Anaemia among schoolchildren; A narrative review

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Abstract
Anaemia is a significant problem in the developing world, such as Sub-Saharan Africa (SSA), with the greatest burden of disease experienced in children. Although extensive research on anaemia has been done among the pre-schoolers, less is documented about schoolchildren. Thus, the current review intends to summarise recent data on the prevalence and risk factors of anaemia among schoolchildren aged 5-18 years across SSA for planning mitigating interventions. A review was conducted on published English articles in Sub-Saharan countries providing estimates on anaemia prevalence and risk factors using databases from PubMed and Google Scholar from January 2010 to April 2021. A total of 41 articles were identified for review. Based on eligibility criteria, 18 articles were included in the current review. The review showed that the prevalence of anaemia among schoolchildren ranged from 11% (Ethiopia) to 83% (Nigeria). Generally, infection (56%), eating less protein and vegetables (33%), age (22%) and sex (16%) of the child were the significant risk factors for anaemia among schoolchildren. The current review established that anaemia is directly associated with infection, less consumption of protein and vegetables, age and sex of the child. Effective public health strategies such as biofortification of food are needed to improve micronutrient intake among older children.

Keywords: *Adolescents, haemoglobin, feeding pattern, predictors, prevalence, risk factors, Sub-Saharan Africa*

INTRODUCTION

Anaemia is the most common nutritional deficiency worldwide and an important public health problem, especially in developing countries. It affects the populations of both rich and poor countries. Globally, 42.6% of children are anaemic, among them 60.2% are from Africa (WHO, 2015). The World Health Organization (WHO) defines anaemia as a low blood haemoglobin (Hb) concentration < 115 g/L for children aged 5–11 years (WHO, 2008). There is limited data about anaemia among schoolchildren in SSA. However, malnutrition persists into the pre-adolescent period affecting school performance and reproductive health during puberty, particularly when child-bearing occurs early in life. The available data revealed that the prevalence of anaemia ranges between 29.3 % and 46% in different studies conducted among schoolchildren in SSA (Gowele *et al.*, 2021, Abizari *et al.*, 2012). Therefore, the rating shows that anaemia is a severe public health problem (WHO, 2015).

Furthermore, children in rural areas are shown to be highly affected compared to children in urban areas. Several strategies have been developed to address the problem of anaemia. This included free dispensing of iron supplements, deworming and iron

fortification in foods. All these interventions have addressed the problem among preschool children. The prevalence of anaemia among schoolchildren who are equally affected has received less attention compared with the pre-schoolers in developing countries. Therefore, there is a need to have data on the prevalence and risk factors of anaemia in schoolchildren. This information will assist in developing interventions focusing on this neglected group.

Iron plays vital roles in the body, including cognitive function (MoHCDGEC *et al.* 2016 and Thalanjeri *et al*. 2016) and biological functions, respiration, energy production, DNA synthesis, and cell proliferation (Zhang, 2014). Anaemia can stunt growth and increase morbidity from infectious diseases. It adversely affects several immune mechanisms. Furthermore, anaemia affects the physical development of an individual leading to decreased working capacity (Abizari *et al*., 2012, FAO/WHO, 2001). However, little, if any, comprehensive review of existing literature on anaemia prevalence and its risk factors in schoolchildren has been done for developing counties to cast the overall picture. Therefore, the objectives of this article are (i) to review the existing literature on the status of anaemia in schoolchildren so as to (ii) determine the prevalence and (iii) determine risk factors for anaemia across SSA.

METHODOLOGY

Search strategy and study selection

The current review included two databases, PubMed and Google Scholar. In addition, grey literature, such as reports and dissertations which focused on strategies to improve the iron status of schoolchildren, was consulted. A literature search was performed to identify existing research articles on anaemia. Key search terms were developed and used either singly or in combination. These terms included anaemia, schoolchildren, school-age children, adolescents, micronutrients, iron and SSA. Other articles that were considered are those, which reflected on feeding patterns, overweight and obesity, the prevalence of and determinants or risk factors for anaemia. The reviewer screened all the selected literature's titles and abstracts as a function of age out of the range, studies not from SSA countries, papers without the full text available, irrelevant or those which did not meet the inclusion criteria. The current review included articles published from January 2010 to April 2021. By using the identified phrases, 41 articles were collected based on the established inclusion and exclusion criteria. After the critical scrutiny to obtain the most relevant articles, 18 were qualified and reviewed. The outcome of interest for inclusion was anaemia, determined by the Hb level < 115 g/L (Table 1).

Table 1: Inclusion and exclusion criteria for selecting articles for review

Aspect	Inclusion criteria	Exclusion criteria
Age of subjects	Schoolchildren aged 5-18 years	Children below five and above 18 years No age identified
Publication	Between January 2010 to April 2021	Published before January 2010 and after April 2021
Subjects	Used human subjects	Used animal subjects
Language	Written in the English language	Written in other languages apart from English
Focus	Childhood anaemia, overweight and obesity	Other nutrition problems
Type of articles	Original articles	Review articles, book chapters, conference proceedings, and correspondence letters.
Schooling level	Pre and Primary school	Below pre-primary and above primary school
Participating countries	Countries in SSA	Countries outside SSA

Data extraction

The data extracted from the studies were first transferred into a Microsoft Excel (Microsoft Corporation, Washington, DC, USA) spreadsheet designed for the current review. Relevant information from each study was included, such as the prevalence of anaemia, dietary intake and predictor variables concerning the child, parents, household and community. Other items extracted were the authors, year of publication, and the location/country in which the study was conducted. Prevalence, proportions and confidence intervals (CI) reported by each study were recorded. When prevalence data were given for subgroups such as male/female, age groups, urban/rural, a weighted average across subgroups was calculated to provide one estimate per study.

RESULTS

Description of included studies

The current review assessed articles from the following regions: Burkina Faso (2), Cameroon (1), Egypt (1), Ethiopia (6), Ghana (1), Kenya (2), Nigeria (2) and Uganda (3). The results section reports the risk factors associated with anaemia among schoolchildren in SSA. The data extracted are those reported from the studies investigating both protective and harmful effects, evident from the Odds Ratios. Furthermore, data on schoolchildren were not equally defined, as some authors used pre-schoolers, schoolchildren and adolescents. Therefore, all these categories were considered in the review. The reviewed articles were from all countries in SSA.

Prevalence of anaemia among schoolchildren

Anaemia is a major public health problem in developing countries. Evidence from reviewed articles showed diverse trends of anaemia among schoolchildren across SSA. A study by Daboné *et al*. (2011) among schoolchildren aged 7-14 years in Ouagadougou, Burkina Faso, indicated that 40.4% of schoolchildren had anaemia. The available data indicate that Burkina Faso is still doing worse with an anaemia rate of 56.2% (Teh *et al*., 2018) and 28.6% (Erismann *et al*., 2017). Likewise, Uganda has not done much to reduce the prevalence of anaemia among schoolchildren. For instance, Legason *et al*. (2017) and Turyashemererwa *et al*. (2013) revealed

that 34.4% and 37.7% of schoolchildren were suffering from anaemia respectively. In addition, Barugahara *et al*. (2013) reported higher rates of anaemia (46%) among female schoolchildren in Masindi district. Studies in Ethiopia have indicated mixed trends in the prevalence of anaemia. Gutema *et al*. (2014) revealed that 23.7% of children from the Somali region had Hb low than 115 g/dL. Moreover, in the same year, Assefa *et al*. (2014) and Desalegn *et al*. (2014) reported a higher prevalence of anaemia (37.6%) among schoolchildren in Jimma Town. Subsequently, Alelign *et al.* (2015) revealed that 11% of schoolchildren in Durbete Town had anaemia, whereas, in Eastern Ethiopia, the prevalence was 27.1% (Mesfin *et al*., 2015). In another study, Getaneh *et al*. (2017) recorded about 16% prevalence of anaemia among schoolchildren from Gondar town in Ethiopia. Similarly, a higher prevalence of anaemia (30.8%) was reported in the Volta region of Ghana (Egbi *et al*. 2014). Likewise, in Kenya, schoolchildren are equally affected by anaemia (28.8% and 35.3%), as revealed by Ngesa & Mwambi (2014)) and Pullan et al. (2013) respectively. Among the articles reviewed, higher anaemia (82.6%) prevalence was reported in rural communities of Abia State in Nigeria among schoolchildren aged 7-12 (Onimawo *et al*., 2010). In Menoufia Governorate, Egypt, Abdel-Rasoul *et al*. (2014) indicated that 25.6% of primary schoolchildren aged 6-11 years had anaemia. Table 2 gives the prevalence rates of anaemia in SSA.

Table 2. Summary of the prevalence of anaemia among schoolchildren

Author (year)	Location/Country	Age (Yrs)	Study design	(n)	%
(Daboné *et al*., 2011)	Ouagadougou Burkina Faso	7-14	Cross-sectional	649	40.4
(Erismann *et al*., 2017)	Plateau Central and Centre-Ouest regions of Burkina Faso	8-14	Cross-sectional	455	28.6
(Teh *et al*., 2018)	Batoke (Limbe) and Tole (Buea), Cameroon	0-14	Cross-sectional	828	56.2
(Abdel-Rasoul *et al*., 2014)	Menoufia Governorate, Egypt	6–11	Cross-sectional	497	25.6
(Alelign *et al*., 2015)	Durbete Town, Ethiopia	5-15	Cross-sectional	403	10.7
(Mesfin *et al*., 2015)	Eastern Ethiopia	5-14	Cross-sectional	1755	27.1
(Getaneh *et al*., 2017)	Gondar town, Ethiopia	6-14	Cross-sectional	523	15.5
(Desalegn *et al*., 2014)	Jimma Town, Ethiopia	6-12	Cross-sectional	616	37.4
(Assefa *et al*., 2014)	Jimma Town, Ethiopia	6-14	Cross-sectional	423	37.6
(Gutema *et al*., 2014)	The Somali region, Ethiopia	5-15	Cross-sectional	355	23.7
(Egbi *et al*., 2014)	Volta Region of Ghana	6-12	Cross-sectional	143	30.8
(Ngesa & Mwambi, 2014)	Kenya	0-14	Cross-sectional	11,711	28.8
(Pullan *et al*., 2013)	Kenya	4-16	Cross-sectional	16 941	35.3
(Onimawo *et al*. 2010)	Abia State, Nigeria	7-12	Cross-sectional	249	82.6
(Adebara *et al*., 2011)	Ilorin metropolis, Nigeria	5-12	Cross-sectional	246	36.2
(Legason *et al*., 2017)	Arua district, Uganda	1-14	Cross-sectional	342	34.4
(Turyashemererwa *et al*., 2013)	Central Uganda	5-11	Cross-sectional	122	37.7
(Barugahara *et al*., 2013)	Masindi District, Uganda	11-14	Cross-sectional	109	46

Dietary iron intake among schoolchildren

The current study established that in SSA countries, the diets of schoolchildren are very limited in quantity and diversity. The data, furthermore, demonstrated that the feeding pattern is characterised by minimal intake of animal-protein foods (Barugahara *et al.,* 2013) and (Desalegn *et al.,* 2014) fruits and vegetables (Desalegn *et al*., 2014), coupled with an overconsumprion of unhealthy foods such as soda, cookies, cakes, candies and ice pop (Daboné *et al.* 2011). A study in Nigeria suggested that school-age children's energy and nutrient intake was unsatisfactory. For instance, 70% of the children had a total iron intake below the Recommended Daily Allowance (RDA) of 10 mg/day (Food and Nutrition Board & National Research Council, 1989). Another study by Fiorentino *et al*. (2016) reported poor dietary iron intake among 46% of schoolchildren in Senegal. Tidemann-Andersen *et al*. (2011) also reported similar findings in the Kumi district. Children had a predominantly vegetable-based diet, while foods of animal origin were consumed occasionally. In Northwest Morocco, Achouri *et al*. (2015) found that 64.9% of the studied sample consumed plant-based foods at least once a day, whereas animal food was less consumed (at least once a week) by the majority (79.3%). These findings imply that the plant-based foods, which were predominantly consumed, were not being complemented with animal-based food to enhance their nutritional quality.

Risk factors of anaemia among schoolchildren

Studies based on SSA investigated risk factors of anaemia among school-going children are dissected in this subsection. These factors are categorised as a child, parental or caregiver, household and community-related factors.

Child-related risk factors for anaemia

Evidence from reviewed articles showed that there are varied risk factors for anaemia. Table 3 describes the distribution of child-related variables for anaemia in the reviewed articles. Infection was highly (56%) associated with anaemia in schoolchildren (Teh *et al*., 2018; Getaneh *et al*., 2017; Legason *et al*., 2017; Alelign *et al*., 2015; Desalegn *et al*., 2014; Gutema *et al*., 2014; Ngesa & Mwambi, 2014; Barugahara *et al*., 2013; Adebara *et al.* 2011; Onimawo *et al*. 2010). For example, Gutema *et al*. (2014) revealed that infection with an intestinal parasite increased the likelihood of anaemia 2.99 times as compared to uninfected schoolchildren (AOR 2.99, 95% CI: 1.05, 849) in Southeast Ethiopia. Furthermore, anaemia was positively correlated with malaria incidences among female schoolchildren (Ngesa & Mwambi 2014). The malaria diagnosis status of a child was strongly associated with the risk of anaemia (OR 4.022, 95% CI:3.399, 4.759). Barugahara *et al*. (2013) also documented a positive correlation between anaemia and improper deworming among female schoolchildren in Masindi District in Uganda.

The habit of eating less protein and vegetables was specified as a risk factor by 33% for anaemia in schoolchildren (Legason *et al*., 2017; Mesfin *et al.,* 2015; Abdel-Rasoul *et al*., 2014; Assefa *et al*., 2014; Desalegn *et al*., 2014; Turyashemererwa *et al*., 2013). For example, low intake of plant food (OR 3.847, 95% CI:2.068, 7.157) and

animal food (OR 2.37, 95% CI:1.040, 5.402) were significantly and independently associated with anaemia (Assefa *et al*., 2014). Several studies (Teh *et al*., 2018; Alelign *et al*., 2015; Mesfin *et al*., 2015; Assefa *et al*., 2014; Ngesa & Mwambi, 2014) have indicated that younger children (1-11 years) were highly affected by anaemia (22%) (Mesfin *et al*., 2015; Assefa *et al*., 2014). With regard to the sex of a child conflicting results were documented. For example, male schoolchildren were indicated to be at a greater risk of anaemia (16%) in Arua district in Uganda and The Somali region in Ethiopia (Legason *et al*., 2017; Gutema *et al*., 2014). In contrast, Barugahara *et al*. (2013) revealed that anaemia affects female children more than their counterparts.

Another risk factor for anaemia among schoolchildren reported by various researchers is nutritional status, including wasting underweight, stunting, overweight and obesity which accounts for 28% (Erismann *et al*., 2017; Getaneh *et al*., 2017; Legason *et al*., 2017, Gutema *et al*., 2014, Ngesa & Mwambi, 2014). For instance, Gutema *et al*. (2014) reported that the Odds of anaemia were 5.5 times higher among stunted children than in non-stunted ones (AOR 5.50, 95% CI: 2.83, 10.72). Underweight schoolchildren were 2.07 times more likely to be anaemic (Hb < 115 g/L) compared to children with normal weight (AOR 2.07, 95% CI: 1.06, 4.05). Other documented factors include fewer meals and food insecurity (Getaneh *et al*., 2017; Barugahara *et al*., 2013; and Turyashemererwa *et al*., 2013), high intake of plant-based foods (Barugahara *et al*., 2013), birth order (Abdel-Rasoul *et al*., 2014), soft drinks, tea and chips utilisation habit (Abdel-Rasoul *et al*., 2014) and irregular legume consumption (Mesfin *et al*., 2015) was least (6%) associated with anaemia in schoolchildren in SSA.

Table 3. Distribution of the child-related risk factors for anaemia

Risk factor	No. of Studies	References
Age of the child (being younger)	4/18 (22%)	(Assefa *et al*., 2014), (Mesfin *et al*., 2015), , (Ngesa & Mwambi, 2014), (Teh *et al*., 2018)
Sex of the child (being a male)	3/18 (16%)	(Gutema *et al*., 2014), (Barugahara *et al*., 2013), (Legason *et al*., 2017)
Intestinal worms/parasites, malaria, illness/infection	10/18 (56%)	(Alelign *et al*., 2015), (Gutema *et al*., 2014), (Adebara *et al*., 2011), (Getaneh *et al*., 2017), (Barugahara *et al*., 2013), (Onimawo *et al*. 2010), (A. Desalegn *et al*., 2014), (Ngesa & Mwambi, 2014), (Teh *et al*., 2018) , (Legason *et al*., 2017)
Nutritional status, BMI, height, weight, stunting, wasting, underweight, overweight, obesity	5/18 (28%)	(Gutema *et al*., 2014), (Getaneh *et al*., 2017), (Erismann *et al*., 2017), (Ngesa & Mwambi, 2014), (Legason *et al*., 2017)
Eating less protein and vegetables	6/18 (33%)	(Assefa *et al*., 2014), (Turyashemererwa *et al*., 2013), (Abdel-Rasoul *et al*., 2014), (Mesfin *et al*., 2015), . (Desalegn *et al*., 2014), (Legason *et al*., 2017)
High intake of plant-based foods	1/18 (6%)	(Barugahara *et al*., 2013)
Fewer meals/food insecurity	3/18 (17%)	(Turyashemererwa *et al*., 2013), (Barugahara *et al*., 2013); (Getaneh *et al*., 2017)
Birth order	1/18 (6%)	(Abdel-Rasoul *et al*., 2014)
Soft drinks/tea/chips utilisation habit	1/18 (6%)	(Abdel-Rasoul *et al*., 2014)
Irregular legume consumption	1/18 (6%)	(Mesfin *et al*., 2015)

Distributions of parental and caregiver-related risk factors for anaemia

Table 4 presents the distribution of the parental and caregiver-related risk factors for anaemia. It was noted that comorbidities of anaemia were associated with the mother's education level in 22% of the studies reviewed. The risk of anaemia was 1.57 times higher in children whose mothers had no education than children whose mothers had post-secondary education (OR: 1.569, 95% CI:1.09, 2.259) (Ngesa & Mwambi, 2014). Fathers' education level had a protective effect on the risk of anaemia in their children (Mesfin *et al*., 2015; Abdel-Rasoul *et al*., 2014). In addition, the occupation of parents (being employed) was a significant determinant in the non-occurance of anaemia in children (Mesfin *et al*., 2015; Abdel-Rasoul *et al*., 2014). However, maternal parity of ≤4 (Legason *et al*., 2017), marital status of parents (being married) and maternal age (being young) (Getaneh *et al*., 2017) were least mentioned in previous studies in associating anaemia among schoolchildren in SSA.

Table 4: Distribution of the parental and caregiver-related risk factors for anaemia

Risk factor	No. of Studies	References
Paternal education level	2/18(11%)	(Mesfin *et al*., 2015), (Abdel-Rasoul *et al*., 2014)
Education of mothers	4/18 (22%)	(Assefa *et al*., 2014), (Ngesa & Mwambi, 2014), (Abdel-Rasoul *et al*., 2014), (Getaneh *et al*., 2017)
Occupation of parents	2/18 (11%)	(Abdel-Rasoul *et al*., 2014), (Mesfin *et al*., 2015)
Occupation of mothers	1/18 (6%)	(Getaneh *et al*., 2017)
Marital status of parents	1/18 (6%)	(Getaneh *et al*., 2017)
Maternal parity	1/18 (6%)	(Legason *et al*., 2017)

Distributions of household-related risk factors for anaemia

Among household-related risk factors, socio-economic status (SES) has been frequently associated with anaemia in schoolchildren in 33% of the studies (Table 5). A study conducted in Southern Ethiopia revealed that the Odds of being anaemic among children whose family's monthly income was less than 500 Ethiopian Birr (about 9$) were 9.44 times higher than among children whose family's monthly income was greater than 2000 Ethiopian Birr (AOR 9.44, 95% CI:2.88, 30.99) (Gutema *et al*., 2014). Several studies (Legason *et al*., 2017; Alelign *et al*., 2015; Desalegn *et al.,* 2015; Abdel-Rasoul *et al*., 2014; Gutema *et al*., 2014; Ngesa & Mwambi, 2014) have associated various SES with anaemia in children from SSA. Anaemia was also observed to increase with the increasing number of children in a household (11%) (Mesfin *et al*., 2015). A similar pattern was recorded by other researchers (Legason *et al*., 2017; Abdel-Rasoul *et al*., 2014), who indicated bigger families of ≥ 5 members were at a greater risk of anaemia. Household food insecurity (Getaneh *et al*., 2017) and level of sanitation (Mesfin *et al*., 2015) were the least (6%) reported household-related risk factors for anaemia in schoolchildren.

Table 5: Distributions of household-related risk factors for anaemia

Risk factor	No. of Studies	References
Number of children	2/18 (11%)	(Mesfin *et al*., 2015)
Family size	2/18 (11%)	(Abdel-Rasoul *et al*., 2014), (Legason *et al*., 2017)
Food insecurity	1/18 (6%)	(Getaneh *et al*., 2017)
SES	6/18 (33%)	(Alelign *et al*., 2015) , (Abdel-Rasoul *et al*., 2014), (Gutema *et al*., 2014), (A. Desalegn *et al*., 2014), (Legason *et al*., 2017), (Ngesa & Mwambi, 2014)
Level of the practice of sanitation	1/18 (6%)	(Mesfin *et al*., 2015)

Distribution of community-related risk factors for anaemia

Community-based risk factors were the least reported factors for anaemia in schoolchildren in all the articles reviewed (Table 6). A place where a school was located (urban/rural) was associated with child anaemia in SSA. For instance, a study by Barugahara *et al*. (2013) revealed that the prevalence of anaemia was twice as high in urban schools compared to rural schools. Furthermore, Abdel-Rasoul *et al*. (2014) revealed that anaemia was higher in children

from urban areas (63.8%) than in rural areas (36.2%). Other factors, such as school management system and altitude, were reported to be the least (6%) associated with anaemia among schoolchildren of SSA.

Table 6: Distribution of community-related risk factors for anaemia

Risk factor	Number of Studies	References
School management (Government, private)	1/18 (6%)	(Daboné *et al*., 2011).
Location (rural, urban)	2/18 (11%)	(Barugahara *et al*., 2013), (Abdel-Rasoul *et al*., 2014)
Altitude (high/low)	1/18 (6%)	(Teh *et al*., 2018)

DISCUSSION

The review aimed to determine the prevalence and risk factors for anaemia across SSA. Anaemia is one of the significant public health problems among schoolchildren of SSA, ranging from 11% (Ethiopia) to 83% (Nigeria). The findings from the current review agree with various studies (Alaofè *et al*., 2017; Ayogu *et al*., 2015; Ngui *et al*., 2012). The higher prevalence of anaemia in the current review was partly caused by low consumption of iron-rich foods (Bakar, 2016; Ochola and Masibo, 2014). Therefore interventions to prevent and correct anaemia are necessary. Some of these interventions are dietary diversification and iron fortification. Another intervention includes nutrient supplementation, especially iron and vitamins, in schoolchildren who are at higher risk of developing anaemia.

Analysis of the findings on the risk factors indicated that child-related factors were the most associated with an increased risk of developing anaemia among schoolchildren in SSA. Most of the reviewed studies reported that infection was significantly associated with anaemia among schoolchildren. This experience is almost similar to what was reported by other researchers. For instance, infections such as general infection (Alaofè *et al*., 2017), intestinal parasites (Ayogu *et al*., 2015; Al-Zabedi *et al*., 2014; Ngui *et al*., 2012) and malaria (Ayogu *et al*., 2015; Foote *et al*. 2013) were significantly associated with anaemia among schoolchildren. Possible reasons for the association could be chronic intestinal blood loss, increased nutrient demand, reduced intake and malabsorption of food nutrients resulting from an illness. Therefore, measures for improved health services and sanitation are necessary to prevent worms and other infections, which will likely facilitate anaemia development among older children. Available data show that infrequent intake of protein and vegetables was linked to anaemia in children. This is in line with earlier reflection by other researchers (Purba *et al*. 2019; Alaofè *et al*. 2017; Choi *et al*. 2011). Inadequate consumption of protein and vegetables may contribute to low protein and micronutrient intake, both of which play an important role of a carrier and enhancer of iron absorption. Therefore, inadequate supply may lower iron absorption in the body.

Most of the reviewed articles documented that younger and older children were equally affected. These findings concurred with the

results from Nigeria, whereby both younger children (<10 years) (Al-Zabedi *et al*., 2014) and older children (≥10 years) (Olumakaiye, 2013) were equally affected by anaemia. This was attributed to the fact that most children in developing countries mainly consume plant-based diets, predominantly from cereals, roots and tubers. Overconsumption of plant-based food with limited animal source foods rich in bioavailable iron and Vitamin $B_{12,}$ is likely to increase the risks of developing anaemia (Rauber *et al.*, 2014 Tidemann-Andersen *et al*., 2011). The risk of anaemia among children was significantly greater with nutritional status. For example, stunting was found to be significantly associated with anaemia among Beninese schoolchildren (Alaofè *et al*., 2017). This might be due to the long-term effect of low intake of macro and micronutrients, especially iron, vitamin B12, folate and other minerals and vitamins associated with anaemia. In addition, being overweight and obese was a significant predictor of the development of anaemia. Obesity is associated with iron deficiency partly because anaemia may lead to fatigue, reducing physical activity and further aggravating weight gain.

In the present review, maternal education was an important factor in the non-occurrence of anaemia among schoolchildren. This supports findings from studies by various authors (Achouri *et al*., 2015; Al-Zabedi *et al*., 2014; Foote *et al*., 2013; Abubakar *et al*., 2012; Choi *et al*., 2011). Maternal education status (being educated) greatly affects child health, nutrition, growth and development. An educated mother will likely plan better meals than mothers with no formal education. In addition, educated mothers are financially well, hence likely to purchase an animal based food and their products, which are richer in haem iron (Choi *et al*., 2011). Furthermore, mothers with no formal education are likely to be negatively affected by low income, limiting food purchasing power. Hence, their children's access to haem iron sources is limited.

Mothers with no formal education are unlikely to practice proper health-seeking behaviours. As a result, a child is left susceptible to infection. As with African culture, the review revealed that fathers' education status is the least predictor of anaemia in schoolchildren. The fact that fathers are not directly involved in child-caring practices such as meal planning, preparation and health seeking, their contribution to improved nutritional status is generally negligible, hence not a strong determinant for anaemia. It was further noted that low household income contributes to anaemia among schoolchildren. This agrees with several studies (Alaofè *et al*., 2017; Rani & Bandrapalli, 2017; Cardoso *et al*., 2012; Ngui *et al*., 2012). One of the assumptions is that households from lower SES are unlikely to be able to purchase foods with haem iron in comparison to their counterparts.

Anaemia has extremely negative implications for children at risk of impaired growth and cognitive development, lower mental and motor function, poor work capacity and a generally lower quality of life. The results of the current review have made a novel contribution to the area of schoolchildren who were less researched. Considering higher rates of anaemia among

schoolchildren, mitigating strategies are necessary. This includes interventions such as promoting dietary diversity, supplementation, fortifications and treatment of malaria and worm infestation. Iron supplementation is one of the effective ways however, it is mostly focusing pregnant and lactating women. This review indicates that infection and poor iron-rich food sources are major predictors of anaemia among schoolchildren. It is further suggested that iron supplementation with infection treatment, especially in malaria-endemic areas, should be administered concurrently in addressing anaemia incidences. Some of the avenues for future research could be to explore the implementation of the proposed intervention, whether continuous or periodic considering issues of toxicity and cost implications.

Strengths and limitations of the current review

The strength of the current review is its focus on anaemia among schoolchildren who are most vulnerable because of their higher iron need to meet the demands of puberty and adolescence. Anaemia is associated with Schoolchildren from SSA are highly affected by anaemia. This review established that the occurrence of anaemia was largely associated with infection. Furthermore, children who consumed protein and plant-based foods less frequently were more likely to develop anaemia than those who frequently used these foods. In addition, age of a child, the nutritional status, such as wasting underweight, stunting, overweight and obesity were predictors of anaemia in schoolchildren from SSA. Effective public health strategies such as biofortification of poor growth and cognitive development, lowered immunity, increased risk of infectious diseases, and reduced work productivity. Furthermore, little attention has been paid in this age group of 5-18 years in most of SSA countries, despite its significance in the development. There are a few limitations to this review. First, the current review restricted itself to published English-language articles. Therefore, the inclusion of non-English published articles may have affected the findings of this review. The use of data from a cross-sectional study design might not reflect a true cause-and-effect relationship between the variables. In addition, the findings from cross-sectional study might also have been affected by recall bias. Furthermore, the definition of schoolchildren differs across articles. Some studies started with pre-scholars, while others started with primary school and others with lower secondary levels. This very wide age gap is likely to bring discrepancies in the study findings. For example, a three-year-old child is quite different from a ten-year-old plus child.

CONCLUSION

Food are needed to improve micronutrient intake among older children.

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Competing interests

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