

Impact of malnutrition on the academic performance of school children in Ethiopia: A systematic review and meta-analysis

SAGE Open Medicine

Volume 10: 1–10

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DOI: 10.1177/20503121221122398

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Abstract

Objective: This study aimed to identify the impact of malnutrition on the academic performance of children in Ethiopia.

Method: The protocol of this study is registered in PROSPERO with a registration number CRD42021242269. A comprehensive search of studies from HINARI, MEDLINE (via PubMed), EMBASE, Cochrane Library, SCOPUS, Google Scholar, and Google was conducted. All published and unpublished studies conducted about the effect of any forms of malnutrition on academic performance of elementary school children in Ethiopia using the English language were included. Quality of the articles was assessed using the Joanna Briggs Institute critical appraisal tool. The pooled log odds ratio with 95% confidence interval was determined to identify the effect of malnutrition on academic performance. I-square statistics was applied to check the degree of heterogeneity between studies. The presence of publication or small study bias had been assessed by Funnel plots, Egger's weighted regression test, and Begg's rank correlation test.

Result: A total of 10 studies were included in this study. The pooled prevalence of good academic performance among elementary school students in Ethiopia was 58% (95% confidence interval: 48%, 69%). Stunting (odds ratio=0.48; 95% confidence interval: 0.30, 0.79), underweight (odds ratio=0.38; 95% confidence interval: 0.27, 0.53), and iodine deficiency (odds ratio=0.49; 95% confidence interval: 0.31, 0.78) had a significant association with the academic performance. Rural residence (odds ratio=0.61; 95% confidence interval: 0.44, 0.83), being female (odds ratio=0.53; 95% confidence interval: 0.37, 0.77), and uneducated parent (odds ratio=0.51; 95% confidence interval: 0.44, 0.58) were also factors associated with good academic performance of primary school children in Ethiopia.

Conclusion: This study concluded that malnutrition in the form of stunting, underweight, and iodine deficiency affected the academic performance of elementary school children in Ethiopia. So, the Ministry of Health worked better to strengthen the nutrition intervention at the critical periods of brain development.

Keywords

Academic performance, malnutrition, school children, Ethiopia

Date received: 16 March 2022; accepted: 3 August 2022

Introduction

Malnutrition refers to deficiency, excess, or an impaired utilization of one or more essential nutrients.¹ It consists of both under and over-nutrition.² Undernutrition includes wasting, stunting, underweight, and micronutrient deficiencies.³ Malnutrition in any of its forms is a significant public health problem.⁴ Globally, 29.8% of school-age children have insufficient iodine intake.⁵ In India, 54% of school children were under-nourished.⁶ In Africa, the prevalence of iodine deficiency among school-age children was 39.3%.⁷ In Ethiopia, the prevalence of wasting, underweight, and

stunting among primary school children were 17.7%, 18.2%, and 21.3%, respectively.⁸ Malnutrition has substantial effects

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on the neurological development and behavioral capacity of children.⁹ Thus, malnourished children may never reach their full scholastic potential. Malnutrition among school age can result in impaired cognitive and motor development, which may undesirably upset academic performance through reduced learning capacity and poor school attendance.^{10,11}

Concurrent with malnutrition, quality of education is a big challenge in Ethiopia.¹² One of the sustainable development goals agenda is inclusive, equitable, and quality education.¹³ Ethiopia is doing well in terms of enrollment and coverage of universal primary education. But the total score of grade 8 students has consecutively decreased from 41.1% in 2000 to 35.3% in 2010.¹⁴ The dropout rate, grade repetition, and completion rate of elementary school student was 13.9%, 5%, and 71%, respectively.¹⁵ A qualitative study reported that teachers have complained about their students' poor academic performance in school.¹² Hence, poor academic achievement has been the main concern for teachers, parents, and students.

Academic performance can be affected by gender, age, residence, study hours, absenteeism, socio-economic status, illness, medium of instruction, and malnutrition.^{16–18} Malnutrition is the main factor for poor academic performance and contributed to the development of other factors.^{19,20} Studies showed that malnutrition among school-age children is a risk factor for high absenteeism, early dropouts, low school enrollment, and unsatisfactory classroom performance.^{21,22}

Efforts such as School Feeding Program have been made to improve the nutritional status, enrollment, attendance, retention, and completion rate of students.^{23–25} However, still many school children suffer from poor nutrition and academic achievement.²² In Ethiopia, studies investigated the effect of malnutrition on the academic performance of primary school children, but there is an inconsistency between their findings. For instance, a study from Dera District and southern Ethiopia reported that stunting was not a factor for academic performance.^{26,27} Whereas studies from northwest Ethiopia and Lalibela stated that stunting and being underweight were factors for poor academic performance.^{28,29} There is no nationally representative information on the effect of malnutrition on the academic performance of primary school children. The evidence generated by this study design would be stronger than individual studies to influence policymakers.^{30,31} Therefore, this study aimed to determine the impact of malnutrition on the academic performance of primary school children in Ethiopia. “Does malnutrition affect the academic performance of elementary school children in Ethiopia?” was the research question of this study.

Materials and methods

Study design, search strategy, and protocol registration

Systematic review and meta-analysis (SRMA) study design was applied for this study. The Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guideline

was applied to report this SRMA.³² An extensive search of studies from HINARY, MEDLINE (via PubMed), EMBASE, Cochrane Library, SCOPUS, Google Scholar, and Google was done. “Nutritional status” OR “malnutrition” OR “under-nutrition” OR “stunting” OR “wasting” OR “underweight” OR “height-for-age z score” OR “weight-for-age z score” OR “weight-for-height z score” OR “iron deficiency” OR “iodine deficiency” AND “academic performance” OR “school performance” OR “school achievement” OR “academic achievement” OR “educational performance” AND “primary school children” OR “elementary school children” OR “student” AND “Ethiopia” were used as key terms. The search was undertaken from 1 February to 23 March 2021. This SRMA was registered in PROSPERO with a registration number CRD42021242269.

Inclusion criteria

All published and unpublished observational studies about the effect of malnutrition on the academic performance of elementary school children in Ethiopia were included. Under-nutrition among primary school children were the exposure variable. Normal nutrition among primary school children was the comparison variable/group for this study. Studies assessed academic performance of primary school children using at least two-semester average scores as a primary outcome were included. To get a more comprehensive result, no restriction was made by the year of publication (studies published until 23 March 2021 were included).

Exclusion criteria

Review articles, conferences, abstracts, editorials, and descriptive studies were excluded from this study. We also excluded studies that did not report the outcome of interest and at least one form of malnutrition.

Study selection and data extraction

The article searches and screening activity was performed by two reviewers (AAZ and SET). Articles were exported and managed using Endnote X8 software. Duplicates were identified and removed from the citation manager. Then the remaining articles were assessed for eligibility by title, abstract, and full-text level. Studies conducted out of Ethiopia and with unrelated topics were excluded. Then the abstract and full document of remaining articles was examined. Those studies that were not eligible based on the full-text assessment were excluded and reasons were described.³² Studies that passed through this selection process were included in the review.

A data extraction sheet was developed using Microsoft Excel worksheet 2013 and the following variables were extracted from each eligible article:

1. Study characteristics: name of first author, year of publication, region, study area, study design, and sample size.
2. Outcome (number of children with good academic performance) and independent variables (count data with 2×2 table, and odds ratio (OR) with 95% confidence interval (CI; where count data not available)).

Quality assessment

The Joanna Briggs Institute (JBI)³³ critical appraisal tool was used to assess the quality of each paper. The tool has Yes, No, Unclear, and “not applicable” answers. A value was given 1 for “Yes” and 0 for “No” and “Unclear” responses. Three investigators (AAZ, FYA, and SZA) independently performed the quality assessment using the JBI criteria. Scores of each item were summed and converted into percentages. The quality scores of the three reviewers were averaged. Disagreement between investigators was solved by discussion and consensus. Agreement between the investigators were determined and there was substantial agreement ($\kappa=0.77$).³⁴ Finally, studies with higher scores ($> 50\%$) were included in this SRMA.

Outcome assessment

The main objective of this study was to identify the effect of malnutrition (stunting, underweight, wasting, and micronutrient deficiency) on academic performance in log OR form. In addition to malnutrition, socio-demographic variables such as place of residence, educational status of the family (no-formal education versus formal education), student sex (male versus female), family size (≥ 5 versus < 5), and income (low versus high) were extracted.

Statistical analysis

The extracted data were exported to STATA version 14.0 for the meta-analysis. The pooled prevalence was calculated to estimate the prevalence of good academic performance. The pooled log OR and its 95% CI was determined to identify the effect of malnutrition on the academic performance of primary school children. Heterogeneity was checked by Higgins's I-square statistics in which I-square value of $> 75\%$, 50% to 75% , and $< 50\%$ was reported as high, moderate, and low heterogeneity, respectively.³⁵ A random effect model with 95% CI was used to report heterogeneous findings. Meta-regression, subgroup analysis, and sensitivity analysis were conducted to identify the possible sources of heterogeneity. Publication bias was visually identified by funnel plots. The funnel plot asymmetry was statistically checked using Egger's and Begg's test. The visual asymmetry of the funnel plot and p -value < 0.05 of the Egger's and Begg's test was suggestive of publication bias.^{35,36} Then, trims and fills analysis was conducted to deal with publication bias. Finally, data were presented in tables and figures.

Result

Study selection and characteristics

A total of 1906 articles were retrieved by literature search. Of these, 398 were excluded because of duplication, 1490 did not have relation with the aim of the study, and 8 did not meet the eligibility criteria due to differences in outcome classification,³⁷ outcome measurement,²⁶ target population^{38,39} and we cannot get the 2×2 table and the OR.^{40,41} Finally, 10 articles were included in this SRMA (Figure 1). All included articles were full text and done using a cross-sectional study design with one prospective cohort.⁴² A total of 5626 students participated in the study with a minimum of 273⁴³ and a maximum of 1254⁴⁴ sample population. Studies were obtained from three regions of Ethiopia; Amhara, Oromia, and Southern Nations, Nationalities, and People (SNNP) region that published or posted from 2013 to 2021 (Table 1).

Pooled prevalence of good academic performance

The pooled estimate indicated that 58% (95% CI: 48%, 69%) of elementary school students have good academic performance in Ethiopia. The true heterogeneity among studies other than chance was 98.6% ($I^2=98.6\%$, p -value < 0.001). The highest frequency was reported from Lalibela, Amhara region 85% (95% CI: 82%, 88%) and the lowest was from Meskan, SNNP region 32% (95% CI: 27%, 37%; Figure 2).

Subgroup analysis

Based on the subgroup analysis, the academic performance was highest in Oromia 69% (95% CI: 59%, 78%) followed by Amhara 62% (95% CI: 42, 83%) and then SNNP 42% (95% CI: 32%, 52%). However, the I-square value was still high in each region. Hence, region is not the source of heterogeneity (Figure 3).

Meta-regression and sensitivity analysis

Meta-regression was conducted by including sample size and publication year. But all of these variables were not the sources of heterogeneity ($p > 0.05$). Sensitivity analysis indicated that there was no study that influences the pooled effect (Figure 4).

Test for publication bias

Visual observation of the funnel plot indicated the presence of some publication bias (Figure 5). However, it was statistically disproved by the Egger's ($p=0.96$) and Begg's test ($p=0.72$).

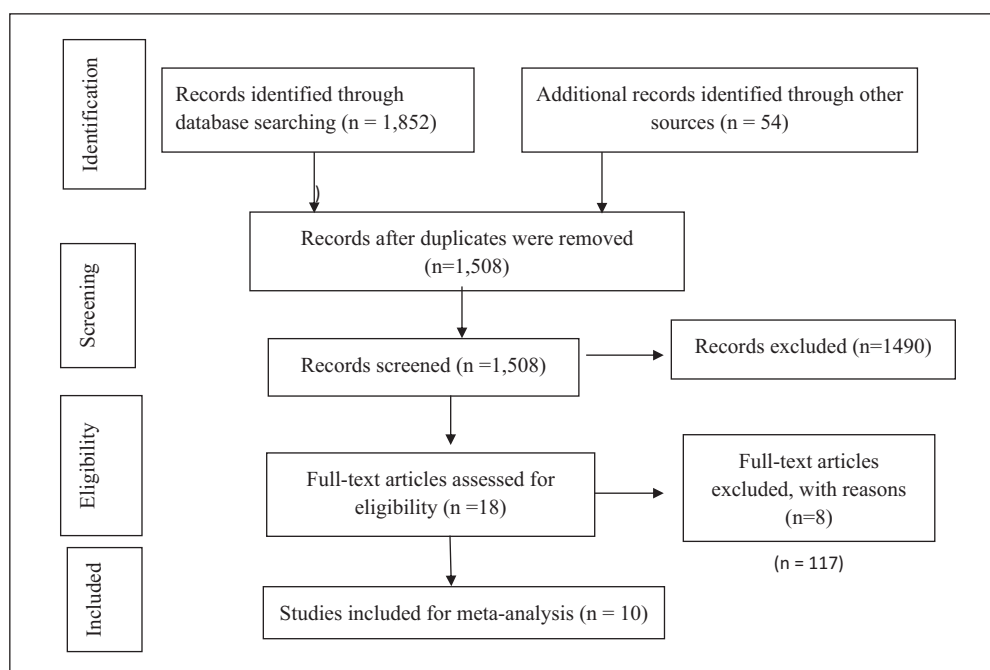


Figure 1. PRISMA flow diagram of included studies in systematic review and meta-analysis of the impact of malnutrition on academic performance of primary school children in Ethiopia from 2013 to 2021.

Table 1. Characteristics of studies included in this systematic review and meta-analysis about the impact of malnutrition on the academic performance of primary school children in Ethiopia from 2013 to 2021.

Author	Publication year	Study area	Region	Study design	Sample size	Prevalence
Ayalew et al. ²⁸	2020	Lalibela	Amhara	Cross-sectional	505	85.3
Abebe et al. ⁴⁵	2017	Hawa Gelan	Oromia	Cross-sectional	630	76.3
Asfaw and Belachew ⁴²	2018	Dawro zone	SNNP	Cohort	652	42.5
Seyoum et al. ⁴⁶	2019	Nekemte	Oromia	Cross-sectional	362	67.7
Mezgebu et al. ⁴⁴	2017	Jimma	Oromia	Cross-sectional	1,254	62.2
Terefe et al. ⁴³	2021	Debre Markos	Amhara	Cross-sectional	273	64.1
Wolde and Belachew ²⁷	2019	Meskan	SNNP	Cross-sectional	378	32.0
Admasie et al. ⁴⁷	2013	South Gonder	Amhara	Cross-sectional	601	43.4
Wolka et al. ⁴⁸	2013	Sodo	SNNP	Cross-sectional	534	50.7
Asmare et al. ²⁹	2018	Debre markos	Amhara	Cross-sectional	436	56.2

SNNP: Southern Nations, Nationalities, and People.

Factors associated with academic performance

Stunting (OR=0.48; 95% CI: 0.30, 0.79), underweight (OR=0.38; 95% CI: 0.27, 0.53), and iodine deficiency (OR=0.49; 95% CI: 0.31, 0.78) had significant negative association with good academic performance. Similarly rural residence (OR=0.61; 95% CI: 0.44, 0.83), being female (OR=0.53; 95% CI: 0.37, 0.77), and non-formal educated parent (OR=0.51; 95% CI: 0.44, 0.58) had significant negative association with good academic performance of Ethiopian primary school children (Table 2).

Discussion

This SRMA aimed to generate pooled evidence on the impact of different forms of malnutrition on the academic performance of elementary school children in Ethiopia. This study reported that the odds of good academic performance were 57% lower among stunted children than not stunted children. It is similar to studies from Burkina Faso, Vietnam, Benin, and a multi-country cohort study.^{49–53} This is because stunting is often occurred within the first 1000 days of a child's life (from conception up to the first 2 years of life)

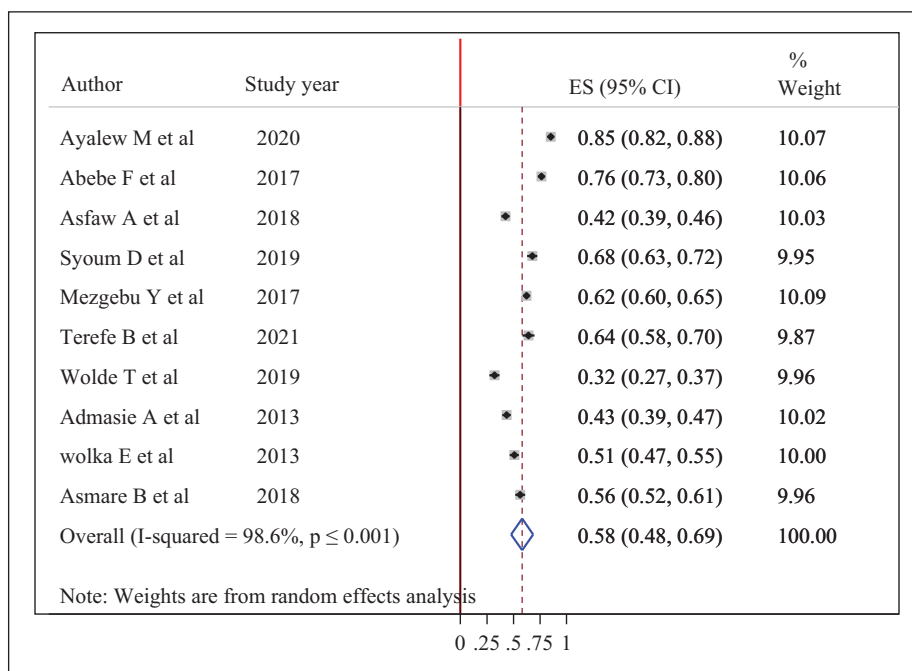


Figure 2. Forest plot for pooled prevalence of good academic performance among elementary school children in Ethiopia, 2013–2021.

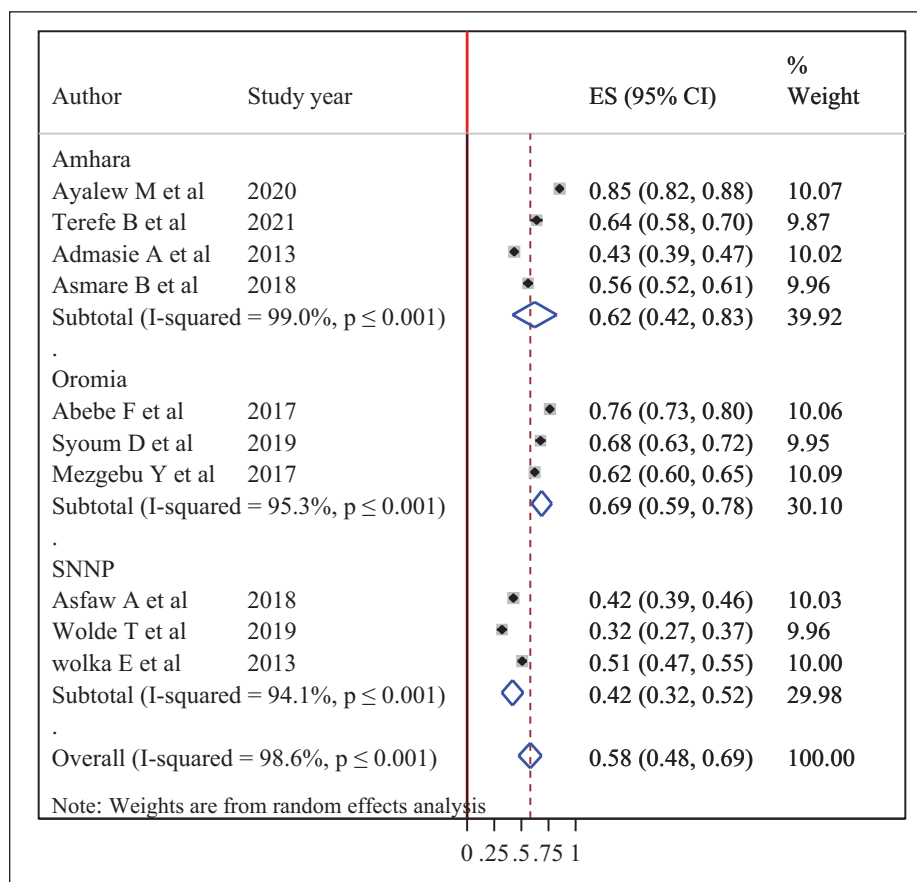


Figure 3. Subgroup analysis by region for the pooled good academic performance of elementary school children in Ethiopia, 2013–2021.

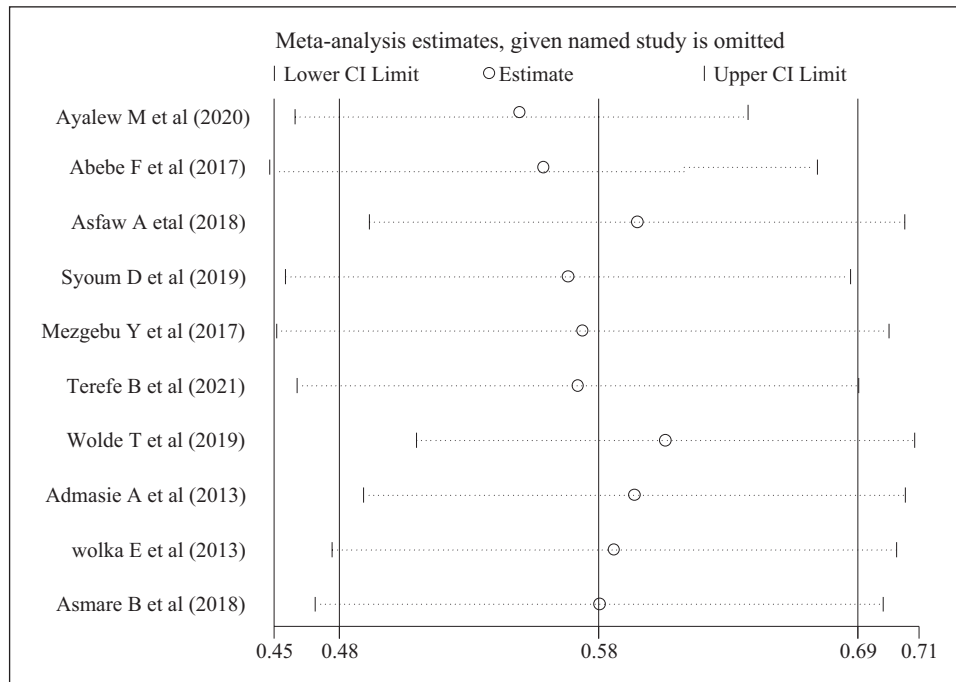


Figure 4. Sensitivity analysis for the academic performance of elementary school children in Ethiopia, 2013–2021

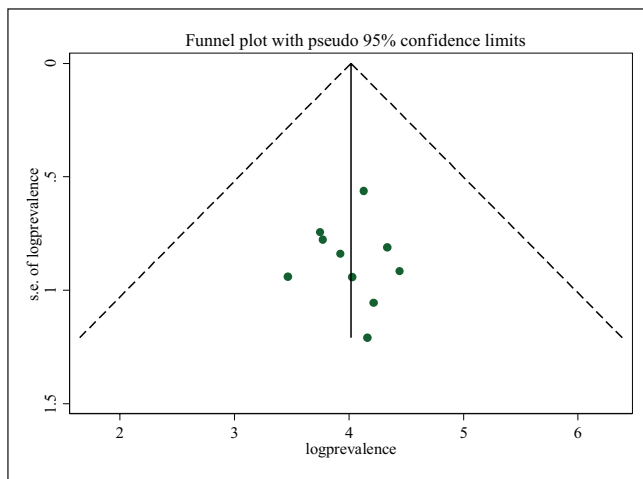


Figure 5. Funnel plot to detect the presence of publication bias regarding the pooled prevalence of good academic performance among elementary school children in Ethiopia, 2013–2021.

which is a period of children's rapid brain development takes place.^{54,55} Once occurred, stunting causes tissue damage, impaired differentiation, delayed myelination, and limited overall development of the brain.^{56,57} Then it results in aberration of the temporal sequences of brain maturation and the foundation of neuronal circuits.⁹ As a result, the brain's cognitive process, motor and language development will be limited and causes a long-term permanent impact on academic performance of children.⁵⁸ This study reported that being underweight reduces the academic performance

of children by 68%. However, a study from Bennis reported that underweight cannot affect the cognitive development of children.⁵¹ Since most researchers focus on the effect of stunting on the academic performance, there is no adequate review to compare and set conclusion about underweight.

In this study, good academic performance was 50% lower among iodine-deficient children than in iodine-sufficient children. Similarly, most reviews reported that iodine deficiency is a risk factor for academic performance.^{59–61} Iodine is an essential micronutrient needed for production of thyroid hormones.⁶² Thyroid hormone is necessary for many body processes such as thermal and metabolic regulation, organ and neurological development, and function of the central nervous system by regulating the genetic expression and cell differentiation of the brain.^{63–65} Therefore, iodine deficiency significantly lowers cognitive capacities ranging from mental retardation to impaired development of intelligence and academic performance.⁵⁹ Although iodine deficiency at early age poses irreversible damage, studies conducted among school-age children showed that iodine supplementation can still improve cognitive abilities.^{66,67} So, iodine fortification should be strengthened to improve the academic performance of primary school children in Ethiopia.⁶⁶

In this review, students from rural residences had a lower academic performance than those from urban areas. This finding is in agreement with a policy-brief report of Ethiopia.⁶⁸ In contrast to this study finding, a review conducted on rural and urban areas reported that rural students had a better academic performance than urban students.⁶⁹

Table 2. Factors associated with academic performance among elementary school children in Ethiopia, 2013–2021.

Variables	Categories	Number of studies	Pooled OR (95% CI)	Heterogeneity (I ²)	Publication bias (p-value of Egger's test)
Stunting	Yes	9	0.43 (0.28, 0.64)	97.0	0.22
	No				
Underweight	Yes	5	0.42 (0.30, 0.59)	88.8	0.49
	No				
Iodine deficiency	Yes	5	0.49 (0.31, 0.78)	94.1	0.29
	No				
Residence	Rural	5	0.61 (0.44, 0.83)	86.8	0.48
	Urban				
Sex	Female	6	0.53 (0.37, 0.77)	74.6	0.19
	Male				
Family size	≤ 5	6	0.88 (0.70, 1.11)	34.9	0.21
	> 5				
Family income	High	5	1.95 (0.98, 3.89)	< 0.01	0.69
	Low				
Educational status of parent	No formal education	6	0.51 (0.44, 0.58)	< 0.01	0.56
	Formal education				

OR: odds ratio; CI: confidence interval.

Then again, a study from Benin showed that place of residence had no association with academic performance.⁵¹ This discrepancy might be due to the sociocultural difference between countries.

In this review, the odds of good academic performance were lower among girls than boys. This might be because better preferences had been given to boys and girls are often faced with the burden of household tasks, which hinders their ability to perform successfully at school. However, a review from the global north and south reported that girls were better in academic performance.⁶⁹ In addition, a systematic review in Trinidad and Tobago stated that females had better performance than males.⁷⁰

In this study, parents' educational level had a significant association with the academic performance of primary school children. Students from non-educated parents were less likely to have good academic performance than students from formally educated parents. This finding was in agreement with a study from Benin.⁵¹ This might be because children from uneducated parents get less support on doing assignments, project work, homework, class work, and other academic and social issues. Conversely, children from highly educated parents may consider their parents as role models for their academic success.⁷¹

Limitation of the study

This study had the following limitations; first, this meta-analysis represented only studies reported from three regions of Ethiopia. Second, it was limited to articles written in the English language only. Third, the result was highly heterogeneous. Fourth, almost all of the included studies

were cross-sectional, which may not show the cause–effect relationships. Fifth, due to the shortage of individual studies, this study cannot assess the effect of iron deficiency on academic performance.

Strength of the study

This review tried to include both published and unpublished studies.

Conclusion

This SRMA concluded that stunting, underweight, and inadequate iodine intake had a significant impact on the academic performance of children. Also being female, rural residents, and from uneducated parents had a negative association with academic performance of children in Ethiopia. So, the Ministry of Health worked better to strengthen the nutrition intervention at the critical periods of brain development. In addition, to improve the nutritional status and the related academic performance of elementary school children, the Ministry of Education enhanced the coverage of school feeding programs by emphasizing rural children, girls, and uneducated parents. Further research is recommended on the effect of iron deficiency/iron deficiency anemia on the academic performance of school children in Ethiopia.

Acknowledgements

We would like to acknowledge Wollo University, College of Medicine and health sciences, School of public health for providing us with basic training on SRMA.

Author contributions

All authors contributed to data analysis, drafting, and revising the article, gave final approval of the version to be published, and agreed to be responsible for all aspects of the work.

Data availability

All the required data are included in the manuscript.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

Ethical approval for this study was obtained from Wollo University, College of Medicine and Health Sciences Ethical Review Committee (CMHS 857/13/13).

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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