogurt, cheese); · Flesh foods (meat, fish, poultry, liver or other organs); · Eggs; · Vitamin A-rich fruits and vegetables; · Other fruits and vegetables.	Clinical status	Value
	Wasting	WHZ <-2
	Severe wasting	WHZ <-3
	Stunting	HAZ <-2
	Severe stunting	HAZ <-3
The minimum daily meal frequency is defined as: · Twice for breastfed infants aged 6–8 months · Three times for breastfed children aged 9–23 months · Four times for non-breastfed children aged 6–23 months	Underweight	WAZ <-2
	Severely underweight	WAZ <-3
	Thinness	BMIAZ <-2
	Severe thinness	BMIAZ <-3

* Both diversity and frequency required to satisfy minimum acceptable diet

Figure 1. Definitions of the Minimum Acceptable Diet and malnutrition

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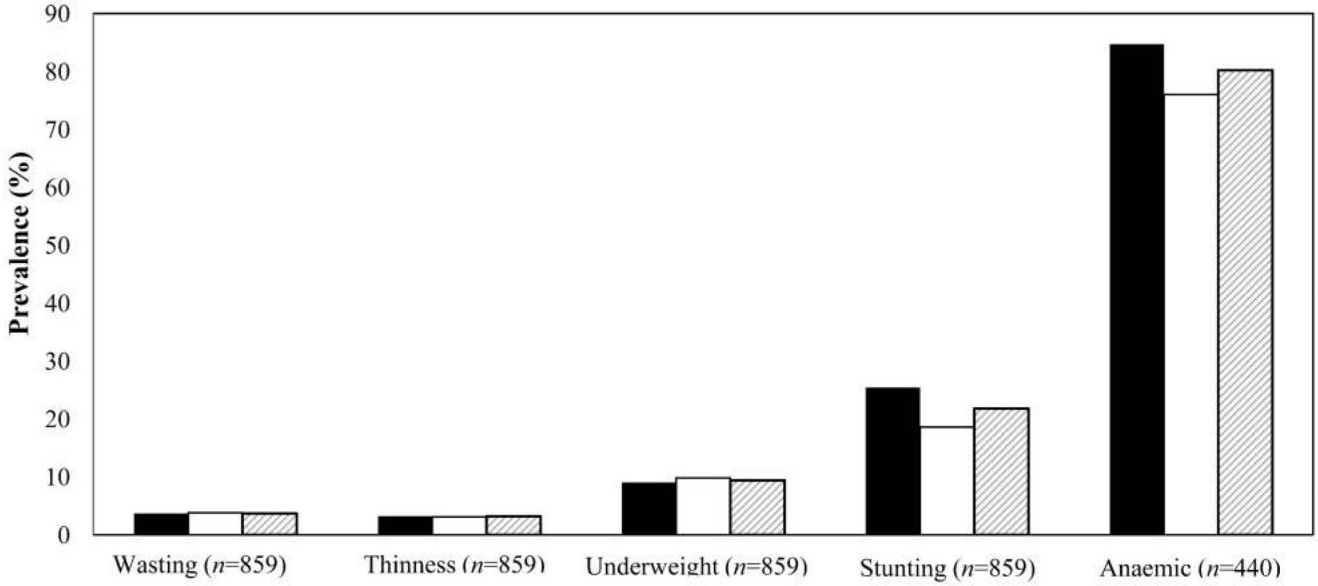

Figure 2. The prevalence of malnutrition indicators stratified by gender (male ■, female □, total ▨)

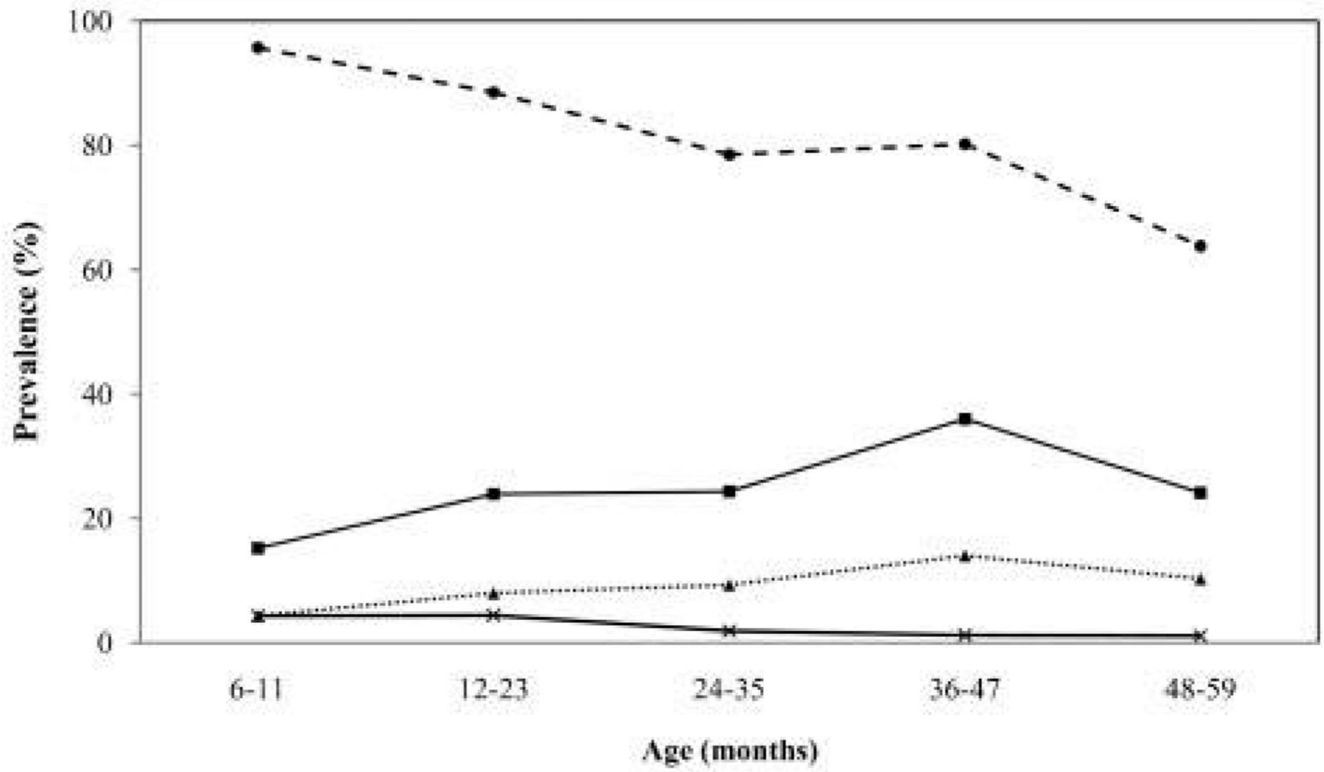

Figure 3. The prevalence of malnutrition indicators stratified by age (*n*=440: anaemic - -•- -, stunted —■—, underweight ·····▲·····, wasted —×—)

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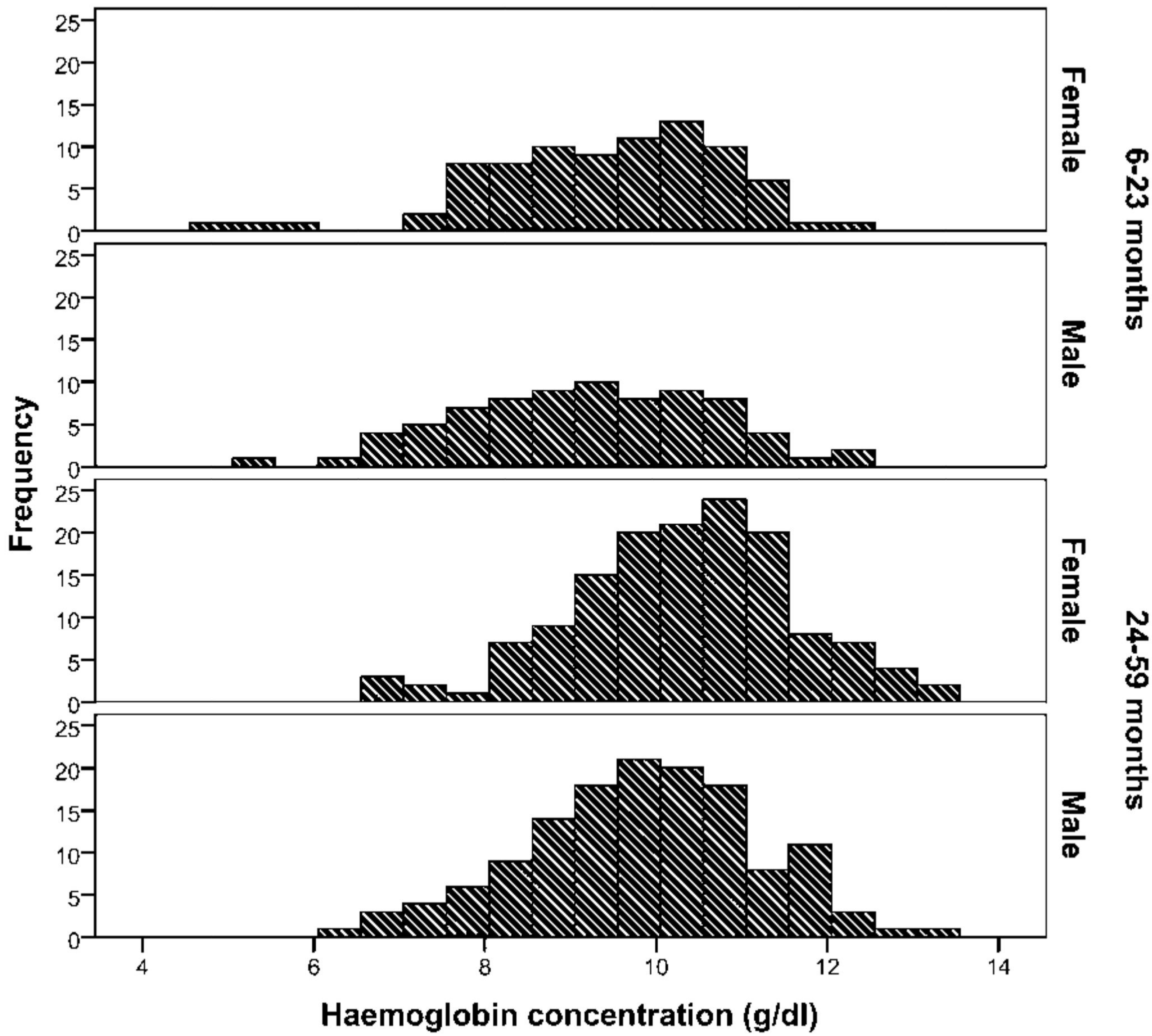

Figure 4. Haemoglobin concentrations stratified by age and gender

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Table 1

Socio-demographic characteristics of study participants

	Total sample, *n*=872			Hemocue sub-sample, *n*=440		
Socio-demographics	**Boys (%)**	**Girls (%)**	**Total (%)**	**Boys (%)**	**Girls (%)**	**Total (%)**
Island						
Bubaque	357 (48.0)	386 (52.0)	743 (85.2)	181 (50.7)	176 (49.3)	357 (81.1)
Rubane	13 (59.1)	9 (40.9)	22 (2.5)	11 (57.9)	8 (42.1)	19 (4.3)
Soga	45 (42.1)	62 (57.9)	107 (12.3)	23 (35.9)	41 (64.1)	64 (14.5)
Urban/rural						
Praça (semi-urban)	203 (46.5)	234 (53.5)	437 (50.1)	90 (47.4)	100 (52.6)	190 (43.2)
Rural village	212 (48.7)	223 (51.3)	435 (49.9)	125 (50.0)	125 (50.0)	250 (56.8)
Age, mths						
Mean [SD]	28.3 [16.6]	27.3 [16.8]	27.8 [16.8]	32.2 [15.1]	30.9 [15.2]	31.6 [15.1]
0–5	39 (41.9)	54 (58.1)	93 (10.7)	0	0	0
6–11	44 (45.4)	53 (54.6)	97 (11.1)	18 (39.1)	28 (60.9)	46 (10.5)
12–23	102 (50.2)	101 (49.8)	203 (23.3)	59 (52.2)	54 (47.8)	113 (25.7)
24–35	88 (46.3)	102 (53.7)	190 (21.8)	48 (44.9)	59 (55.1)	107 (24.3)
36–47	70 (48.3)	75 (51.7)	145 (16.6)	47 (54.7)	39 (45.3)	86 (19.5)
48–59	72 (50.0)	72 (50.0)	144 (16.5)	43 (48.9)	45 (51.1)	88 (20.0)
Total	415 (47.6)	457 (52.4)	872 (100)	215 (48.9)	225 (51.1)	440 (100)

Table 2
Univariate predictors of stunted growth and anaemia

Factors associated with stunted growth			95% CI		
Included	**B (SE)**	**Odds ratio**	**Lower**	**Upper**	***P*-value**
Male gender	-3.55 (0.17)	1.43	1.03	1.97	0.03
Age, mths	0.02 (0.01)	1.02	1.01	1.03	0.001
Rural residence	0.58 (0.17)	1.78	1.28	2.48	0.001
Anaemia	0.91 (0.33)	2.48	1.29	4.76	0.006
Residence on Rubane compared with Bubaque	-0.01 (0.52)	1.01	0.36	2.77	0.99
Residence on Soga compared with Bubaque	-0.23 (0.26)	0.80	0.47	1.33	0.38

Factors associated with anaemia			95% CI		
Included	**B (SE)**	**Odds ratio**	**Lower**	**Upper**	***P*-value**
Age, mths	-0.04 (0.01)	0.96	0.94	0.98	0.001
Male gender	0.59 (0.26)	1.81	1.53	5.86	0.02
Stunting	0.91 (0.33)	2.48	1.29	4.76	0.006
Wasting	0.92 (1.06)	2.51	0.32	19.9	0.38
Underweight	0.92 (0.54)	2.51	0.87	7.24	0.09
Rural residence	-0.27 (0.25)	0.76	0.47	1.23	0.27
Residence on Rubane compared with Bubaque	1.53 (1.04)	4.63	0.61	35.2	0.14
Residence on Soga compared with Bubaque	0.01 (0.34)	1.01	0.52	1.95	0.98

Table 3

Forward stepwise logistic regression for the prediction of stunted growth and anaemia

Significant predictors of stunted growth			**95% CI**		
Included	**B (SE)**	**OR**	**Lower**	**Upper**	***P*-value**
Constant	-3.29 (0.49)				0.001
Age, mths	0.03 (0.08)	1.03	1.01	1.04	0.001
Rural residence	0.84 (0.25)	2.32	1.42	3.80	0.001
Anaemia	1.27 (0.35)	3.55	1.78	7.08	0.001
Residence on Soga	-0.82 (0.36)	0.44	0.22	0.90	0.02

n=439; Cox & Snell 0.07; Nagelkerke 0.10; model χ^2 (5) 31.4, P<0.001.

Other non-significant factors entered into the model were residence on the islands of Bubaque and Rubane and gender.

Significant predictors of anaemia			**95% CI**		
Included	**B (SE)**	**OR**	**Lower**	**Upper**	***P*-value**
Constant	2.50 (0.35)				0.001
Age, mths	-0.05 (0.01)	0.96	0.94	0.97	0.001
Male gender	0.59 (0.26)	1.81	1.53	5.86	0.02
Stunting	1.06 (0.34)	2.87	1.46	5.62	0.002

n=439; Cox & Snell 0.10; Nagelkerke 0.15; model χ^2 (3) 43.8, P<0.001.