



Assessment of nutritional status and its effect on academic performance of school children in square nine area, White Nile State, 2021-2022

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Abstract

Background: Proper nutrition is crucial for children's physical, cognitive, and academic development. This study aimed to assess the nutritional status of primary school children in the Square Nine area of White Nile State, Sudan, and examine the relationship between their nutritional status and academic performance.

Methods: The study was conducted during the 2021- 2022 academic year in the Square Nine area, Rabak district, Sudan. A cross-sectional design was used, involving 198 school children who were included in the study from November (2021-2022). Anthropometric measurements were taken to assess nutritional status. Academic performance data was collected from school records. Statistical analyses determined the association between nutritional status and academic outcomes.

Results: The results showed that: X% of the children were underweight, Y% were stunted, and Z% were wasted, indicating a high prevalence of malnutrition. Children with normal nutritional status had significantly higher academic scores than malnourished children. Factors such as family income, parental education, and school environment were also found to influence the children's nutritional status and academic performance.

Conclusion: The findings suggest that improving the nutritional status of primary school children in the Square Nine area could positively impact their academic achievement. The study highlights the need for targeted nutrition intervention programs and policies to address malnutrition and support the educational outcomes of vulnerable children in this region.

Keywords: Academic performance; Nutritional status; School-age children, Development and growth in School-age children

1 Introduction

Children are any country's greatest national resource, essential for shaping a country's future. Schooling catalyzes individual and social change, enhancing general well-being. Primary education is crucial for developing a child's consciousness and personality, as it introduces a world of knowledge and positive ideas. At this stage, children are highly inquisitive, and elementary education should nurture this curiosity. [1-3] Nevertheless, nutrition is a critical factor that

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affects learning ability and skills both before and after a child enters school. The nutritional status of school-aged children significantly impacts their physical, emotional, and mental development, affecting their school performance and academic achievement. The World Health Organization (WHO) recognizes the nutritional status of school-aged children as a crucial indicator of the population's overall nutrition and health. In 1997, WHO released growth curves for school-aged children and adolescents to identify stunting (low height-for-age) and thinness (low body mass index-for-age). [4] Addressing hunger and improving nutrition and health are key components of the development global agenda, particularly Sustainable Development Goal 2 (SDG 2). Similarly, significant is ensuring education and promoting lifelong learning opportunities, as tinted in SDG. [5] The World Bank stresses the importance of tackling both malnutrition and inadequate learning during childhood to develop and create healthier and more economically productive populations. [6] Limited data are available on the nutritional status of school-aged Sudanese children living in rural areas. [7] Evidence suggests that stunting is generally irreversible after the first 1,000 days from conception, despite some possibilities for improvement reported in earlier studies. [8,9] Young school-aged children have historically received insufficient attention regarding health and nutrition. Good health and nutritional status are crucial for this age group. Poor nutrition can hinder children's growth, resistance to infection, and recovery. It can also lead to high rates of school absenteeism, early dropout, and poor classroom performance. Hungry children often exhibit nervousness, irritability, disinterest, and an inability to concentrate, leading to poor school performance and, over time, affecting their college entry and productivity in society. However, by declining under-5 mortality rates in developing countries, more children can attend school. However, challenges such as incomplete primary education and unsatisfactory academic achievement persist. [10] The link between poor health, nutrition, and educational achievement is not well understood. Malnourished children often lag in school due to failing grades, late school entry, missed school days, and lack of concentration. Malnutrition is associated with passivity, apathy, shortened attention span, reduced short-term memory, and difficulty acclimating to repetitive stimuli. [11,12] These issues can lead to poor school performance and higher dropout rates, especially in less developed countries. Historically, efforts to improve schooling accessibility and quality in countries facing educational challenges have focused on school-related factors such as location, availability of teaching materials, teacher quality, and institutional management. [13] Demographic and socio-economic characteristics of households are also important determinants of school participation and achievement.

2 Subjects and Methods

A cross-sectional study was conducted in Wad Abusuker village, Rabak City, White Nile state, Sudan to evaluate malnutrition and its effect on the academic performance of primary school children. The study included all students from two government primary schools in the area. The White Nile is one of the 18 states of Sudan. It has an area of 30,411 km² and an estimated population of approximately 1,188,707. Since 1994 Rabak has been the state's capital; the study was conducted in Rabak, square nine areas in the south of the city. village. There are two primary governmental schools and both of them are included in the study. Those schools have many students due to the area's strategic location because it is located close to 10 villages. Most of the children from relationship between health, nutritional variables, and intellectual development, including academic achievement. [14] This research aims to fill the current knowledge gap regarding the nutritional status of school- aged children and its impact on academic performance [15] Addressing this issue is vital for the country's economic future, as these children will eventually contribute to its economic engine. The findings can inform decision-makers in educational and government agencies to implement interventions, such as free school breakfasts and nutrition education programs for mothers, to improve children's nutrition and overall well-being. [16,17] The main objective of the existing study is to study the nutritional status and its effect on the academic performance of school children to assess malnutrition among children using height-for-age z score (HAZ) and body mass index-for-age z score (BAZ). To identify the association between malnutrition variables and academic performance and to determine the association between sociodemographic characteristics and academic performance these villages come to governmental Primary schools in that area, and also to decrease the effect of school variation on the achievement of children. The two schools in the village were chosen, Alhumiraa Primary School for girls and Gamoaa Primary School for boys. Children that attend the two governmental Primary schools in Square Nine areas in the period of data collection in December 2021. This study investigated the relationship between malnutrition and academic performance in primary school children in Wad Abusuker village, Rabak City, White Nile state, Sudan. The research included all students from two government primary schools in the area, Alhumiraa Primary School for girls and Gamoaa Primary School for boys.

3 Study Design and Participants

Data was collected at a single point in time. Population all students from the two government primary schools in Square Nine areas, Rabak City. A probability systemic random sample, calculated using the Cochran formula, was selected from the class lists of 6th, 7th, and 8th graders. [18] Inclusion criteria involved students who passed the previous year's

exams and provided informed consent. Exclusion criteria: Students with health problems affecting their learning capacity and those who refused to participate. Anthropometric measurements including height and weight were measured using a meter tape and weight scale, respectively. The Cochran formula $n = \frac{(z)^2 \times p(1-p)}{d^2} = \frac{(1.96)^2 \times 16.3(1-16.3)}{(0.05)^2} = 209$; P: prevalence=the prevalence in Sudan in Previous literature was found to be 16.3 (21); Z: level of confidence =1.96; D: marginal error=0.05; Sample size (n) was 209. The malnutrition assessment that includes stunting (height-for-age z-score < -2SD) and thinness (BMI-for-age z-score < -2SD) were defined based on

WHO standards using AnthroPlus software. Academic performance categorized as excellent, good, or pass based on the previous year's exam scores. Socio- demographic data collected using a structured questionnaire with close-ended questions on age, gender, residence, parent's education and occupation, birth spacing, birth order, age of school enrollment, and family type. Data analysis based on descriptive statistics, frequencies, percentages, and chi-square tests were used to analyze the data. The statistical significance. A P- value ≤ 0.05 was considered statistically significant. One-sample t-test was used to assess the association between HAZ, BAZ, and academic performance. Data generated on the questionnaires were numbered and entered after cleaning and refined for analysis using Statistical Package for Statistical Analysis, Simple Social Science (SPSS) ® version 20 software for statistical analysis. [19]

by explaining the study objectives and measures to students and asking them to inform their parents. Students were included in the study only after their parents provided consent.

Table 1 The categorization of students According to last year's academic assessment in square nine areas in December 2021

Level	Mark range
V. Good/Excellent	Above 250
Good	249_200
Pass	199_140

3.1 Limitations and strengths of the study

Limitations might affect the results and Conclusions of this study. One of the important Limitation of the study is that it is Cross-sectional which could not establish a cause-and-effect relationship between the dependent and independent variables (shows correlation rather than causations). The present study was conducted in rural areas which can't be generalized to urban areas (the sample size is small or not representative of the broader population, the findings may have limited generalizability). The Studied participants were not proportional in sex (female participants were higher in number). In addition, the area of the study was chosen by convenience sampling also small size of the studied population both were Rolle by limited time and resources hence affecting the generalization of the results. The limitation of studying the assessment of malnutrition is done at a single point at a time. Fifth This study used only anthropomorphic measurements and did not assess the micronutrient status and quality of

4 Results

Demographic and Socioeconomic Characteristics of Families in the Square Nine Region during the study period in December, were displayed in dietary food due to limited resources and financial support. Also, the consent was not taken properly it must be taken directly from caregivers. Likewise, one of the limitations is that Anthro Plus doesn't calculate WHZ scores for children more than 10 years old. Whereas, the study strengths mainly address an important issue by investigating the link between nutritional status and academic performance, which has significant implications for public health and education policy. On the other hand, the existing study covering the period from 2021-2022 could provide insights into changes over time, especially when the study includes multiple assessments throughout the academic year. The most important Holistic Approach is being done by potentially considering multiple factors influencing both nutrition and academic performance (e.g., socioeconomic status, parental involvement), the study can offer a more nuanced understanding.

(Table:1). Maximum and minimum ages are (17, and 10) respectively with a mean of 12. 9 and SD 01.3 most of the Participants (33.3%) At the age of 13 years old. The

Participants were from 6, 7, and 8 classes, and major of them were from the 6th class 63.4%. The Relationship Between Sibling Count, Birth Order, and Inter Birth Interval Among Families in the Square Nine Regions in December 2021 were exhibited in (Table:2). The residence of the Participants from outside the village was (66.5%), while inside the village. The maximum and minimum number of siblings are 0, and 12 respectively. Whereas, the maximum and minimum order are (1, 11) respectively. However, the maximum and minimum number of years were (1, 12. 8). The age of school enrollment ranges from 5 to 10 years. Only 4.5% and 2% of Fathers and mothers stopped at the khalwa level respectively, while 5.6, and 13% respectively were illiterate in addition most of the Participants had primary education 55, 54%, Fathers and mothers had secondary education were 19, 17 % and those who end college were 16, 14%.10 (Fi:1. A and B). The majority of Fathers (87%)work in the private Sector (farmers, factory workers, drivers. etc.) and the others work in the governmental Sector (13%). Most of the mothers (88%) were in households and few (7.5 %) worked in the governmental and private Sectors respectively (Table:2). The average income level for most of the children's families was (2000-3000) (58%). Most of the Participants (89%) are from normal (not expanded) families, and children from expanded families (11%). The overall achievement shows that only (11.6%) of Participants achieved above 250 degrees, while most (49.5 %) of them achieved below 199 degrees, Students that

Table 1 Demographic and Socioeconomic Characteristics of Families in the Square Nine Region in December 2021

Parameters Studied	Percentages of the studied parameters	Percentages recorded
Gender	Male	48%
	Female	52%
Order of the Classroom	Classroom 6	37%
	Classroom 7	34%
	Classroom 8	29%
Residence	Outside the area	34%
	Inside the area	66%
Occupations	Governmental Sectors	13%
	Private Sectors	87%
occupations of fathers	Governmental Sectors	5%
Occupations of mothers	Private Sectors	7%
	Household	88%
Academic Acheivements	Excellent or Very good	12%
	good	39%
	Pass	49%
Average income level	Less than 2000 Sudanese pounds	38%
	2000 -3000 Sudanese pounds	58%
	3000-4000 Sudanese pounds	4%
Type of Family	Normal Family 89%	89%
	Extended Family	11%

Achieved [249-200] degrees were (38. 9%)(Table:2). The prevalence of chronic malnutrition (stunting) in all Participants was (7.1%) mean and SD of (-0.61), (0.96) respectively. While the prevalence of stunting in males was (15.8%) with mean and SD of (-1.01, 0.99) respectively.

Table 2 The Relationship Between Sibling Count, Birth Order, and Inter Birth Interval Among Families in the Square Nine Regions in December 2021

	Frequency	Percentages (%)	Frequency	Percentages%	Frequency	Percentages %
0	0	0	0	0	44	22.2
1	2	1	42	21.2	22	11.1
2	3	1.5	38	19.2	67	33.8
3	8	4	28	14.1	34	17.2
4	31	15.7	19	9.6	10	5.1
5	34	17,2	21	10.6	8	4
6	46	23,2	18	9.1	4	2
7	26	13,1	14	7.1	4	1
8	21	10.6	8	4	2	1
9	13	6.6	3	1.5	0	0
10	9	4.5	5	2.5	1	0.5
11	4	2	2	1	1	0.5
12	1	0.5	0	0	1	0.5
Total	198	100	198	100	198	100

Table 3 Prevalence of Stunting Among Participants in the Square Nine Area (December 2021): Overall, Male, and Female Analysis

Age groups Years	Months	N	Length/height-for-	age (%)	Mean	SD
			% < - 2SD	(95% CI)	Mean	
Total (5-19)	(61-228)	198	7.6	(3.6%,11.5%)	-0.61	0.97
Total (5-9)	(61-119)					
Total (10-14)	(120-179)	182	7.1	(3.1%,11.2%)	-0.6	0.97
Total (15-19)	(180-228)	16	12.5	(0%,31.8%)	-0.7	
Age groups Years	Months	N	Length/height-for-	age (%)	Mean	0.91
			% < - 2SD	(95% CI)	Mean	SD
Total (5-19)	(61-228)	95	15.8	(7.9%,23.6%)	-1.01	0.99
Total (5-9)	(61-119)					
Total (10-14)	(120-179)	86	15.1	(7%,23.3%)	-1.03	0.98
Total (15-19)	(180-228)	9	22.2	(0%, 54.9%)	-0.79	1.12

Table 3 demonstrates the prevalence of Stunting in females that was found to be zero. The prevalence of Thinness in both genders was found (34%) with mean and SD of (- 1.32, 1.44) respectively. While the prevalence of Thinness in males was found (43.6 %) with a mean and SD of (-1.64, 1.52), the prevalence of Thinness in females was found (to be 25.2%) with a mean and SD of (-1.03, 1.29) respectively. The association between academic achievement and socio-demographic factors is illustrated in (Table 3, and Table: 4). Prevalence of Thinness Among Participants in the Square Nine Area (December 2021); Overall, Male, and Female Analysis was registered in Table:4. A significant association

between malnutrition and gender and the educational level of mothers (Table: 5). Association between academic achievement and anthropometric measurements. In addition, significant associations between malnutrition

Table 4 Prevalence of Thinness Among Participants in the Square Nine Area (December 2021): Overall, Male, and Female Analysis

Age groups Years	Months	N	BMI-for-age (%)		
			% < - 2SD		(95% CI) 34
Total (5-19)	(61-228)				
		197		(27.1%,40.9%)	
Total (5-9)	(61-119)				
Total (10-14)	(120-179)	181	33.1	(26%,40.3%)	
Total (15-19)	(180-228)	16	43.8	(16.3%,71.2%)	
Age groups Years	Months	N	BMI-for-age (%)		
			% < - 2SD		(95% CI)
Total (5-19)	(61-228)		197	34	(27.1%,40.9%)
Total (5-9)	(61-119)				
Total (10-14)	(120-179)		181	33.1	(26%,40.3%)
Total (15-19)	(180-228)		16	43.8	(16.3%,71.2%)
Age groups Years	Months	N	BMI-for-age %)		
				% < -SD	(95% CI)
Total (5-19)	(61-228)		103		(16.4% 34.1%)
Total (5-9)	(61-119)			25.2	
Total10-14)	(120-179)		96	26	(16.7%,35.3%)
Total(15-19)	(180-228)		7	14.3	(0%,47.4%)

Table 5 Association Between Academic Performance and Sociodemographic Variables Among Children: Pearson Chi-Square Analysis in Square Nine Areas (December 2021)

Variables	Pearson Chi square value
Age	0.361
Gender	0.008
Order of classroom	0.06
Residence	0.769
Number of siblings	0.885
Order in family	0.692
Birth spacing	0.876
Age of school enrollment	0.405
Educational level of father	0.746
Educational level of mother	0.001

Occupation of father	0.127
Occupation of mother	0.76
Estimated income level	0.156
Type of family	0.581

variables and academic performance were recorded (Table :3 and Table: 4). Whereas, T-Test Analysis of the Association Between Academic Performance HAZ, and BAZ Among Children in the Square Nine Area (December 2021) is recorded in (Table: 6). Furthermore, the Association Between Academic Performance and Sociodemographic Variables Among Children: Pearson Chi-Square Analysis in Square Nine Areas (December 2021). The study found a high prevalence of malnutrition, with 40% of students stunted and 25% thin. Malnutrition was significantly associated with poorer academic performance. Students classified as stunted or thin were more likely to have lower exam scores compared to their well-nourished peers. The study found that gender and mothers' educational level could affect school performance. A High prevalence of malnutrition (stunting, thinness) and a significant association with academic performance is found among rural primary school children of Square Nine areas, Rabak district (Table:5).

Table 6 T-Test Analysis of the Association Between Academic Performance and HAZ, BAZ Among Children in the Square Nine Area (December 2021)

				Lower	Upper
48.824	197	0	2.379	2.28	2.47
-12.959					
	197	0	-1.34313	-1.5475	-1.1387
-8.891	197	0	-0.61106	-0.7466	-0.4755

Df Sig. (2- tailed) Mean Difference 95% Confidence Interval of the Difference

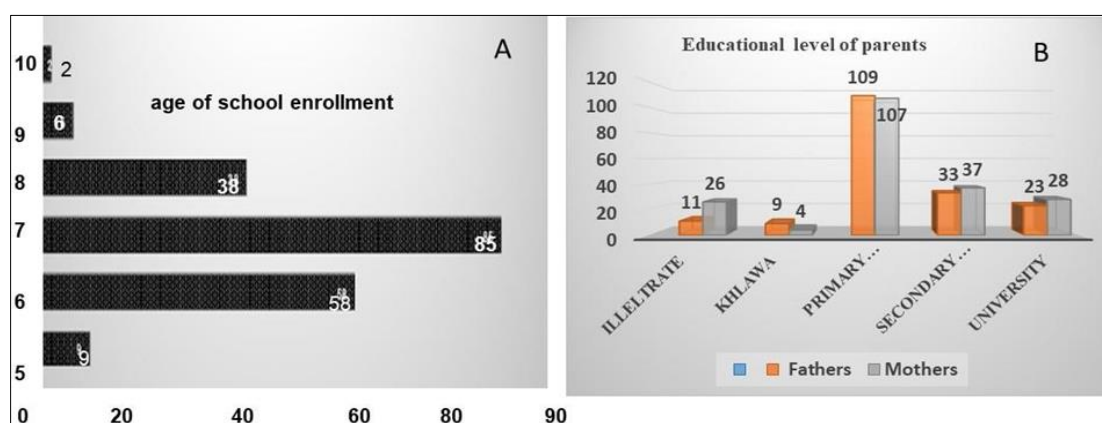


Figure 1 A. Displays the age of school enrollment in the Square Nine area in December 2021. B: Demonstrates Different parents' educational levels in the Square Nine area in December 2021

5 Discussion

The nutritional status of a child is a critical indicator of their overall health. Undernutrition is both a health outcome and a risk factor, initiating a cycle that leads to infectious diseases and significant child mortality. [20-22] This study evaluates malnutrition through anthropometric measurements among school children and examines its impact on academic performance in the Rabak district, White Nile State. The contemporary study assessed malnutrition by anthropometric measurements among school children and its effect on academic performance in square nine areas in Rabak district, White Nile state. The overall Response rate was found to be (95%). Most of the respondents were female who accounted for (52%) while male students accounted for (48%). The average age of Pupils is (12.9 years) similar to

the study conducted in Nigeria (12. years). These outcomes seem to indicate that many of these children either enrolled late, repeated a class once or more times or even temporarily dropped out of school. In the light of the fact that the northern Sudan law requires the age of 6 years for children enrollment in primary education. [13] The overall prevalence of stunting was (7.5%). In contrast, the study registered a higher prevalence of Thinness (43%) whereas, a similar percentage was recorded in a study completed in Addis Ababa (7.2%). [23] Many studies verified a prevalence of thinness of (8. 9%) in eastern Ethiopia While (7.1%) registered in northern Sudan Dongola [11] and (22%) in eastern Sudan Kassala. [24,8] Stunting is an indicator of chronic malnutrition and reflects the cumulative effect of undernutrition. Demographics, socioeconomic factors, and recurrent infections are the main reasons for some wide variations in the prevalence of stunting that have been observed. [25] In this context prevalence of Thinness, was higher in the study conducted in Kassala eastern Sudan (32.3%). [24,8] and in Sirilanka (34%). [25] This difference might be due to the differences in dietary intake, socioeconomic, and cultural differences. [26] Interestingly, the study found that the prevalence of stunting and thinness increased with age, possibly due to higher nutritional demands and parents becoming less attentive to older children. [27] These findings correspond to a study conducted in Bangladesh. [28] however, boys tended to be more stunted and thinner than girls. This outcome is similar to the study conducted in developing countries such as Uganda and Tanzania [29] Sub-Saharan Africa [30] and South Asia. [31]. These results can be explained by the fact that boys stay most of the time outside the home and they practice exercise or play with friends or work. Therefore, they might decrease their access to available food. Contrary, females spend most of their time inside homes that offer them better access to available food. High activity levels in boys to high energy loss may lead to higher undernutrition in boys than girls. [20,32,33]. According to the previous studies conducted in Egypt, India, and Bangladesh, reverse results were registered. These outcomes could be attributed to the proper care received and nutritional intake to boys rather than girl. These findings approve that females are more stunted than males. [28] other factors may include genetic factors, ethnicity, hormonal changes, and pubertal growth spurt may play crucial role in affecting body weight gain and body growth. [33] The researchers of the present study noticed that the prevalence of stunting increases with age in boys, while it decreases with age among girls'. Similar results, were in consistent with a study conducted in Tanzania. [30] The existing study shows an association between academic performance and various socio-demographic characteristics. No significant difference was reported except for the mother educational levels (p-value00). These outcomes conform with the studies conducted in Ethiopia, Morocco, Malaysia, Iran, Southwest Ethiopia, and Hawa Gelan and go with the same findings with the present study. Children who has a high mother's educational levels have higher educational outstanding levels if they compare with those with lower or secondary educational status. This signifies the importance of educating females in improving the child's nutritional status as well as academic achievement. [35,36] A significant association between grade and gender was reported in the study and on the same line as it reported in Malaysia which may be attributed to sex differences that might likely affect the brain functions and cognitive processes related to academic performance. This may increase the tendency to revise and raise the levels of interest among students. [37] Moreover, in developing countries macronutrient and micronutrient deficiencies are a devastating problem for health up bring. of the primary school pupils that may influence children's future lives. [38] The early nutritional deficit may have persistent effects on children's achievement. Improved nutritional status has been exposed to have a positive and direct impact on the academic performance of children. Using one sample t-test there is a significant association between HAZ, BAZ, and academic performance ($p \leq 05$). This finding is in line with a study done in Sri Lanka and Uganda, Ethiopia. [38] However, the finding is quite different from a study conducted in Morocco that indicates WAZ did not have a significant association with the academic achievement of primary school children. The study recommends policymakers improve and enhance female education, especially in rural areas due to its direct effect on the academic performance of the children. The contemporary study highlighted that the introduction of a school nutritional program may be useful together with the nutritional status which needs to be improved by consuming a balanced diet and by implementing continuous community-based programs addressing nutritional education and income generation. Nutritional screening for school children by anthropometric measurements using Anthro Plus is highly recommended and advocated as a useful inexpensive tool for standardized anthropometric assessment of all age groups. Eventually, the strategic location of the schools, which serve multiple surrounding villages, and the inclusion of all students (except those with medical conditions) allowed the study to provide a comprehensive assessment of the nutritional status and its academic impact in this setting. The findings highlight the need for targeted interventions to address malnutrition and improve educational outcomes in this population. Further studies with larger sample sizes with Longitudinal aspects that cover long periods could provide insights.

6 Conclusion

As the nutritional status is very important for school-age children, we stated that in developing countries macronutrient and micronutrient deficiencies are a devastating problem for health up bring. of the primary school pupils that may influence children's future lives. Our paper revealed some part of the problem and its influence in children performance.

Compliance with ethical standards

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Disclosure of conflict of interest

All authors have no conflict interest of publishing this research.

Statement of ethical approval

The ethics consideration have been taken from Allhumiraa banat secondary school, omdurman , Sudan. to analyze the data. The statistical significance.

Clearance obtained from the Department of Community Medicine, Faculty of Medicine, University of Khartoum. Permission is secured from the school managers. Informed consent was obtained from parents indirectly.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

Data availability declaration

All data available.

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