J Glob Health Sci. 2025 Dec;7(2):e27
https://doi.org/10.35500/jghs.2025.7.e27
pISSN 2671-6925·eISSN 2671-6933

Journal of Global Health Science JGHS

Original Article

Check for updates

Association of health and nutrition challenges on school children in Kibaha, Tanzania

Sunjoo Kang[1], **Insook Kwon**[1], **Da Sol Jung**[1], **Peter Dattani**[2], **Felician Paschal Mgasa**[3], **Youngjong Baek**[4], **Gyuri Kwon**[5], **Seohyun Song**[1], **Vasuki Rajaguru**[6]

[1]Deaprment of Global Health and Disease Control, Graduate School of Public Health Yonsei University, Seoul, Korea
[2]Department of Pediatrics, Muhimbili National Hospital - Mloganzila, Dar es Salaam, Tanzania
[3]Department of Curative Services, National Public Health Laboratory, Ministry of Health, Dar es Salaam, Tanzania
[4]Severance Hospital, Yonsei University Health System, Seoul, Korea
[5]Department of English for International Conferences and Communication, Hankuk University of Foreign Studies, Seoul, Korea
[6]Department of Healthcare Management, Graduate School of Public Health Yonsei University, Seoul, Korea

OPEN ACCESS

Received: Sep 23, 2025
Accepted: Nov 16, 2025
Published online: Dec 15, 2025

Correspondence to
Vasuki Rajaguru
Department of Healthcare Management, Graduate School of Public Health Yonsei University, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea.
Email: vasuki@yuhs.ac

ORCID iDs
Sunjoo Kang
https://orcid.org/0000-0002-1633-2558
Insook Kwon
https://orcid.org/0009-0000-0603-2335
Da Sol Jung
https://orcid.org/0000-0003-1004-769X
Peter Dattani
https://orcid.org/0009-0008-9098-8521
Felician Paschal Mgasa
https://orcid.org/0009-0007-8199-5255
Youngjong Baek
https://orcid.org/0009-0009-2727-7521

ABSTRACT

Background: School children in peri-urban Tanzania face a dual burden of malnutrition, including undernutrition and overweight, compounded by limited health knowledge, suboptimal hygiene practices, and varying family support. Understanding these factors is critical for developing effective school-based interventions. This study aims to examine nutrition status, and health behaviors of school children in Kibaha and evaluate associations with demographic, familial, and socioeconomic factors.

Methods: A cross-sectional study was conducted among 319 children aged 10–13 years. Data was collected using structured questionnaires adapted from the Global School-Based Student Health Survey and supplemented with physical health examinations. Health practices, interpersonal relations, family environment, and health knowledge were assessed. The correlations and multiple linear regression analyses were performed to determine associations with covariates.

Results: Among participants, prevalence was 26.9% underweight, 67.8% normal weight, and 5.3% overweight/obese. Health practices were positively correlated with family environment ($r = 0.101$, $P < 0.05$) and negatively correlated with health knowledge ($r = –0.208$, $P < 0.01$). Regression indicated that grade level ($\beta = –0.154$, $P = 0.010$) and socioeconomic status ($\beta = 0.035$, $P = 0.032$) were significant predictors of health practices, while gender ($\beta = 0.111$, $P = 0.049$) influenced health knowledge.

Conclusion: The coexistence of undernutrition and overweight underscores the dual burden of malnutrition in this population. School-based interventions integrating nutrition education, hygiene promotion, and psychosocial support are urgently needed. Programs should be tailored to local socioeconomic conditions, involve families, and reinforce healthy behaviors throughout education to promote long-term health, cognitive development, and well-being in peri-urban Tanzanian children.

Keywords: Nutritional intake; Child malnutrition; Health behaviors; School-based health services; Tanzania; Malnutrition

Gyuri Kwon
https://orcid.org/0009-0007-0299-6605
Seohyun Song
https://orcid.org/0009-0004-1078-7991
Vasuki Rajaguru
https://orcid.org/0000-0003-2519-2814

Conflict of Interest
The authors declare that they have no competing interests.

Author Contributions
Conceptualization: Kwon I, Dattani P, Baek Y, Song S; Data curation: Kang S, Jung DS, Dattani P, Paschal Mgasa F, Baek Y, Song S; Formal analysis: Kang S, Kwon I, Jung DS, Dattani P, Paschal Mgasa F, Baek Y, Song S, Kwon G, Rajaguru V; Funding acquisition: Kang S; Investigation: Kwon I, Jung DS, Dattani P, Paschal Mgasa F, Baek Y, Song S, Kwon G; Methodology: Kwon I, Jung DS, Paschal Mgasa F, Baek Y, Song S, Kwon G, Rajaguru V; Project administration: Kang S; Resources: Kang S, Kwon I, Jung DS, Dattani P, Paschal Mgasa F, Song S, Kwon G, Rajaguru V; Software: Jung DS, Song S, Rajaguru V; Supervision: Kang S, Jung DS; Validation: Kwon I, Jung DS, Dattani P, Baek Y, Kwon G, Rajaguru V; Visualization: Dattani P, Baek Y, Kwon G, Rajaguru V; Writing - original draft: Kang S, Rajaguru V; Writing - review & editing: Kang S, Kwon I, Paschal Mgasa F, Baek Y, Song S, Kwon G, Rajaguru V.

INTRODUCTION

Tanzania has experienced increasing internal migration, with many families relocating from rural areas to urban peripheries in search of income, disrupting traditional family and community structures. Urbanization affects children's physical and emotional wellbeing in both developed and developing countries.[1] Consequently, low-income urban areas host large populations of children exposed to poverty, unstable housing, and heightened health risks, including infectious diseases and pediatric human immunodeficiency virus (HIV), of which only 50.1% of the 90% diagnostic coverage target has been met.[2,3]

Kibaha, the capital of Pwani Region and a rapidly growing peri-urban area approximately 40 km west of Dar es Salaam, has seen an influx of low-income families, outpacing infrastructure development, particularly in school health services.[4] However, this urbanization has outpaced infrastructure development, particularly in school health services. The area was selected for this study because it represents the socioeconomically disadvantaged yet rapidly transforming setting where children's health needs are often overlooked. Since 2013, Korean ODA programs have operated in the region, providing an opportunity to assess the health of school children within the context of ongoing interventions.[5]

Although Tanzania shows some improvement in child health indicators, including under-5 mortality and immunization coverage, the prevalence of malaria, tuberculosis, HIV/acquired immunodeficiency syndrome (AIDS), and AIDS-related mortality remains high.[6] Limited access to clean water, poor sanitation, and low education exacerbate vulnerabilities, threatening children's physical and cognitive development.[7] In low-income regions, malnutrition, anemia, micronutrient deficiencies, and parasitic infections remain prevalent,[8-10] while food insecurity contributes to both undernutrition and a rising prevalence of overweight and obesity, projected to reach 9.1% among children by 2030.[11] Childhood obesity is strongly associated with adult obesity and increases the risk of costly chronic conditions such as cardiovascular disease and diabetes.[12]

In the Pwani Region, adolescent health concerns include early pregnancy, sexual health, overcrowded schools, limited access to clean water, and shortages of healthcare resources.[13] Given that childhood and adolescence are critical periods for future health, schools serve as essential environments for health promotion, where habits and knowledge formed influence adult wellbeing and academic achievement.[14,15] Structured school health services are thus crucial to support physical, psychological, and behavioral development.[16,17] Despite the National Health Policy emphasizing public health promotion, limited data and weak program implementation hinder the evaluation of adolescent health.[18,19]

The Global School-based Student Health Survey (GSHS), developed by World Health Organization (WHO) and U.S. Centers for Disease Control and Prevention (CDC) and implemented in over 100 countries, collects data on key adolescent health behaviors and protective factors, facilitating policy development.[20,21] Although primarily targeting ages 13–17, younger children aged 10–12 can also provide meaningful insights into early health and nutrition interventions.[18]

Building on this evidence, this study surveyed and conducted physical examinations of school children in grades 4–7 (ages 10–13) in Kibaha. The study aimed to examine nutrition

and health behaviors among these children and evaluate associations between nutritional status, health behaviors, and socioeconomic factors. Health knowledge and behaviors were assessed alongside physical health to identify potential issues and generate foundational data to inform school-based health education programs and targeted interventions

This conceptual framework draws upon the UNICEF Conceptual Framework for Child Malnutrition and the WHO Commission on Social Determinants of Health, illustrating the multi-level influences on child health and nutrition outcomes in peri-urban Tanzania.[22,23] At the structural level, socio-economic determinants including gender, age/grade level, and household economic conditions, access to health-promoting resources and daily living environments, particularly in rapidly urbanizing settings (**Fig. 1**). These structural conditions influence the household and interpersonal context, such as caregiver support, peer interactions, and household food availability, which are known to play a crucial role in shaping children's health behaviors.[24]

At the individual level, immediate behavioral factors, including children's health knowledge (e.g., nutrition, hygiene, HIV awareness) and health practices (e.g., diet quality, physical activity, and hygiene routines) serve as proximal determinants that mediate the effects of broader social structures and family environments.[25] Together, these multi-layered determinants influence child health and nutrition outcomes, such as body mass index (BMI) status (underweight, normal, overweight), physical development, and risk of future non-communicable diseases.

By emphasizing the interconnected and layered nature of influences on school-aged children's health, the framework underscores the need for multi-level, school-family-community integrated strategies rather than single-component interventions to address the dual burden of malnutrition in peri-urban Tanzania.

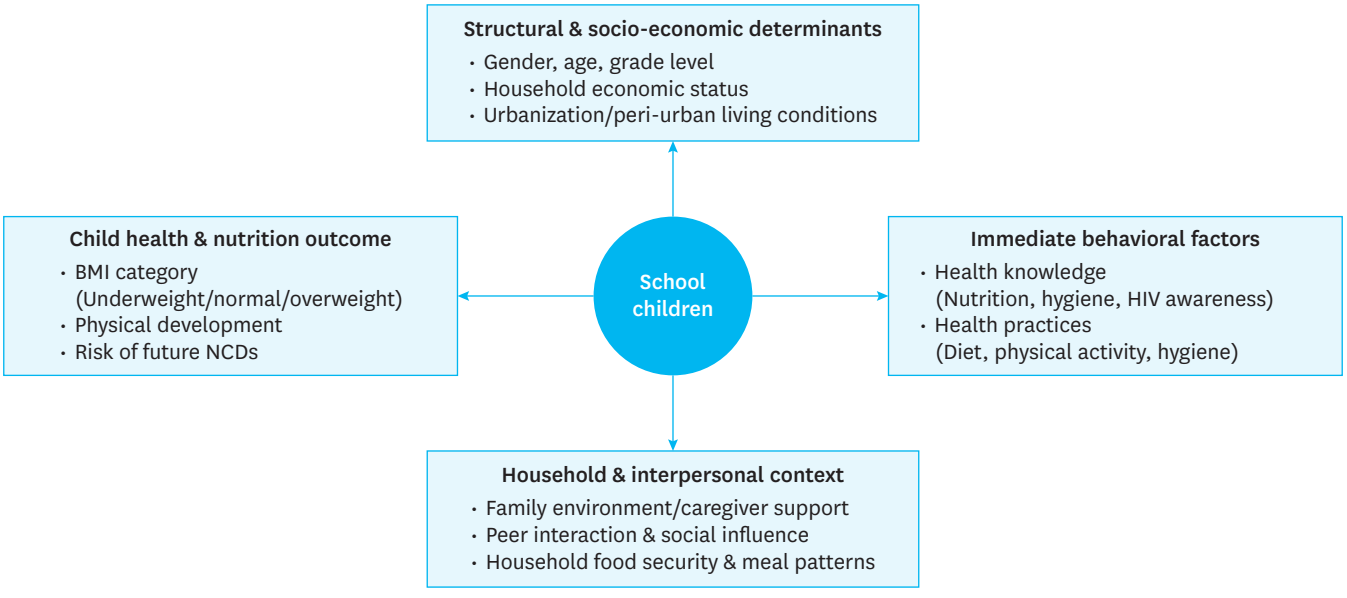

Fig. 1. Conceptual framework.
BMI = Body mass index; NCD = Non-communicable disease; HIV = Human immunodeficiency virus.

METHODS

Research design

This study employed a cross-sectional descriptive design, targeting school children from a public school in Kibaha, Pwani Region, Tanzania. Data was collected using both structured questionnaires and physical health examinations. The study focused on children aged 10–13 years (grades 4–7), a critical developmental stage when health behaviors and knowledge are forming, making it ideal for early health intervention strategies.

Population and setting

The study was conducted in the Pwani Region, one of Tanzania's poorest areas despite its proximity to Dar es Salaam and some industrial activity (**Supplementary Fig. 1**). With a gross domestic product per capita of 1.7, well below the national average of 3.05, Pwani ranks among the bottom 4 of 16 regions nationwide.[26] Persistent poverty has contributed to widespread malnutrition from antenatal care through childhood, including food insecurity, limited vegetable intake, and low access to affordable protein among school-age children.[27,28]

Kibaha, a peri-urban area near Dar es Salaam where Korean ODA projects have operated since 2013, was selected for its low-income communities, health disparities, and relevance for assessing schoolchildren's health and nutrition. The school was chosen based on accessibility, safety, and administrative willingness to participate, with gender proportion balanced across the sample.

The study participants were school children in grades 4 to 7 who provided written informed consent along with their parents or guardians. Schoolchildren were excluded if they had severe physical or mental illnesses, communication difficulties, or were unable to obtain parental consent. The required sample size was calculated using the G*Power 3.1 program, yielding a target of 305 participants. To account for a 20% dropout rate, the final sample size was set at 366. A total of 375 responses were collected, and after excluding incomplete or insincere responses, data from 319 participants were included in the final analysis.

Instrumentation

In this study, BMI-for-age Z-scores (BAZs) were calculated using WHO reference standards for children aged 5–19 years. Categories were defined as: BAZ < −2 standard deviation (SD) (thinness), −2 to +1 SD (normal), > +1 SD (overweight), and > +2 SD (obesity) (**Table 1**).[29]

The survey instrument was adapted from the GSHS, developed jointly by the WHO and the CDC.[30] The interpersonal relations were measured using 5 Likert-scale items (1 = never to 5 = always) assessing peer and family communication quality. The health-knowledge items were factual multiple-choice questions (16 items, scored 0–5), with total scores converted to a composite index (Cronbach's α = 0.89). Items were modified to ensure appropriate

Table 1. BMI-for-age Z-scores

BAZ	Nutritional status	Category
> +2 SD	Obese	Overweight/obese
> +1 SD to ≤ +2 SD	Overweight	
≥ −2 SD to ≤ +1 SD	Normal weight	Normal
< −2 SD	Thinness/underweight	Underweight or low
< −3 SD	Severe thinness	

BAZ = body mass index-for-age Z-score; SD = standard deviation.

https://doi.org/10.35500/jghs.2025.7.e27

age content for middle school children (**Supplementary Table 1**). In addition to the questionnaire, physical health examinations were conducted, which included measurements of students' height, weight, visual acuity, and hearing ability, providing objective data to complement the survey responses.

A pilot test was conducted to refine the questionnaire, ensuring clarity, relevance for the target population, and internal consistency, with a Cronbach's alpha of 0.89. This structured approach allowed for a comprehensive assessment of students' health behaviors, social environments, and physical health status, contributing to a more holistic understanding of the factors influencing their well-being.

Data collection

Recruitment notices were posted on the school bulletin board and shared during school assemblies to inform students and their parents or guardians about the study. Written informed consent from guardians and assent from children were obtained prior to participation, emphasizing voluntary involvement, confidentiality, and the right to withdraw at any time. A team of trained research assistants conducted data collection over one month (November–December 2024), following standardized protocols to ensure accuracy and maintain a child-friendly environment.

Data collection comprised 2 components: administration of the structured questionnaire and physical health screenings. Students completed surveys on demographics, health behaviors, interpersonal relationships, family environment, and health knowledge under supervision for about 40 minutes, with research assistants providing clarifications when needed. Physical measurements, including height, weight, visual acuity, and hearing ability, were conducted using calibrated equipment in private settings about 2–3 hours per week. Survey responses and screening results were linked using unique participant codes to maintain confidentiality. Any health concerns identified during screenings were referred to the school nurse or local health services for follow-up, enabling a comprehensive assessment of students' health status and behaviors.

Data analysis

Data were analyzed using SPSS version 28. First, descriptive statistics summarized participants' demographics, BMI categories, health behaviors, family relations, and health knowledge. Second, χ^2 tests and *t*-tests/analysis of variance assessed associations between sociodemographic variables and BMI or health-related outcomes. Third, Pearson correlations evaluated relationships among health behaviors, family relations, and health knowledge. Multivariate logistic regression examined factors associated with BMI categories by adjusting the covariates, with odds ratios and 95% confidence intervals (CIs) reported. Multiple linear regression analyzed predictors of continuous health behavior, interpersonal relations, family environment, and health knowledge scores, controlling for sociodemographic factors, with beta coefficients, standard errors, and adjusted R^2 values reported. The significance level considered is set at $P < 0.05$.

Ethical considerations

This study received ethical approval from Severance, Yonsei University Ethical Committee (IRB No. 2024 0942 004, dated October 16, 2024). Written informed consent was obtained from guardians of all participating school children. No personally identifiable information beyond school and grade level was collected during the study.

RESULTS

General characteristics of participants

Table 2 presents the general characteristics of the 319 schoolchildren. The sample was nearly balanced by sex (51.4% boys, 48.6% girls) and predominantly aged 13–15 years (56.7%), with smaller proportions aged 10–12 (5.6%) and 16–18 (37.6%). Most students were in grades 5–7, and the majority came from medium economic backgrounds (86.3%). Regarding nutritional status, 67.8% had normal BMI, 26.9% were underweight, and 5.3% were overweight or obese. Visual acuity was good in over 92% of children for both right and left eye, while normal hearing was observed in 72.8% for both ears. Mean scores indicated moderate Health Behavior (2.5 ± 0.22) and family support (2.69 ± 0.50), but lower health knowledge (1.43 ± 0.10).

Fig. 2 illustrates the distribution of BMI categories among school children by gender. Most boys and girls fall within the normal weight range (BMI category 1), with 67.8% overall. Boys and girls have similar proportions in the overweight category, representing 26.9% of the sample, while a small fraction of children (5.3%) is classified as obese (BMI 3).

Table 2. General characteristics of participants (n = 319)

Variables	Values
Sex	
Male	164 (51.4)
Female	155 (48.6)
Age (yr)	
10–12	18 (5.6)
13–15	181 (56.7)
16–18	120 (37.6)
Grade	
7	88 (27.5)
6	89 (27.8)
5	97 (30.3)
4	46 (14.4)
Economic level	
High	5 (1.6)
Middle	276 (86.3)
Low	39 (12.2)
Visual acuity (right)	
Good	302 (94.4)
Not good	18 (5.6)
Visual acuity (left)	
Good	297 (92.8)
Not good	23 (7.2)
Hearing right	
Good	233 (72.8)
Not good	87 (27.2)
Hearing left	
Good	233 (72.8)
Not good	87 (27.2)
BMI	
Underweight	217 (67.8)
Normal	86 (26.9)
Overweight/obesity	17 (5.3)
Health behaviors	2.50 ± 0.23
Interpersonal relations	3.30 ± 0.95
Family environment	2.69 ± 0.50
Health knowledge	1.43 ± 0.10

Values are presented as mean ± standard deviation or number (%).
BMI = body mass index.

https://doi.org/10.35500/jghs.2025.7.e27

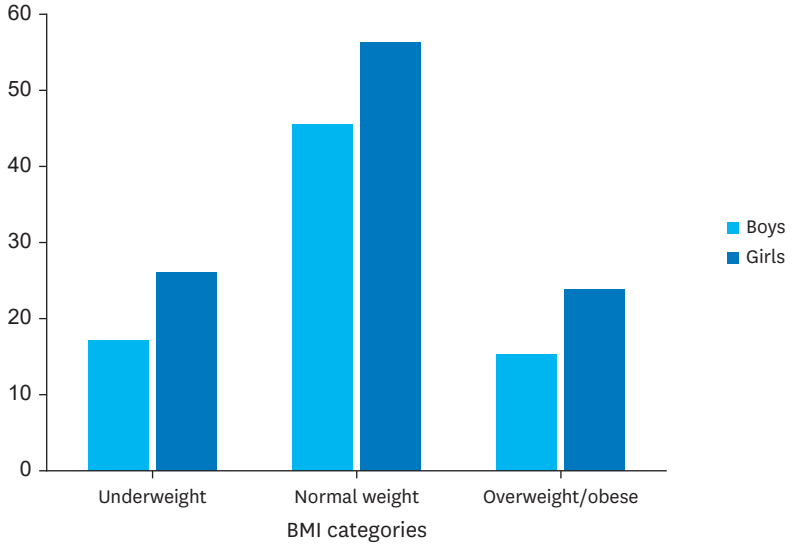

Fig. 2. BMI categories of the school children by sex.
BMI = Body mass index.

Comparison of differences between BMI and health related behaviors

Table 3 shows the distribution of BMI categories by demographic and sensory variables. Underweight was most common overall, with 71.2% of males and 64.7% of females

Table 3. Comparison of differences in association between BMI categories with sociodemographic variables

Variables	BMI			χ^2	*P*-value
	Underweight	Normal	Overweight/obesity		
Sex				1.708	0.426
Male	116 (71.2)	40 (24.5)	7 (4.3)		
Female	101 (64.7)	45 (28.8)	10 (6.4)		
Age (yr)				27.831	< 0.001
10 to 12	16 (88.9)	1 (5.6)	1 (5.6)		
13 to 15	140 (77.3)	34 (18.8)	7 (3.9)		
16 to 18	61 (50.8)	50 (41.7)	9 (7.5)		
Grade				57.274	0.394
7	40 (87.0)	6 (13.0)	0 (0.0)		
6	73 (75.3)	20 (20.6)	4 (4.1)		
5	72 (80.9)	15 (16.9)	2 (2.2)		
4	32 (36.8)	44 (50.6)	11 (12.6)		
Economic status				4.088	0.032
Low	24 (61.5)	12 (30.8)	3 (7.7)		
Middle	191 (69.5)	70 (25.5)	14 (5.1)		
High	2 (40.0)	3 (60.0)	0 (0.0)		
Visual (right)				2.387	0.114
Good	202 (67.1)	83 (27.6)	16 (5.3)		
Bad	15 (83.3)	2 (11.1)	1 (5.6)		
Visual (left)				4.348	0.061
Good	197 (66.6)	83 (28.0)	16 (5.4)		
Not good	20 (87.0)	2 (8.7)	1 (4.3)		
Hearing (right)				5.602	0.041
Good	66 (75.9)	20 (23.0)	1 (1.1)		
Not good	151 (65.1)	65 (28.0)	16 (6.9)		
Hearing (left)				1.298	0.523
Good	58 (26.7)	26 (30.6)	3 (17.6)		
Not good	159 (73.3)	59 (69.4)	14 (82.4)		

Values are presented as number (%).
BMI = body mass index.

https://doi.org/10.35500/jghs.2025.7.e27

($P = 0.426$). Age was significantly associated with BMI ($P < 0.001$), with 88.9% of 10–12-year-olds underweight, 77.3% of 13–15-year-olds underweight, and 50.8% of 16–18-year-olds underweight. Economic status also showed significance ($P = 0.032$), with 61.5% of low-, 69.5% of middle-, and 40% of high-income children underweight. Hearing status was significantly related to BMI (right ear: $P = 0.041$; left ear: $P = 0.002$), with children with normal hearing more underweight (75.9%) than those with impaired hearing (65.1%). Gender, grade, and visual acuity were not significantly associated with BMI.

Multiple logistic regression analysis-association between the BMI categories and covariates

Table 4 presents the multinomial regression results indicate that age, grade level, and hearing status were key factors associated with BMI categories among schoolchildren. Compared to children aged 10–12 years, those aged 13–15 and 16–18 years showed higher odds of being underweight (B = 1.57 and 2.17, respectively), although these associations did not reach statistical significance ($P = 0.17$ and $P = 0.07$). Grade level demonstrated a meaningful trend: students in grade 7 had substantially higher odds of being either underweight (B = 1.21, $P = 0.06$) or overweight/obese (B = 2.43, $P < 0.001$) compared with those in grade 4. However, hearing difficulties showed strong associations: children with impaired hearing in the right ear had significantly higher odds of overweight/obesity (B = 4.44; 95% CI, 0.85 to 8.03; $P = 0.02$), while impaired hearing in the left ear was associated with significantly lower odds of overweight/obesity (B = –4.14, $P = 0.02$).

Table 4. Multinomial logistic regression analysis of factors associated with BMI categories (reference: underweight)

Variables	Normal					Overweight/obesity				
	Estimate	SE	Z	95% CI	*P*-value	Estimate	SE	Z	95% CI	*P*-value
Age group (yr)										
10–12	1.00					1.00				
13–15	1.57	1.14	1.37	−0.67 to 3.80	0.17	−2.77	1.74	−1.59	−6.17 to 0.64	0.11
16–18	2.17	1.21	1.80	−0.19 to 4.54	0.07	−2.74	1.76	−1.56	−6.18 to 0.71	0.12
Sex										
Male	1.00					1.00				
Female	0.4	0.29	1.36	−0.17 to 0.97	0.17	0.91	0.58	1.56	−0.23 to 2.05	0.12
Grade										
4	1.00					1.00				
5	0.10	0.57	0.18	−1.01 to 1.21	0.86	0.82	0.50	1.65	−0.10 to 1.87	0.10
6	−0.29	0.64	−0.46	−1.54 to 0.96	0.65	0.47	0.51	0.92	−0.49 to 1.55	0.35
7	1.21	0.65	1.85	−0.07 to 2.48	0.06	2.43	0.49	5.00	1.54 to 3.48	<.001
Economic level										
Middle	1.00					1.00				
Low	−0.16	0.43	−0.37	−1.00 to 0.68	0.71	−0.11	0.10	−1.05	−0.30 to 0.09	0.29
High	0.70	1.20	0.58	−1.65 to 3.05	0.56	0.14	0.28	0.50	−0.41 to 0.68	0.62
Visual acuity (right)										
Good	1.00					1.00				
Not good	−0.43	0.81	−0.53	−2.02 to 1.16	0.60	0.88	1.24	0.71	−1.55 to 3.30	0.48
Visual acuity (left)										
Good	1.00					1.00				
Not good	−1.06	0.78	−1.36	−2.58 to 0.46	0.17	0.06	1.17	0.05	−2.23 to 2.34	0.96
Hearing right										
Good	1.00					1.00				
Not good	1.57	1.16	1.35	−0.71 to 3.85	0.18	4.44	1.83	2.42	0.85 to 8.03	0.02
Hearing left										
Good	1.00					1.00				
Not good	−1.81	1.17	−1.55	−4.10 to 0.48	0.12	−4.14	1.73	−2.39	−7.53 to −0.75	0.02

SE = standard error; CI = confidence interval.

https://doi.org/10.35500/jghs.2025.7.e27

Table 5. Correlation between health behaviors, interpersonal relations, family environments and health knowledge

Variables	Health practice	Interpersonal relations	Family environments	Health knowledge
Health practice	1	0.094	0.101[a]	−0.208[b]
Interpersonal relations		1	0.053	−0.106
Family environment			1	−0.026
Health knowledge				1

[a]Correlation is significant at the 0.05 level (2-tailed).
[b]Correlation is significant at the 0.01 level (2-tailed).

Correlation among health practice, interpersonal relations, family environment, and health knowledge

The interrelationships among the 4 key variables were examined using Pearson correlation coefficients (**Table 5**). Health practice showed a small positive correlation with interpersonal relations ($r = 0.094$) and family environment ($r = 0.101$, $P < 0.05$), indicating that supportive family and social contexts are modestly associated with healthier behaviors. Conversely, health knowledge was negatively correlated with health practice ($r = –0.208$, $P < 0.01$) and interpersonal relations ($r = –0.106$). Family environment demonstrated minimal correlations with health knowledge ($r = –0.026$, $P < 0.05$) and interpersonal relations ($r = 0.053$).

Multinomial linear regression association between health practice, interpersonal relations, family environment, and health knowledge and covariates

Table 6 illustrates the results of multiple linear regression analyses showed that health practice scores declined with increasing grade level (β = –0.154; 95% CI, –0.058 to –0.008; $P = 0.010$), indicating reduced hygiene and nutrition behaviors among older students. Health

Table 6. Multiple linear regression association between health practice, interpersonal relations, family environments and health knowledge and covariates

Variables	B	SE	Beta	t	95% CI	*P*-value
Health practice[a]						
(Constant)	2.679	0.097		27.509	2.488 to 2.871	< 0.001
Sex	−0.016	0.025	−0.036	−0.639	−0.064 to 0.033	0.523
Age	0.022	0.035	0.035	0.625	−0.046 to 0.090	0.532
Economic status	−0.008	0.022	−0.021	−0.352	−0.052 to 0.036	0.725
Grade	−0.033	0.013	−0.154	−2.606	−0.058 to −0.008	0.010
Interpersonal relations[b]						
(Constant)	3.203	0.223		14.355	2.764 to 3.642	0.016
Sex	−0.052	0.056	−0.052	−0.916	−0.163 to 0.059	0.062
Age	−0.053	0.079	−0.038	−0.667	−0.209 to 0.103	0.021
Economic status	−0.032	0.051	−0.037	−0.626	−0.132 to 0.068	0.027
Grade	−0.050	0.029	−0.103	−1.737	−0.107 to 0.007	0.016
Family environments[c]						
(Constant)	3.203	0.223		14.355	2.764 to 3.642	< 0.001
Sex	−0.052	0.056	−0.052	−0.916	−0.163 to 0.059	0.361
Age	−0.053	0.079	−0.038	−0.667	−0.209 to 0.103	0.366
Economic status	−0.032	0.051	−0.037	−0.626	−0.132 to 0.068	0.505
BMI	−0.050	0.029	−0.103	−1.737	−0.107 to 0.007	0.083
Health knowledge[d]						
(Constant)	1.407	0.044		32.118	1.321 to 1.493	< 0.001
Sex	0.022	0.011	0.111	1.978	0.000 to 0.044	0.049
Age	0.028	0.016	0.101	1.810	−0.002 to 0.059	0.734
Economic status	−0.007	0.010	−0.042	−0.707	−0.027 to 0.013	0.007
Grade	−0.009	0.006	−0.092	−1.571	−0.020 to 0.002	0.117

B = estimate; SE = standard error; CI = confidence interval.
[a]$R = 0.169$; $R^2 = 0.029$; Adjusted $R^2 = 0.016$; $F = 2.319$; $P = 0.057$.
[b]$R = 0.127$; $R^2 = 0.016$; Adjusted $R^2 = 0.016$; $F = 1.029$; $P = 0.041$.
[c]$R = 1.574$; $R^2 = 0.248$; Adjusted $R^2 = 0.393$; $F = 1.586$; $P = 0.178$.
[d]$R = 0.193$; $R^2 = 0.037$; Adjusted $R^2 = 0.025$; $F = 3.035$; $P = 0.018$.

knowledge was significantly higher among girls than boys (β = 0.111; 95% CI, 0.000 to 0.044; $P = 0.049$). Economic status and gender were not significant predictors of health practice, interpersonal relations, or family environment scores ($P > 0.05$). Correlation analysis demonstrated a negative correlation between health knowledge and health practice ($r = –0.208$, $P < 0.01$), and a weak positive correlation between family environment and health practice ($r = 0.101$, $P < 0.05$). Economic status and grade level demonstrated positive but non-significant associations with health knowledge.

DISCUSSION

This study aimed to determine the associations between nutritional status, multiple health, behaviors, and social indicators among school children in Kibaha, Tanzania. The findings revealed that overweight and obesity were more prevalent among girls, especially in higher grades,[31,32] while underweight prevalence showed little sex difference. BMI was significantly associated with several health-related outcomes.

The study's findings contribute to growing evidence of the dual burden of malnutrition among school-aged children in low- and middle-income countries (LMICs), where undernutrition and overweight increasingly coexist due to rapid urbanization and dietary transitions. The observed disparities in health practices and knowledge among Tanzanian schoolchildren are consistent with prior studies in sub-Saharan Africa showing that socioeconomic inequities and weak school health systems exacerbate nutritional imbalances.[18,33] International research further highlights that the erosion of traditional diets, coupled with limited access to balanced meals and physical activity, drives early-onset obesity while persistent food insecurity sustains undernutrition.[34] The positive association between family support and health practices underscores the importance of integrating parents into school-based nutrition and hygiene programs, a strategy proven effective in similar LMIC contexts. These results emphasize the need for comprehensive, school-centered health interventions that combine education, family engagement, and targeted nutritional support to mitigate the double burden of malnutrition and foster long-term behavioral change.

The study findings showed a balanced gender distribution and a range of BMI categories, with a substantial proportion of children within the normal weight range, while underweight and overweight statuses were also observed. These findings reflect the dual burden of malnutrition in transitional societies, where undernutrition and overweight coexist due to dietary transitions and urbanization.[9,11] Similar trends have been reported in peri-urban areas of sub-Saharan Africa, where rapid urban migration has led to dietary shifts, increased sedentary behavior, and rising childhood overweight prevalence alongside persistent undernutrition.[1,35] These patterns highlight the need for integrated school-based nutrition and physical activity interventions that address both undernutrition and overweight, tailored to the local socioeconomic and cultural context.

Age and grade level were associated with variations in health practice, suggesting that as children advance in school, engagement in healthy behaviors may decline, consistent with studies showing reduced physical activity and nutritional adherence in older school children.[14,34,36] Interpersonal relations and family environment scores were moderately correlated with health practices and knowledge, highlighting the importance of social and familial support in shaping health behaviors. These results aligned with prior research

indicating that strong parental engagement and positive peer interactions enhance adherence to healthy behaviors among school-aged children.[7,16,36,37] These findings suggest that school health interventions should actively involve families and peer networks, alongside age-appropriate education, to reinforce healthy practices and improve long-term child well-being.

Regression analyses revealed limited predictive power of sociodemographic variables such as gender, age, economic status, and grade for health behaviors and family interactions, explaining only a small proportion of variance. However, health knowledge was positively associated with female, corroborating findings from other sub-Saharan African settings, where girls often exhibit higher health literacy and awareness than boys.[2,18,38,39] The observed negative correlation between health knowledge and health practice emphasizes the well-documented knowledge-behavior gap, where children may understand recommended health practices but face environmental, social, or structural barriers that limit behavioral adoption.[10,14,15,18,40,41]

The finding that girls demonstrated significantly higher health knowledge than boys is consistent with prior research suggesting gender differences in school-based health learning and peer communication.[18] However, the negative association between health knowledge and health practice reinforces the well-documented knowledge-practice gap, in which children understand recommended behaviors but are constrained by environmental factors such as food insecurity, limited autonomy in household decisions, and peer norms.[7,33] The weak but positive influence of supportive family environments on health behaviors further underscores the importance of caregiver engagement in shaping daily routines and dietary choices.[16]

The decline in health practice scores with increasing grade level suggests that as children age, health behaviors may become more influenced by peer culture, academic stress, and reduced parental oversight, a trend mirrored in LMIC school health studies.[15,34,42] These findings support school-based, age-responsive interventions that combine classroom health education with structured nutrition guidance, hygiene strengthening, and psychosocial support, as recommended in recent reviews of school health programs in low-resource settings.[43-48] However, given that this study was conducted in a single peri-urban school using a cross-sectional design, findings should be interpreted within the local socioeconomic context and not generalized nationally. Future research should adopt multi-site longitudinal designs and incorporate qualitative inquiry with caregivers and teachers to better understand structural barriers to adopting healthy behaviors. Strengthening school health programming that integrates family engagement, nutrition support, and adolescent-friendly health messaging has the potential to improve child health outcomes and mitigate the growing dual burden of malnutrition in similar urbanizing settings.

Despite demonstrating adequate health knowledge, many students were unable to translate this into consistent health practices. This knowledge–practice gap may be shaped by contextual barriers such as limited access to nutritious foods, inconsistent parental supervision, and peer influence factors commonly described in ecological models of child health behavior. These structural constraints underscore the need for integrated school–family health interventions rather than knowledge-based education alone.

These findings underscore the multifactorial determinants of child health and the necessity of integrated interventions. Enhancing health knowledge alone is insufficient; effective programs should combine health education with parental involvement, peer-led initiatives,

school-based supportive environments, and improved access to resources such as clean water and nutritious food.[4,17] Policy implications include strengthening structured school health services, addressing disparities in health resources, and implementing ongoing monitoring of health behaviors to inform adaptive and context-specific interventions.

This study has several limitations. The cross-sectional design precludes causal inference, and self-reported data on health behaviors may be subject to recall or social desirability bias. Conducted in a single peri-urban school in Kibaha, the findings may not be generalizable to other regions or settings. The study captured a limited set of health indicators and did not include measures such as mental health, physical activity, or biochemical assessments, restricting the depth of analysis. Additionally, the absence of longitudinal data limits understanding of long-term health outcomes. Future research should incorporate larger, multi-site samples, longitudinal designs, and qualitative approaches to explore children's perceptions, parental attitudes, and school- and community-level factors affecting health behaviors.

The findings have several implications for health policy and school-based interventions in Tanzania. School programs should combine health education with practical activities, engage parents to strengthen family support, and provide nutritional interventions such as school feeding and diet education to address both undernutrition and emerging obesity. Targeted support for economically disadvantaged students is essential to reduce disparities in health knowledge, behaviors, and outcomes. The study findings recommend the context-specific strategies for peri-urban communities rather than universal prescriptions for the national level. Broader generalizations would require data from multi-regional or longitudinal studies. These recommendations align with Tanzania's National Health Policy and global strategies for adolescent and school-based health promotion.[17,19] Multi-level interventions in schools can enhance immediate health outcomes and support children's long-term physical, cognitive, and social development.

This study highlights the dual burden of undernutrition and overweight, hygiene challenges, and limited health knowledge among school children in a peri-urban Tanzanian setting. Health behaviors were influenced by grade level and socioeconomic status, while family support and health knowledge were key determinants. While this study provides valuable insights into the health and nutrition challenges of school children in peri-urban Tanzania, its findings should be interpreted within the context of a single-site, cross-sectional design. The policy recommendations proposed are therefore context-specific and intended to inform local school-based and community-level interventions rather than national generalizations. Future multi-site and longitudinal studies are needed to confirm these associations and strengthen the evidence base for broader health and nutrition policy development in Tanzania and similar LMIC contexts. These findings emphasize the need for multifaceted, context-specific interventions, including school-based health education, nutritional support, and parental engagement, to improve child health outcomes and promote sustainable well-being in rapidly urbanizing communities.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the invaluable assistance of teacher Richard Ezekia from Tumbi Primary School for their support in data collection.

SUPPLEMENTARY MATERIALS

Supplementary Table 1

The global school-based student health survey questionnaire

Supplementary Fig. 1

Study setting.

REFERENCES

1. Gracey M. Child health in an urbanizing world. *Acta Paediatr* 2002;91(1):1-8. PUBMED | CROSSREF
2. Shitindi J, Zhang Y, Nyello AO. To examine the underpinning factors responsible for child streetism in Dar Es Salaam and Dodoma cities, Tanzania. *Int J Sociol* 2023;7(2):13-39. CROSSREF
3. Exavery A, Charles J, Kuhlik E, Barankena A, Ally A, Mbwambo T, et al. Correlates of uptake of antiretroviral therapy in HIV positive orphans and vulnerable children aged 0–14 years in Tanzania. *HIV AIDS (Auckl)* 2020;12:233-41. PUBMED | CROSSREF
4. Fredrick LA, Lucian C, Urassa J. Women and land rights: the impact of formalization in Tanzania's Coastal Region. *Res Globalization* 2025;10:100288. CROSSREF
5. Atkinson J. What motivates South Korean official development assistance? *Asian Politics Policy* 2024;16(2):273-93. CROSSREF
6. Genda E, Mkute T. The persistence of mother to child transmission of HIV in Njombe Town Council in Tanzania. *East Afr J Appl Health Monit Eval* 2024;7(1):1-11. CROSSREF
7. Sangalang SO, Medina SAJ, Ottong ZJ, Lemence ALG, Totanes D, Valencia JC, et al. Protocol for a trial assessing the impacts of school based WaSH interventions on children's health literacy, handwashing, and nutrition status in low and middle income countries. *Int J Environ Res Public Health* 2020;18(1):226. PUBMED | CROSSREF
8. George B, Zemba J, Sewando P. Nutritional status of under-five children in Arumeru District, Tanzania. *East Afr J Agric Biotechnol* 2023;6(1):285-94. CROSSREF
9. Kanire E, Erick SB, Mdoe CN. Exploring the factors influencing undernutrition among children under five in Tanzania. *African J Empirical Res* 2024;5(2):240-9. CROSSREF
10. Mrimi EC, Palmeirim MS, Minja EG, Long KZ, Keiser J. Malnutrition, anemia, micronutrient deficiency and parasitic infections among schoolchildren in rural Tanzania. *PLoS Negl Trop Dis* 2022;16(3):e0010261. PUBMED | CROSSREF
11. Adom T, Kengne AP, De Villiers A, Puoane T. Prevalence of overweight and obesity among African primary school learners: a systematic review and meta-analysis. *Obes Sci Pract* 2019;5(5):487-502. PUBMED | CROSSREF
12. Kibret KT, Strugnell C, Backholer K, Peeters A, Tegegne TK, Nichols M. Life-course trajectories of body mass index and cardiovascular disease risks and health outcomes in adulthood: systematic review and meta-analysis. *Obes Rev* 2024;25(4):e13695. PUBMED | CROSSREF
13. Lugalla JL, Mbwambo JK. Street children and street life in urban Tanzania: the culture of surviving and its implications for children's health. *Int J Urban Reg Res* 1999;23(2):329-44. CROSSREF
14. Johnsunderraj SE, Francis F, Prabhakaran H. Child-to-child approach in disseminating the importance of health among children -a modified systematic review. *J Educ Health Promot* 2023;12(1):116. PUBMED | CROSSREF
15. Zhuravleva IL, Lakomova N. The role of the school in shaping the health of adolescents: socio cultural and regulatory aspects. *Sociol Med* 2023;21(2):159-70. CROSSREF
16. Singhal J, Herd C, Adab P, Pallan M. Effectiveness of school-based interventions to prevent obesity among children aged 4 to 12 years old in middle-income countries: a systematic review and meta-analysis. *Obes Rev* 2021;22(1):e13105. PUBMED | CROSSREF
17. International Commission on the Futures of Education; UNESCO. *Reimagining Our Futures Together: a New Social Contract for Education*. Paris, France: UNESCO; 2022.
18. Noor RA, Paulo HA, Shinde S, Tadesse AW, Tinkasimile A, Hussen Y, et al. School health and nutrition environments: a multicountry survey in five countries of sub Saharan Africa region—Burkina Faso, Ethiopia, South Africa, Sudan, and Tanzania. *Matern Child Nutr* 2023;21(S1):e13614. CROSSREF

19. Sahadevan S, Dar Iang M, Dureab F. Effect of adolescent health policies on health outcomes in India. *Adolescents* 2023;3(4):613-24. CROSSREF
20. World Health Organization. GSHS core questionnaire modules (2021). https://www.who.int/publications/m/item/gshs-core-questionnaire-modules-(2021). Updated 2021. Accessed September 11, 2025.
21. Jain S, Thapar RK. Life's crucial transition and leads for comprehensive trajectory: adolescents survey at physiological stages for prudent policies and refinements for practice. *J Family Med Prim Care* 2020;9(9):4648-55. PUBMED | CROSSREF
22. UNICEF. Conceptual framework on the determinants of maternal and child nutrition. https://www.unicef.org/media/113291/file/UNICEFConceptualFramework.pdf. Updated 2021. Accessed August 29, 2025.
23. World Health Organization. Closing the gap in a generation: health equity through action on the social determinants of health. https://www.who.int/publications/i/item/WHO-IER-CSDH-08.1. Updated 2008. Accessed August 30, 2025.
24. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet* 2013;382(9890):427-51. PUBMED | CROSSREF
25. Azzopardi PS, Hearps SJC, Francis KL, Kennedy EC, Mokdad AH, Kassebaum NJ, et al. Progress in adolescent health and wellbeing: tracking 12 headline indicators for 195 countries and territories, 1990–2016. *Lancet* 2019;393(10176):1101-18. PUBMED | CROSSREF
26. IPP. More regions with GDP per capita below national average. https://www.ippmedia.com/the-guardian/business/read/more-regions-with-gdp-per-capital-below-national-average-2024-11-05-130505. Updated 2024. Accessed September 15, 2025.
27. Heri R, Malqvist M, Yahya-Malima KI, Mselle LT. Dietary diversity and associated factors among women attending antenatal clinics in the coast region of Tanzania. *BMC Nutr* 2024;10(1):16. PUBMED | CROSSREF
28. Ngimbudzi EB, Massawe SN, Sunguya BF. The burden of anemia in pregnancy among women attending the antenatal clinics in Mkuranga District, Tanzania. *Front Public Health* 2021;9:724562. PUBMED | CROSSREF
29. World Health Organization. BMI-for-age (5–19 years)-indicators for growth reference data for 5–19 year. https://cdn.who.int/media/docs/default-source/child-growth/growth-reference-5-19-years/bmi-for-age-(5-19-years)/bmifa-girls-5-19years-z.pdf?sfvrsn=8f7e5b11_4. Updated 2007. Accessed September 12, 2025.
30. World Health Organization. *Global School-based Student Health Survey*. Geneva, Switzerland: World Health Organization; 2003.
31. Grimay AM, Hassen MN. Prevalence of overweight and obesity and associated factors among private primary school students in Gulele Sub-City of Addis Ababa, Ethiopia. *Epidemiology (Sunnyvale)* 2018;8(3):352. CROSSREF
32. Lee YH, You MA. Perception of COVID-19, and knowledge, attitude and practice of hand washing in elementary school students. *J Korean Public Health Nurs* 2022;36(1):20-32. CROSSREF
33. Jackson D, Prochnow T, Ettekal AV. Programs promoting physical activity and social-emotional learning for adolescents: a systematic literature review. *J Sch Health* 2024;94(10):994-1004. PUBMED | CROSSREF
34. Mosha M, Salla G, Mosha V, Nauma H, Msuya SE. The school environment and its effect on overweight/obesity: a case of Kilimanjaro, Tanzania. *Clin Nutr ESPEN* 2023;58:674. CROSSREF
35. Mwanri LMM. Sanitation and health in East Africa. *Public Health* 2020;120(9):883-9. CROSSREF
36. Mwakalebela FS, Minja EG, Mwalugelo YA, Killel E, Rajab RK, Mollel GJ, et al. Association between physical activity, nutritional status and cognitive performance among school children in southern Tanzania. *Front Public Health* 2025;13:1552215. PUBMED | CROSSREF
37. Zahedi H, Kelishadi R, Heshmat R, Hasani Ranjbar S, Esmaeil Motlagh M, Ardalan G, et al. Association of adolescents' weight status with life satisfaction: role of self, peers, family and school perception; the CASPIAN-IV study. *Minerva Pediatr* 2019;71(3):235-41. PUBMED | CROSSREF
38. Palermo T, Chzhen Y, Balvin N, Kajula L, Palermo T, Groppo V, et al. Examining determinants of gender attitudes: evidence among Tanzanian adolescents. *BMC Womens Health* 2020;20(1):195. PUBMED | CROSSREF
39. Kulkarni P, Nagendra , Ashok NC, Kumar DS, Siddalingappa H, Madhu B. World health organization-body mass index for age criteria as a tool for prediction of childhood and adolescent morbidity: a novel approach in southern karnataka, India. *Int J Prev Med* 2014;5(6):695-702. PUBMED
40. Alshahrani MS, Gannamaneni VK, Kakaraparthi VN, Alahmari KA, Alkhamis B, Reddy RS, et al. Health behaviors in school-aged children: global trends in education, socioeconomic status, and adolescent health. *Front Public Health* 2025;13:1514386. PUBMED | CROSSREF
41. Abdul-Raheem JN, Liu AJ, Collins ME. Reimagining the role of school-based health centers during the COVID-19 pandemic. *J Sch Health* 2021;91(4):271-3. CROSSREF

42. Global Nutrition Target Collaborators. Global, regional, and national progress towards the 2030 global nutrition targets and forecasts to 2050: a systematic analysis for the Global Burden of Disease Study 2021. *Lancet* 2025;404(10471):2543-83. PUBMED | CROSSREF

43. Jourdan D, Samdal O, Diagne F, Carvalho GS. The future of health promotion in schools goes through the strengthening of teacher training at a global level. *Promot Educ* 2008;15(3):36-8. PUBMED | CROSSREF

44. Kilgour L, Matthews N, Christian P, Shire J. Health literacy in schools: prioritising health and well-being issues through the curriculum. Sport Educ Soc 2015;20(4):485-500. CROSSREF

45. Kolbe LJ. School health as a strategy to improve both public health and education. Annu Rev Public Health 2019;40:443-63. PUBMED | CROSSREF

46. Paakkari L, Paakkari O. Health literacy as a learning outcome in schools. *Health Educ* 2012;112(2):133-52. CROSSREF

47. Zhang X, Mori Y, Abio A, Khorasani ZK, Gilbert S, Grimland M, et al. Cross-national research on adolescent mental health: a systematic review comparing research in low, middle and high-income countries. *BMJ Glob Health* 2025;10(7):e019267. PUBMED | CROSSREF

48. GBD 2021 Adolescent BMI Collaborators. Global, regional, and national prevalence of child and adolescent overweight and obesity, 1990–2021, with forecasts to 2050: a forecasting study for the Global Burden of Disease Study 2021. *Lancet* 2025;405(10481):785-812. PUBMED | CROSSREF