Socioeconomic factors associated with anemia among children aged 6-59 months in Namibia

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Abstract

Anemia remains a public health concern, and its prevalence varies between countries as well as between age, sex and levels of poverty. This study aims at examining the association between socio-demographic factors and anemia among children aged 6–59 months in Namibia. Data was extracted from the 2013 Namibian Demographic Health Survey. The association between anemia and other factors was examined with logistic regression. Results are reported in odds ratio (OR), with 95% confidence intervals (CI). In total, 1,383 children aged 6–59 months had complete data and included in the analyses. Our study shows that there is a statistically significantly increased risk of anemia among children from poorer households compared with the richest quintile. Also, there was a statistically significance supporting anemia being more common among boys than girls. There was also a statistically significant negative effect related to age. Our study shows that young children, boys and children in poorer households have an increased risk of anemia. Considering the adverse impact of anemia on child development, policies must prioritize factors exacerbating anemia risk.

Introduction

Anemia is a prevalent public health problem affecting all countries, but the greatest burden is in the developing countries, and most notably in the sub-Saharan Africa region. Children under 5 years of age are at the highest risk of anemia, and they are classified as anemic when their hemoglobin (Hb) level is below 11.0 g/dL.[1] Iron deficiency is the leading causative factor of anemia, accounting for nearly half of the anemia prevalence globally.[2,3]

Childhood anemia is a public health interest due to its irreversible impact posed on children's physical health and cognitive development. These impairments further lead to issues such as poor concentration and poor performance in school, to mention just a few.[2–6] Moreover, anemia persistently leads to increased mortality and morbidity in low-resourced countries.[7,8] Childhood anemia also comes together with economic implications, mainly increased medical care expenditure, and reduced parental productivity and wages, as it obliges parents to take care of sick children.[1,9]

Globally, anemia is estimated to affect about one-quarter of the entire population. Children below 5 years of age have the highest estimated prevalence of anemia, with reports of 42-47% being affected in Africa.[2,10] Overall, high prevalence rates are reported in the sub-Saharan Africa region, with some countries reporting prevalence above 70% in the general population.[2,11,12] Anemia is one of the diseases with the highest burden from years lived with disability (YLDs) in the region, adding up to around 2,300 YLDs per 100,000 individuals.[9]

Despite the adverse effects of anemia on child development, it is preventable and curable upon diagnosis. The commonest and most cost-effective approaches for anemia prevention include: (i) iron supplementation by tablets, (ii) dietary supplementation, and (iii) food fortification. In severe cases, blood can be transfused to resolve anemia.[3,13,14] Identifying the causative factors of anemia appropriately can ensure effective management and treatment.[14]

In Namibia, the fifth national representative Namibia Demographic and Health Survey (NDHS) 2013 estimated a prevalence of 47.5% among under-5 year-olds. This prevalence has also been consistently high in the previous years.[15] According to the World Health Organization (WHO) criteria, anemia prevalence above 40% in a population, as is the case in Namibia, is regarded a severe public health problem. Additionally, anemia is reported causing about a 2.5% reduction in adult wages, and elevated medical expenses in the country.[16] With an evident burden, information pertaining to anemia control in Namibia is reported in form of interventions targeting a reduction of anemia prevalence in children, namely: (i) expanded distribution of multi-micronutrient powders, (ii) deworming and vitamin A supplements to children under the age of 5 years every 6 months, and (iii) promoting utilization of insecticide-treated mosquito bed nets in malaria endemic areas.[17]

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Well-known risk factors include vitamin A and B12 deficiency, parasitic infections (*e.g.* intestinal parasites and malaria), and genetic factors that prevent synthesis of haemoglobin and the development of blood cells.[2–4,18,19] Furthermore, child nutritional status (stunting, wasted, or underweight) is also found to be associated with the onset of anemia.[11,20,21]

Studies examining the relationship between childhood anemia and socio-economic and demographic factors show varying results. Some studies demonstrated evidence of anemia associated with child age and sex,[8,12,20–24] with some studies also finding anemia associated with place of residence (urban or rural).[11,25,26] Maternal education and household wealth status are among factors reported to be associated with anemia among children.[18,20,21] Based on the literature, awareness does exist regarding childhood anemia and its consequences for the health and the development of children. In Namibia, little is known about the association between socioeconomic factors and childhood anemia.

Aims

This study aims to describe the association between socio-demographic factors and anemia among children aged 6–59 months in Namibia.

Materials and Methods

Study design

The NDHS aims to gather data, amongst other things, on key health indicators such as fertility, maternal and child health, and nutritional status of mothers and children, and it has been conducted four times, in 1992, 2000, 2006-2007, and 2013.[17] In our study, data from the 2013 NDHS was used.

The two-stage sampling frame used in the 2013 NDHS was mainly based on the frame for the Namibia Population and Housing Census during 2011, though with partial updates. Namibia consists of 6,102 enumeration areas (EAs), 2,818 in urban areas, with an average of 86 households in them, and 3,284 in rural areas, with an average of 74 households in them. A predefined number of urban and rural EAs within each of the 13 regions in Namibia, totaling 269 urban and 285 rural clusters, were decided before the randomization took place. Within these 26 areas, in the first stage, probability proportional to size was used to select the 554 clusters. In the second stage, 20 households were chosen with equal probability systematic sampling in each of the clusters, and the total sample size was, therefore, 11,080 households. Detailed information about the sampling methods and the entire survey can be found in the 2013/14 NDHS report.[17]

In each household, a questionnaire was used, in which all members of the household were listed, and covering information about assets, which was used to calculate a wealth index. Additionally, all women aged 15-49 years in the households responded to a face-to-face questionnaire, which included questions about their educational level, and their children's use of vitamin A supplements and deworming medication. Additional to these questionnaires, hemoglobin, height and weight of the children were measured.

Study sample

In our study children aged 6–59 months whose parent participated in the 2013 NDHS and provided information for them were included.

Hemoglobin was measured in 2,303 children aged 6 – 59 months.[17] After restricting to children who had anemia tested, their height and weight measured, and a face-to-face interview conducted with their mother, we got a total sample size of 1,537 children.

Study variables

Hemoglobin testing was performed by trained health technicians, by drawing a drop of capillary blood from a child's fingertip or heel. The blood was drawn into a micro-cuvette and analyzed with a battery portable HemoCue photometer (HemoCue AB, Ängelholm, Sweden) that displays the hemoglobin concentration. We followed the WHO criteria and defined anemia as an Hb level of $\leq$ 11.0 g/dL.[2] Height and weight were measured lying down for children below 24 months and for older children was measured standing.

In our analyses, we used sex, place of residence, age, household wealth status, maternal education, received vitamin A supplement, received deworming medication, wasted, underweight, and stunted as exposure variables. These socioeconomic variables have previously been reported as being associated with anemia in children under 5.

For the variable sex, girls were defined as the exposure group. Age was grouped as 6–11 months (reference group), 12–23 months, 24–35 months, 36–47 months, and 48–59 months. For place of residence, urban was used as reference and rural as exposure. The household wealth index was compiled in the NDHS dataset using the principle component analysis of asset variables, which are then categorized into quintiles,[17] with the highest wealth quintile as reference group. Questions about household characteristics (roofing type, flooring type, cooking fuel), possession of durable goods (bicycle, radio, television) and access to basic services (electricity, toilet, source of drinking water) were used to compile the household assets.[17] This method is considered the most reliable measure of household socio-economic position.[27] We used the lowest quintile as a reference group. Maternal education was divided into no education (defined as never went to school), primary education (attended school for 1–7 years), secondary education (attended school for 8–12 years) and higher education (attended university studies or similar) with secondary education used as the reference group. For received vitamin A supplement, received deworming medication was used as the exposure group. In our analyses, we excluded responses of *do not know* regarding vitamin A supplement and deworming medication(227 individuals and 405 individuals respectively) from analyses. Children were classified as stunted for a low height-for-age, as underweight for a low weight-for-age, and as wasted for low weight-for-height, according to the WHO child growth criteria.[17]

Statistical analyses

Descriptive statistics were performed with adjustments for the sampling weights of the NDHS. The weights are used to ensure a national representative survey sample for NDHS's two-stage stratified cluster sampling methodology, which leads to a non-proportional distribution of sample divisions across regions.[17]

Multivariable logistic regression was applied to study the association between anemia and other factors. Estimates from this were presented with odds ratios (ORs) and 95% confidence intervals (CI). Stratified estimates were applied for sex. In these analyses, 1,383 children were included, whereas 154 participants were excluded because of missing data, either for use of Vitamin A, use of deworming medicine or no data for weight and/or height.

To evaluate whether the drop-out because of lack of interview data might affect our results, a complementary analysis was performed on the 2,208 children aged 6–59 months with haemoglobin data, anthropometric data, and socioeconomic data (not including mother's education). These analyses consequently did not include the variables mother's education, vitamin A supplements and deworming medication. Furthermore, we conducted logistic regression without sample weights. This was done as the sample weights were calculated for the whole NDHS, while our study was based on a limited part of the sample due to our inclusion criteria, which meant that only mothers of 6–59 months old children with all required measurements was included. This limits our data to on average less than 2.5 children per EA in comparison to the 20 household per EA that was sampled, and this causes potential bias due to unstable sample weights.

Statistical significance was set at 0.05. The statistical analyses were performed using STATA statistical software (Version 13; The StataCorp LP, College Station, Texas). We checked whether collinearity between stunting, underweight and wasting might affect our estimates by performing analyses with one of them at a time in separate logistic regressions (results not shown). We have not evaluated whether collinearity might affect our results in any other way.

Ethical considerations

The DHS is conducted in countries with which WHO have established collaborations. Ethical clearance was obtained from WHO and the participating individual countries' ethical committees before the surveys were conducted. Informed consent was obtained from legal guardian for participation in the study before individuals were interviewed. The DHS data that was used for the current study is available freely on a public domain (downloaded from http://www.dhsprogram.com/data/dataset_admin/download-datasets.cfm) after completion of a user's agreement and the granting of access. No separate permission is required for data usage and publication.

Results

Socio-demographic characteristics of study population

A total of 1,537 children between the ages of 6 and 59 months participated. The estimated weighted prevalence of anemia was 49.6% (Table 1), which is a little higher than the previously reported 47.5% for the whole dataset.[17] More than half of the children were aged 24–59 months (60%), and there was a 51:49 ratio of girls to boys. A greater proportion of our sample resided in rural areas (56.8%). About 46.9% of the children were from households in the poorer wealth quintile, while 33.5% were from the richer quintile households. Children with mothers having secondary education (64%) were the majority in the sample, and only 6% of the mothers had no formal education. There was a good coverage of vitamin A supplement, totaling (86%). However, only (48%) of the participants had received deworming medicine. Of the children, (23%) were stunted, (14%) were underweight, and (8%) were wasted. The weighted prevalence of anemia per socio-

Table 1. Study characteristics and anemia prevalence's for groups of individuals.

Group	All n	All %	Anemia n	Anemia Weighted[a] % [95% CI]
All	1537		785	49.6 [46.5-52.6]
Age				
6-11 months	224	14.6	144	62.8 [55.0-70.0]
12-23 months	395	25.7	264	64.2 [58.7-69.4]
24-35 months	341	22.2	173	49.5 [43.4-55.6]
36-47 months	304	19.8	118	38.8 [32.6-45.3]
48-59 months	273	17.8	86	30.1 [24.2-26.7]
Sex				
Boys	751	49.0	406	52.7 [48.5-57.0]
Girls	786	51.0	379	46.5 [42.5-50.7]
Place of residence				
Urban	633	43.2	313	48.0 [43.2-53.0]
Rural	904	56.8	472	50.8 [46.9-54.6]
Household wealth status				
Richest	180	12.6	70	38.3 [31.7-45.4]
Richer	324	20.9	155	47.7 [40.5-55.1]
Middle	331	19.6	174	51.9 [45.2-58.6]
Poor	328	21.1	189	55.0 [48.6-61.2]
Poorest	374	25.8	197	50.4 [44.7-56.2]
Mother education level				
Higher	60	5.2	508	68.7 [64.4-72.7]
Secondary	964	64.3	483	50.0 [46.2-53.8]
Primary	385	24.1	210	25.4 [21.7-29.5]
No education	128	6.4	67	5.9 [4.4-7.9]
Using vitamin A supplement[b]				
Yes	1319	86.4	669	49.5 [46.1-52.9]
No	183	11.8	99	50.8 [42.5-59.0]
Don't know	25	1.7	12	41.8 [21.9-64.8]
Using deworming medicine[b]				
Yes	672	43.5	347	51.0 [46.3-55.7]
No	792	52.3	402	48.7 [44.6-52.8]
Don't know	66	4.2	34	48.4 [33.8-63.2]
Stunting[c]				
No	1,119	77.1	562	48.4 [45.1-51.9]
Yes	352	22.9	191	52.3 [46.1-58.4]
Underweight[c]				
No	1,263	85.9	649	49.3 [46.0-52.5]
Yes	208	14.1	104	49.6 [41.4-57.8]
Wasting[c]				
No	1,355	92.3	682	48.5 [45.3-51.8]
Yes	116	7.7	71	58.9 [48.4-68.6]

[a]Using sampling weights from the Namibia Demographic and Health Survey. [b]There were missing data for ten persons for "Using vitamin A supplement" and seven persons for "Using deworming medicine". [c]There were missing data for weight and/or height, and also values outside plausible limits for stunting, underweight and wasting.

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demographic factor was highest among boys (52.7%).

Associated risk factors of anemia

In our study, we found a statistically significant association between anemia and age (OR ranging from 0.21 to 0.49 between the youngest and other ages) with the exception of the comparison between the youngest and the 12–23 month-old children (Table 2). We could also show statistically significant associations with anemia for sex, with a greater risk for boys than girls (OR 0.73, CI 0.56-0.95), and household wealth status (OR ranging from 1.66 to 2.22) when comparing richest quintile with the third, fourth and fifth quintile, though only significant with third and fourth quintile).

For boys, we had a similar pattern as for the all participants, though no statistical significance for 24–35 month-old children in comparison with the youngest age group and for the third wealth quintile in comparison with the richest, and a statistically significantly increased odds for the poorest compared with the richest. For girls, the only statistically significant association with anemia was for age, also here with exception of the comparison between the two youngest groups.

Analyses of all children with anemia and without sample weights gave similar results in most cases (Table 2 and Table 3. Most notable differences from the main analyses was for analyses of the relationship between poverty and anemia for boys. For all children with anemia there was no statistical significance and also lower effect estimates than for the main analyses, while for the logistic regression effect estimates were higher and all statistically significant compared with the richest quintile.

Discussion

In our study, we could show that household wealth is a strong determinant of childhood anemia in Namibia, and that the risk of having anemia is higher among boys than girls. The link between anemia and household wealth is higher among boys than girls, where we could not even provide evidence of such association. For other factors, such as health problems related to the child's weight, we could not find evidence of associations with anemia .

In our analysis, we found the prevalence of anemia to be higher amongst very

Table 2. Factors associated with anemia among children aged 6-59 months in Namibia.

Variables	Univariable[w] OR[95%CI]	Multivariable[w] OR[95%CI]	Multivariable[nw] OR[95%CI]	Multivariable[wc] OR[95%CI]
Age (in months)				
6 - 11 (n=224)	1	1	1	1
12 - 23 (n=395)	1.06 [0.72-1.57]	0.86 [0.57-1.31]	0.89 [0.60-1.31]	0.97 [0.68-1.38]
24 - 35 (n=341)	*0.58 [0.40-0.84]*	*0.49 [0.32-0.76]*	*0.47 [0.31-0.70]*	*0.54 [0.38-0.77]*
36 - 47 (n=304)	*0.37 [0.25-0.55]*	*0.29 [0.19-0.45]*	*0.27 [0.18-0.41]*	*0.33 [0.23-0.48]*
48 - 59 (n=273)	*0.25 [0.16-0.39]*	*0.21 [0.13-0.35]*	*0.20 [0.13-0.31]*	*0.27 [0.18-0.40]*
Sex				
Boys (n=751)	1	1	1	1
Girls (n=786)	*0.78 [0.62-0.98]*	*0.73 [0.56-0.95]*	*0.75 [0.60-0.94]*	*0.83 [0.68-1.01]*
Place of Residence				
Urban (n=633)	1	1	1	1
Rural (n=904)	1.11 [0.87-1.43]	0.79 [0.56-1.10]	0.76 [0.57-1.01]	0.87 [0.64-1.18]
Wealth quintile				
Richest (n=180)	1	1	1	1
Richer (n=324)	1.47 [0.98-2.20]	1.32 [0.82-2.13]	*1.65 [1.06-2.55]*	*1.15 [0.78-1.67]*
Middle (n=331)	*1.74 [1.17-2.58]*	*1.66 [1.01-2.72]*	*2.06 [1.28-3.31]*	*1.38 [0.91-2.10]*
Poor (n=328)	*1.97 [1.33-2.91]*	*2.22 [1.28-3.84]*	*2.77 [1.70-4.53]*	*1.58 [1.02-2.46]*
Poorest (n=374)	*1.64 [1.13-2.38]*	*1.75 [0.98-3.14]*	*2.19 [1.30-3.68]*	*1.47 [0.93-2.34]*
Mother's education				
Secondary (n=964)	1	1	1	1
Higher (n=60)	0.59 [0.34-1.03]	0.81 [0.43-1.52]	1.06 [0.57-1.96]	-
Primary (n=385)	1.09 [0.83-1.44]	1.05 [0.8-1.44]	1.18 [0.89-1.56]	-
No education (n=128)	0.84 [0.55-1.29]	0.99 [0.61-1.60]	1.19 [0.77-1.86]	-
Vitamin A				
Yes (n=1319)	1	1	1	-
No (n=183)	1.05 [0.73-1.52]	1.20 [0.78-1.83]	1.23 [0.86-1.76]	-
Deworming				
Yes (n=672)	1	1	1	-
No (n=792)	0.91 [0.71-1.18]	0.79 [0.59-1.07]	0.87 [0.69-1.10]	-
Stunting				
No	1	1	1	1
Yes	1.17 [0.88-1.54]	1.08 [0.75-1.55]	1.17 [0.87-1.59]	1.15 [0.90-1.47]
Underweight				
No	1	1	1	1
Yes	1.01 [0.71-1.44]	0.98 [0.61-1.56]	0.85 [0.58-1.26]	1.03 [0.73-1.45]
Wasting				
No	1	1	1	1
Yes	1.52 [0.97-2.37]	0.88 [0.52-1.47]	0.99 [0.62-1.58]	1.10 [0.72-1.68]

[w]Sample weights from the Namibia Demographic and Health Survey 2013 applied to analyses (n=1383). [nw]Sample weights not applied for analyses (n=1383). [wc]Sample weights were applied with complimentary analyses that included all children who had been evaluated for anemia . Mother's education, use of Vitamin A medication and use of deworming medication were excluded from analyses (n=2208). Statistical significances (P<0.05) are noted in italics.

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young children (6–24 months), and the likelihood of being anemic declining with age. This can relate to the reduced iron requirements per body kg in elder children.[20] Additionally, older children have an improved chance of iron consumption with their shift in diet from complementary food to a varied diet of table food which is greater in quantity and contains more nutritious food rich in iron and vitamins.[20,26,28] Our results are similar with previous studies from other sub-Saharan African countries and elsewhere that have also reported a declining risk with increasing age.[11,20,26,28,29] These patterns indicate a need to focus anemia interventions more toward children of less than 24 months old.

That we observed a higher level of anemia among boys than girls might be attributed to the higher growth rate in boys, which increases the demand for iron in the body. Such elevated demands may be difficult to fulfil by diet.[18,25,28] Previous findings on this association vary. Several studies have reported a high risk among boys, and some studies have reported a high risk among girls, while some could not confirm a difference between the sexes.[25,30–32] Our findings are thus similar to results from other sub-Saharan African countries, Asian countries, and Brazil,[11,18,28,33–35] while differing from results from India and Timor-Leste that had found a high risk among girls.[36,37]

The increased risk of anemia related to poverty (household wealth) is consistent with the literature.[11,20,21,26,29,33,35] Our results might be explained by a poor access to nutritious meals in poor households, thus increasing the risk of anemia. Being Namibia a dry country, the majority of the population relies solely on seasonal farming. The country also has high rates of poverty and child malnutrition.[15,38] The increased risk of anemia might therefore be explained by poorer access to nutritionally good food for the poor. Interestingly, poverty only seems to affect the prevalence of anemia in boys, even if the estimates varies with the choice of analysis, where our two complimentary analyses show both more and less statistical significances than for the main analyses, and give reasons to dispute this finding. We have no good reasoning to explain these findings. Results further demonstrate the significant influence of poverty as a major social health determinant. Hence an urgent need of effective measures to reduce poverty among the population to improve access to food and nutri-

Table 3. Factors associated with anemia among girls and boys aged 6-59 months in Namibia.

Variables	Boys	Girls						
	Univariable[w] OR[95%CI]	Multivariable[w] OR[95%CI]	Multivariable[nw] OR[95%CI]	Multivariable[wc] OR[95%CI]	Univariable[w] OR[95%CI]	Multivariable[w] OR[95%CI]	Multivariable[nw] OR[95%CI]	Multivariable[wc] OR[95%CI]
Age (in months)								
6 - 11 (n=224)	1	1	1	1	1	1	1	1
12 - 23 (n=395)	1.24 [0.73-2.09]	0.92 [0.50-1.67]	0.89 [0.51-1.57]	1.05 [0.64-1.72]	0.96 [0.55-1.68]	0.82 [0.46-1.49]	0.86 [0.50-1.50]	0.91 [0.54-1.52]
24 - 35 (n=341)	0.64 [0.38-1.09]	*0.58 [0.31-1.08]*	*0.50 [0.29-0.89]*	*0.65 [0.40-1.05]*	*0.53 [0.30-0.91]*	*0.42 [0.23-0.79]*	*0.41 [0.23-0.74]*	*0.45 [0.26-0.75]*
36 - 47 (n=304)	*0.31 [0.17-0.56]*	*0.25 [0.13-0.48]*	*0.27 [0.15-0.47]*	*0.32 [0.19-0.55]*	*0.45 [0.26-0.79]*	*0.35 [0.18-0.66]*	*0.28 [0.15-0.50]*	*0.35 [0.20-0.62]*
48 - 59 (n=273)	*0.30 [0.16-0.55]*	*0.26 [0.13-0.52]*	*0.23 [0.13-0.43]*	*0.29 [0.17-0.48]*	*0.23 [0.12-0.43]*	*0.18 [0.09-0.37]*	*0.18 [0.09-0.33]*	*0.26 [0.14-0.46]*
Sex								
Boys (n=751)	-	-	-	-	-	-	-	-
Girls (n=786)	-	-	-	-	-	-	-	-
Place of Residence								
Urban (n=633)	1	1	1	1	1	1	1	1
Rural (n=904)	1.23 [0.87-1.74]	0.72 [0.45-1.15]	0.61 [0.40-0.92]	0.70 [0.47-1.05]	1.02 [0.73-1.44]	0.88 [0.57-1.35]	0.93 [0.63-1.37]	1.05 [0.71-1.58]
Wealth quintile								
Richest (n=180)	1	1	1	1	1	1	1	1
Richer (n=324)	*1.88 [1.04-3.40]*	1.65 [0.86-3.17]	*2.15 [1.17-3.95]*	1.21 [0.72-2.04]	1.15 [0.63-2.11]	1.06 [0.48-2.34]	1.22 [0.64-2.33]	1.06 [0.57-1.96]
Middle (n=331)	*2.02 [1.14-3.58]*	1.86 [0.91-3.79]	2.44 [1.28-4.66]	1.51 [0.82-2.79]	1.49 [0.79-2.79]	1.49 [0.66-3.36]	1.71 [0.85-3.45]	1.28 [0.68-2.39]
Poor (n=328)	*2.94 [1.57-5.49]*	*3.20 [1.46-7.05]*	*3.92 [1.95-7.89]*	1.88 [0.99-3.57]	1.41 [0.77-2.55]	1.60 [0.68-3.76]	1.95 [0.96-3.93]	1.36 [0.70-2.64]
Poorest (n=374)	*2.42 [1.33-4.38]*	*2.56 [1.15-5.73]*	*3.55 [1.70-7.40]*	1.84 [0.97-3.52]	1.10 [0.62-1.94]	1.14 [0.46-2.80]	1.30 [0.61-2.77]	1.19 [0.59-2.40]
Mother education								
Secondary (n=964)	1	1	1	1	1	1	1	1
Higher (n=60)	*0.32 [0.14-0.76]*	0.56 [0.24-1.34]	0.84 [0.36-1.96]	-	1.06 [0.47-2.41]	1.24 [0.50-3.11]	1.26 [0.51-3.13]	-
Primary (n=385)	1.05 [0.71-1.56]	0.94 [0.61-1.45]	1.14 [0.76-1.71]	-	1.12 [0.76-1.67]	1.18 [0.76-1.85]	1.24 [0.84-1.83]	-
No education (n=128)	1.27 [0.68-2.37]	1.30 [0.61-2.79]	1.55 [0.78-3.07]	-	0.58 [0.31-1.07]	0.75 [0.41-1.40]	0.95 [0.52-1.73]	-
Vitamin A								
Yes (n=1319)	1	-	1	-	1	1	1	-
No (n=183)	n/a	n/a	1.10 [0.66-1.81]	-	1.28 [0.75-2.18]	1.32 [0.69-2.52]	1.38 [0.82-2.33]	-
Deworming								
Yes (n=672)	1	1	1	-	1	1	1	-
No (n=792)	0.87 [0.62-1.23]	0.79 [0.54-1.16]	0.96 [0.69-1.35]	-	0.92 [0.63-1.32]	0.78 [0.51-1.19]	0.77 [0.56-1.08]	-
Stunting								
No	1	1	1	1	1	1	1	1
Yes	1.32 [0.89-1.95]	1.08 [0.68-1.72]	1.06 [0.69-1.63]	1.14 [0.80-1.64]	1.01 [0.69-1.47]	1.09 [0.66-1.82]	1.33 [0.86-2.07]	1.16 [0.81-1.67]
Underweight								
No	1	1	1	1	1	1	1	1
Yes	1.17 [0.71-1.94]	0.87 [0.47-1.64]	0.79 [0.45-1.36]	1.05 [0.64-1.70]	0.83 [0.51-1.33]	1.01 [0.53-1.93]	0.86 [0.49-1.50]	0.97 [0.59-1.57]
Wasting								
No	1	1	1	1	1	1	1	1
Yes	1.66 [0.97-2.82]	1.04 [0.56-1.92]	1.23 [0.68-2.29]	1.28 [0.76-2.15]	1.08 [0.54-2.15]	0.74 [0.33-1.60]	0.76 [0.35-1.64]	0.85 [0.43-1.66]

[w]Sample weights from the Namibia Demographic and Health Survey 2013 applied to analyses (n=1383). [nw]Sample weights not applied for analyses (n=1383). [wc]Sample weights were applied with complimentary analyses that included all children who had been evaluated for anemia. Mother's education, use of Vitamin A medication and use of deworming medication were excluded from analyses (n=2208). n/a Analysis not applicable due to missing standard errors because of stratum with single sampling unit. Statistical significances (P<0.05) are noted in italics.

tion access is highly recommended.

In our analysis, we could not confirm an association between mother's education and onset of childhood anemia . This is similar to a study in Nigeria,[26] but however differs from studies in Bangladesh, Brazil, India, Indonesia, and Uganda that reported evidence of low mother's education as a risk factor regarding childhood anemia .[18,28,29,33] For child health and feeding practices, the mother's education level is believed to be a key influencer as mothers are the primary caregivers.[39] Thus, we acknowledge that the mother's education might play an important role in reducing the prevalence of anemia , even if our study is not giving such indication.

Despite vitamin A deficiency and intestinal parasitic diseases being key determinants of the onset of anemia, we found no association between their corresponding indicators and childhood anemia. The lack of association with intestinal parasite medication differs from a similar study in Rwanda, which reported a low likelihood of anemia amongst medicine recipients.[11] Even if our study shows no evidence of these medicines being related to the existence of anemia ; considering the key role vitamin A plays in iron deficiency and parasitic diseases related to high risk of anemia , we encourage interventions to be maintained.[11,23,30]

We could not give evidence of an association between anemia and the nutritional factors stunting, underweight and wasting. Our results are in line with some other studies.[30,31] In most studies, however, there is evidence of an association between anemia and at least one of the nutritional factors.[20,21,23,29,33,40] The fact that anemia is a malnutrition deficit, a co-existent and increased risk of anemia is mostly assumed among malnourished children.[20,21,41] However, our results indicate that this might not be the case for Namibian children. On the other hand, Namibia has high rates of malnutrition among children under the age of five and thus attention must be paid to these factors. Resolving malnutrition can surely play a vital role in curbing the high prevalence of anemia . Lastly, we found no association between place of residence (urban, rural) and onset of childhood anemia . Our results are similar to those of a previous study in Nigeria.[26]

Our analysis has some key strengths and limitations. A key strength is that we used a large national representative sample to provide empirical evidence related to determinants of anemia among children in Namibia. The fact that our analyses were restricted only to children whose mothers were present to be interviewed might have led to a selection bias. However, our complimentary analyses with the entire sample of children aged 6–59 months gave a similar result, showing that such a bias likely is low, if it exists at all. Malaria information for the children would likely have strengthened our study with, as it has been shown in previous studies that it increases the risk of becoming anaemic,[9,11] and malaria is prevalent in Namibia in some of the densely populated areas.[42]

Childhood anemia is a major public health concern in Namibia, and a prevalence of 47.5% has previously been reported.[17] Our study gives valuable evidence of age, sex and household wealth status being the key determining factors for the onset of anemia among children aged 6–59 months in Namibia. Targeting poverty reduction in the population can enhance the likelihood of reducing childhood anemia through improved access to nutritious food. Special attention must be paid to younger children of less than 2 years, as they carry the most prevalence and highest likelihood of anemia. One group that we consider extra important to keep an eye on is boys whose parents are poor, as this group had a high risk of anemia in comparison with the richest households. We recommend that current interventions be maintained, and amendments can be made accordingly, related to the current knowledge of determinants of anemia .

Conclusions

In conclusion, our study shows that the youngest children, boys and households with a poor wealth status have an increased risk of having anemia among children of the age of 5 years. However, the prevalence of anemia is in most groups considered to be on too high a level despite a lower risk in these groups. We highlight the persistent challenges anemia poses to public health and poverty as a social determinant of health. Our study can help with priorities for public health policymaker, so that they can plan for preventions and control programmes to prevent anemia among children. Cost-effective measures such as nutrition education and food fortification must be explored adequately to achieve significant reduction in anemia prevalence. Future research is encouraged in order to further understand the specific determinants of childhood anemia. The inclusion of biomarker data on haemolysis diseases (malaria, intestinal helminths, HIV/AIDS etc.) will also be vital to future research.

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