

Research Article



Nutritional Status of Primary School Children in Kintamani, Bangli, Bali Based on School Screening Program

Cintya Riska Prathiwi Ni Ketut^{1*}, Sutadarma I Wayan Gede²

¹ Kintamani VI Primary Health Center, Bangli, Bali, Indonesia

² Clinical Nutrition Department, Udayana University, Bali, Indonesia

* Correspondence: cintyariskap@gmail.com

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ABSTRACT

Background: Bangli regency has the highest prevalence of stunting in Bali with 43.2% children under 5 years old is stunting. However, nutritional status among school age children here has not been reported in any studies. The aim of this study is to determine the nutritional status of primary school children in Kintamani, Bangli.

Method: This study was a descriptive cross-sectional study which conducted alongside school screening programs in 9 primary schools. Nutritional status of children aged 6-13 years was assessed based on body mass index, weight and height for age and gender according to the references from WHO.

Results: Out of 1,158 children participated, 602 (52.0%) were male and 556 (48.0%) were female. The prevalence of severe thinness, thinness, overweight, and obesity are 0.3%, 1.2%, 71.6%, 15.9%, 11.0%, respectively. The prevalence of stunting among primary school age children ($HAZ < -2$) was 9.3%. The proportion of children with nutritional problems (both under and overnutrition) were higher in male than female. This study showed that other than undernutrition, overnutrition such as overweight and obesity in older children is increasing and the trend were also found in other countries, possibly due to lack of physical activity, micronutrient deficiencies, and unhealthy diet. Therefore, evidence-based interventions are needed for all children with nutritional problems.

Conclusion: Double burden of malnutrition was found in Kintamani, Bangli, Bali. The higher prevalence of overnutrition among school aged children should be highlighted and concerned as important as undernutrition mattered.

Keywords: Kintamani; Nutritional status; Primary school; School screening

INTRODUCTION

Optimal nutrition is the essential requirement for children's growth and development. If there is any nutritional problem in this period of life, it may possibly affect the development of other chronic diseases in the future.¹ The nutritional status of school-age children (generally defined as 5 to 15 or 19 years old) is characterized by a "triple burden" of malnutrition: the simultaneous persistence of undernutrition, rapidly rising rates of overweight and obesity, and widespread micronutrient deficiencies.²

The global landscape of nutrition for school-age children is complex and varies significantly by region. Chronic undernutrition remains a major problem, particularly in low- and middle-income countries (LMICs). Approximately 22% of children under five were stunted globally in 2020, many of whom carry this growth failure into their school years.³ Regional stunting prevalence for school-age children is high in South-East Asia (29%), the Eastern Mediterranean (24%), and Africa (22%).⁴ Thinness and wasting as indicators of acute undernutrition are most prevalent in South Asia and Africa.³ In South Asia, the prevalence of thinness can range as high as 88.8% in certain populations.² While undernutrition persists, there is a sharp increase in childhood overweight and obesity, particularly in urban areas and transition economies.^{5,6} In urban Ghana, the prevalence of overweight and obesity among school-aged children reached 17%.⁷

While global health efforts have historically prioritized the first 1,000 days of life, this age group is increasingly recognized as a critical "second window of opportunity" to correct early growth deficits and establish long-term healthy behaviors.³ Approximately 40% of an individual's total linear growth occurs during these years. Nutrients like protein and zinc are essential hormonal drivers of this process. Inadequate nutrition here increases the risk of bone fragility and future osteoporosis. Significant neuro-maturational processes, including myelination and synaptic pruning, peak during this time. These processes are critical for developing cognitive abilities, language proficiency, and executive functions like goal-setting and problem-solving.³ Proper nutrition is essential for optimal brain function and learning. Deficiencies, particularly in iron, are linked to lower cognitive scores, inferior scholastic accomplishment, and reduced concentration.⁸

Regarding long-term health, adequate nutrition maintains a healthy immune system, protecting children from infectious diseases.⁹ Malnutrition in school-age children—including the "double burden" of undernutrition and obesity—is a major risk factor for adult health.^{8,10} Overweight and obese children are far more likely to remain obese as adults, significantly increasing their risk of non-communicable diseases (NCDs). Meanwhile, in terms of economic impact, undernutrition reduces work capacity and earning power in adulthood.⁴ From an economic perspective, preventing malnutrition is highly cost-effective; it is estimated that every \$1 spent on prevention delivers \$16 in returns on investment. Conversely, some regions lose up to 11% of their Gross Domestic Product (GDP) annually due to the costs of treating malnutrition-related problems.¹¹

Despite its importance, the nutritional status of school-age children remains understudied and inconsistently monitored.² Data for this age group is often scarce or embedded in broader "childhood" or "adult" surveys, making it difficult to set targets and monitor progress. Addressing these gaps is vital, as interventions during these years—such as school-based

fortification, supplementation, and nutrition education—can lead to significant "catch-up" growth and improved cognitive performance, maximizing an individual's long-term productivity and health.³

Based on the Indonesian Health Survey in 2018, Bangli regency has the highest prevalence of children with stunting in Bali Province, Indonesia, with 43.2% of children under 5 years old stunting. Bangli regency has 4 subdistricts: Susut, Tembuku, Bangli, and Kintamani. Kintamani subdistrict is one of the regions with the highest prevalence of stunting for children under age 5 years in Bali province.¹² But no study has reported the nutritional status of older children in this area. This specific age group has long been neglected. Meanwhile, many studies on nutritional status and problems among children under 5 years in Kintamani have been conducted previously; a study focusing on nutrition problems among school-age children is much needed. Our study was conducted to describe the prevalence of nutritional problems, including thinness, underweight, stunting, overweight, and obesity, among primary school children in Kintamani, Bangli, Bali.

METHOD

This descriptive, cross-sectional study was held alongside the school screening program in Kintamani, a subdistrict in Bangli regency, Bali Province, Indonesia. The study was conducted in 9 primary schools across 9 villages in Kintamani subdistrict, supervised by Primary Health Care Center 6 Kintamani, namely Bayunggede, Abuan, Sekardadi, Banua, Katung, Mangguh, Bonyoh, Sekaan, and Belancan. In every school, children within grades 1 and 6, aged 6 to 13 years, were eligible to participate in the study and were measured. The data were collected for 3 weeks in February 2025 by trained healthcare staff. Informed consent was obtained from the participants' parents or guardians and head class teachers. Permission for the study was granted by Bangli District Health Office.

Trained staff, including a dietitian, performed anthropometric measurements at school as part of the health screening program. They measured the weight and height and calculated the body mass index. Body weight was measured in kilograms with 0.1 kg precision using a digital weight scale, Omron HN 286, that was previously calibrated (June 2024) and is scheduled for annual calibration. While being weighed, children wore minimal clothing and no shoes. Body height was measured in centimeters with 0.1 cm precision using a portable GEA stadiometer. Body Mass Index (BMI) of the children was calculated by dividing weight (in kilograms) by height (in meters) squared. The socio-demographic data, including birth date and age, of the sample were obtained through one-on-one interviews, and the family index data were previously collected by the teachers.

Nutritional status is assessed using body mass index, weight, and height for age and gender, according to World Health Organization references, with WHO AnthroPlus software. Nutritional status for children aged 5 to 18 years old is classified based on WHO Reference BMI for Age Z-score, which is adopted by the Indonesian Health Ministry Regulation with categorization: Severe Thinness (<-3 SD), Thinness (-3 to -2 SD), Normal (>-2 to <0.99), Overweight (1.00 to 1.99 Z), and Obese (≥ 2 Z score).

RESULTS

The total target population from 9 primary schools is 1226 participants, but due to absenteeism and lack of data from 68 participants, 1158 children eventually completed the anthropometric measurements. Out of the 1,158 children who participated, 602 (52.0%) were male, and 556 (48.0%) were female (Table 1).

Table 1. Characteristics of Sample

Variable	Male <i>N</i> = 602 (52.0%)	Female <i>N</i> = 556 (48.0%)	Total
Grade			
1	100 (16.6%)	97 (17.4%)	197 (17.0%)
2	97 (16.1%)	77 (13.8%)	174 (15.0%)
3	102 (16.9%)	91 (16.4%)	193 (16.7%)
4	105 (17.4%)	92 (16.5%)	194 (17.0%)
5	102 (16.9%)	89 (16.0%)	191 (16.5%)
6	96 (15.9%)	110 (19.8%)	206 (17.8%)
Age	9.23 ± 1.73	9.31 ± 1.83	9.27 ± 1.78
Height	129.47 ± 11.09	129.96 ± 12.35	129.70 ± 11.70
Weight	30.08 ± 9.83	30.19 ± 10.27	30.12 ± 10.04
Body Mass Index	17.54 ± 3.37	17.39 ± 3.33	17.46 ± 3.35

The prevalence of severe thinness, thinness, overweight, and obesity are 0.3%, 1.2%, 71.6%, 15.9%, 11.0%, respectively. The proportion of children with nutritional problems (both under and overnutrition) were higher in male than female (Table 2). Stunting is still found in primary school age children in Kintamani, Bangli, Bali with total number of 9.3% (Table 3).

Table 2. Nutritional Status of Primary School Age Children

Variable	Male <i>N</i> = 602 (52.0%)	Female <i>N</i> = 556 (48.0%)	Total
Nutritional Status			
Severe thinness	3 (0.5%)	1 (0.2%)	4 (0.3%)
Thinness	7 (1.2%)	7 (1.3%)	14 (1.2%)
Normal	424 (70.4%)	405 (72.8%)	829 (71.6%)
Overweight	85 (14.1%)	99 (17.8%)	184 (15.9%)
Obese	83 (13.8%)	44 (7.9%)	127 (11.0%)

Table 3. Proportion of Children Age 6-13 years with Stunting

Variable	Male <i>N</i> = 602 (52.0%)	Female <i>N</i> = 556 (48.0%)	Total
Normal	554 (92.0%)	496 (89.2%)	1050 (90.7%)
Stunting	48 (8.0%)	60 (10.8%)	108 (9.3%)

DISCUSSION

Worldwide studies show that the nutritional status of young people is far from ideal.¹³ A previous study shows that Indonesia is facing double malnutrition in the child population, where 1 out of 3 children under age 5 years is stunted, and more than 8% of children are overweight.¹⁴ Our study showed that primary school-aged children in Kintamani, Bangli, Bali

are also facing this "double burden" of malnutrition, where undernutrition and overnutrition coexist within the same populations and sometimes the same individuals. This age group is critical because dietary habits formed during this period often persist into adulthood, impacting long-term health and productivity.⁶

Undernutrition (thinness) was found at 1.5% and stunting at 9.3% among school-age children in Kintamani. This number is below the prevalence of severe thinness and thinness among children aged 5-12 years in Bali Province, as reported in the latest Indonesian Health Survey (2,6%).¹⁵ Chronic undernutrition, manifesting as stunting (low height-for-age) and thinness or wasting (low BMI-for-age), remains a persistent issue in developing regions.⁴ For instance, in Sri Lankan plantation communities, prevalence rates for underweight, stunting, and wasting were recorded at 35.6%, 26.9%, and 32.9%, respectively.¹⁶

Malnutrition leads to reduced cognitive capacity, repeated infections, and increased risk of death.⁴ Research indicates that multi-component school nutrition interventions—which combine nutrition education with physical activity and healthy food provision—are significantly more effective at reducing BMI and improving nutritional status than programs focused solely on education.⁵ While nutrition education can successfully improve knowledge and attitudes, long-term implementation and the involvement of parents and caregivers are essential to change actual dietary practices and the home food environment.⁶

In our study, there is a higher prevalence of overnutrition, with a total of 26.9% of school-age children either overweight or obese. A systematic review that examined the nutritional status and dietary habits of children aged 0-12 years in Middle Eastern countries (Jordan, Lebanon, KSA, UAE) reported findings similar to ours. The prevalence of overweight and obesity in these countries varies from 11.5% to 34.9%.¹

Our study results also showed the same trend and continuity with a study from China; during its nutrition transition, China has progressively shifted from predominant stunting, to simultaneous underweight and overweight, and finally to a higher prevalence of overweight and obesity. Among Chinese children under 12 years, stunting and underweight are now present concomitantly with obesity and overweight.¹⁷ Based on the China Health and Nutritional Survey in 2011, among school-age children (7-12 years), stunting was found at 0.4% and underweight at 21.4%, meanwhile overweight and obesity were 12.6% and 6.3% globally, even though predominantly found in urban areas rather than in rural areas.¹⁷

Overnutrition has recently become the leading type of nutritional problem found in high-income countries; meanwhile, double burden malnutrition (either under- and overnutrition) is mostly found in middle- to low-income countries such as Asia and Africa.¹⁸ Overnutrition is defined as the accumulation of fats that is excessive or abnormal in adipose tissues and could affect individual health status. Children with overnutrition tend to remain obese into adolescence and are at higher risk of having chronic diseases, such as diabetes mellitus, hypertension, coronary heart disease at a young age, and eventually increasing the risk of breathing difficulties, fractures, insulin resistance, cancer, asthma, and other comorbidities. Overnutrition is also associated with higher mortality than undernutrition globally.¹⁹

Several factors contribute to these nutritional imbalances: socio-economic factors, dietary behaviors, eating environment, and sedentary lifestyles. Regarding socio-economic factors,

low household income, low parental education, large family sizes, and maternal employment outside the home are significantly associated with higher rates of undernutrition.¹⁶ The reality of today's generation is facing rapid urbanization and a high supply of ultra-processed foods in the market. It is possible to link this to a new trend in children's eating that is more dependent on energy-dense, nutrient-poor foods. Moreover, sedentary lifestyles have become prevalent among children. Without any concern and action, the rates of overnutrition will continue to rise over time.²⁰

Many children have poor dietary practices, including high consumption of "junk foods" (chips, sausages, candies) and sweetened beverages, with very low intake of fruits and vegetables.⁶ Other than dietary habits and eating environment, sedentary lifestyle also makes a contribution. Rapid urbanization and technological shifts have led to a decline in physical activity.¹⁴ Many children fail to meet the recommended 60 minutes of daily moderate-to-vigorous activity.¹³ A study from Ethiopia that involved 736 school-aged children reported risk factors that have been scientifically found to be associated with the high prevalence of overnutrition in school-aged children are the habits of eating while watching television/reading, not having close friends, the habits of eating sweets, consuming fats more than 3 times a week, and also not doing any high-intensity exercises.¹⁹

Kintamani, Bangli is a rural area where most people work as farmers. Even though this area is categorized as rural, it is also highly visited due to the Batur Mountain tourist destination. Kintamani is also very famous for their agricultural products, especially oranges, coffee, and fresh vegetables. Children in Kintamani, Bangli are also influenced by digitalization and high technology. Fewer children help their parents work in the garden and on farms; accessible public transportation has led to fewer children walking to school; and imbalanced dietary practices, with more ultra-processed foods in the school canteen, may contribute to the results of this study, where undernutrition persists but is far lower than overnutrition.

Interventions and management strategies for childhood nutritional problems are broadly categorized into nutrition-specific actions that address immediate dietary needs and nutrition-sensitive approaches that tackle underlying socioeconomic and environmental causes. Effective management increasingly requires "double-duty actions" that simultaneously address the co-existing burdens of undernutrition, micronutrient deficiencies, and obesity.²¹

Interventions for undernutrition—including stunting, wasting, and thinness—focus on increasing caloric and nutrient intake while preventing infections.^{21,22} Therapeutic and supplementary feeding interventions, such as using Ready-to-Use Therapeutic Food (RUTF), Lipid-based Nutrient Supplements (LNS), and school feeding programs, as well as micronutrient supplementation and fortification.^{21,22,23} Nutrition-sensitive strategies include WASH (Water, Sanitation, and Hygiene), cash transfers to provide a social safety net that can significantly reduce the probability of wasting, and education, especially nutritional behavioral change education for parents, which focuses on the importance of exclusive breastfeeding for the first six months, proper weaning practices, and utilizing nutrient-dense local foods.^{21,22,24}

Management of obesity typically shifts toward family-based, multi-component interventions that target diet, physical activity, and sedentary behavior.²⁵ Behavioral and psychological support is highly advocated as a holistic approach to address psychological factors such as

low self-esteem, stress, and emotional eating, which often act as barriers to sustained lifestyle change.²⁵ Weight reduction diets like low-carbohydrate, ketogenic, or intermittent fasting can produce large weight losses, but also carry a high risk of exacerbating micronutrient deficiencies and require close clinical monitoring and supplementation.²⁶

Broad societal and policy changes are necessary to create a healthier food environment.²¹ Multisectoral programs are essential because success is found in packaging interventions across health, education, and social protection platforms.²³ Moreover, government and policy action, such as recommended measures, include taxing sugar-sweetened beverages, restricting the marketing of unhealthy foods to children, and implementing clear front-of-pack nutrition labeling.²¹ Regarding youth engagement, involving children and adolescents in defining their own context-specific solutions increases the likelihood of intervention success.²³ Besides that, intensifying school health service activities with a special focus on regular nutritional screening is vital for early detection of both undernutrition and obesity.²⁴

CONCLUSION

A double burden of malnutrition was identified among school-aged children in Kintamani, Bangli, Bali. Although Kintamani is categorized as a rural area, the population is experiencing a nutritional transition characterized by a shift from predominantly stunting toward a higher prevalence of overweight and obesity. This study has several limitations, including its cross-sectional design, which precludes causal inference, and the lack of detailed assessment of individual dietary intake and other potential confounding factors. Therefore, the findings should be interpreted with caution. Nevertheless, the increasing prevalence of overnutrition among school-aged children in rural areas warrants as much attention as undernutrition. Comprehensive and multisectoral interventions are needed to promote healthy dietary habits, increase physical activity, and improve awareness of balanced nutrition among children, families, schools, and communities.

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Declarations

Authors' contributions

CRPNK contributed to conceptualization, methodology, data collection, and manuscript drafting and editing. SIWG contributed to supervision, validation, and final approval of the manuscript.

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Conflict of interest

There is no conflict of interest in this research.

REFERENCES

1. Nasreddine LM, Kassis AN, Ayoub JJ, Naja FA, Hwalla NC. Nutritional status and dietary intakes of children amid the nutrition transition: the case of the Eastern Mediterranean Region. *Nutrition Research*. 2018;57:12-27. <https://doi.org/10.1016/j.nutres.2018.04.016>
2. Choedon T, Brennan E, Joe W, Lelijveld N, Huse O, Zorbas C, et al. Nutritional status of school-age children (5–19 years) in South Asia: A scoping review. *Maternal & Child Nutrition*. 2024;20(1):e13607. <https://doi.org/10.1111/mcn.13607>
3. Saavedra JM, Prentice AM. Nutrition in school-age children: a rationale for revisiting priorities. *Nutrition Reviews*. 2023;81(7):823-840. <https://doi.org/10.1111/mcn.13607>
4. Ernawati F, Efriwati, Nurjanah N, Kusuma Aji G, Tjandrarini DH, Widodo Y, et al. Micronutrients and nutrition status of school-aged children in Indonesia. *Journal of Nutrition and Metabolism*. 2023;2023:4610038. <https://doi.org/10.1155/2023/4610038>
5. Pongutta S, Ajetunmbi O, Davey C, Ferguson E, Lin L. Impacts of School Nutrition Interventions on the Nutritional Status of School-Aged Children in Asia: A Systematic Review and Meta-Analysis. *Nutrients*. 2022 Jan 28;14(3):589. <https://doi.org/10.3390/nu14030589>
6. Kigaru DMD, Loechl C, Moleah T, Macharia-Mutie CW, Ndungu ZW. Nutrition knowledge, attitude and practices among urban primary school children in Nairobi City, Kenya: a KAP study. *BMC Nutr*. 2016;1:40. <https://doi.org/10.1186/s40795-015-0040-8>
7. Antwi J, Ohemeng A, Boateng L, Quaidoo E, Bannerman B. Primary school-based nutrition education intervention on nutrition knowledge, attitude and practices among school-age children in Ghana. *Glob Health Promot*. 2020;0(0):1-9. <https://doi.org/10.1177/1757975920945241>
8. Wansyaputri RR, Deswita, Novrianda D. An overview of school-age children's nutritional status in the Talang Banjar Health Center's working area, Jambi City. *International Journal for Multidisciplinary Research (IJFMR)*. 2024;6(1). <https://doi.org/10.36948/ijfmr.2024.v06i03.21743>
9. Shahirabhanu R, Hiregoudar R, Natekar DS. Nutritional status and eating behaviour of school aged children residing rural area of Bagalkot, a cross-sectional study. *Scholars Journal of Applied Medical Sciences*. 2025;13(3):651-657. <https://doi.org/10.36347/sjams.2025.v13i03.008>
10. Wrottesley SV, Mates E, Brennan E, Bijalwan V, Menezes R, Ray S, et al. Nutritional status of school-age children and adolescents in low- and middle-income countries across seven global regions: a synthesis of scoping reviews. *Public Health Nutrition*. 2023;26(1):63-95. <https://doi.org/10.1017/S1368980022000350>
11. Sathiadass MG, Antonyraja A, Viswalingam A, Thangaraja K, Wickramasinghe VP. Nutritional status of school children living in Northern part of Sri Lanka. *BMC Pediatrics*. 2021;21(1):41. <https://doi.org/10.1186/s12887-021-02501-w>
12. Dinas Kesehatan Provinsi Bali. *Profil Kesehatan Provinsi Bali Tahun 2023*. Bali: Dinkes Bali; 2024. Available from: <https://diskes.baliprov.go.id/download/profil-kesehatan-bali-2023/>
13. Akseer N, Al-Gashm S, Mehta S, Mokdad A, Bhutta ZA. Global and regional trends in the nutritional status of young people: a critical and neglected age group. *Ann N Y Acad Sci*. 2017;1393(1):3-20. <https://doi.org/10.1111/nyas.13336>
14. Rah JH, Melse-Boonstra A, Agustina R, van Zutphen KG, Kraemer K. The Triple Burden of Malnutrition Among Adolescents in Indonesia. *Food Nutr Bull*. 2021 Mar;42(1S):S4-S8. <https://doi.org/10.1177/03795721211007114>
15. Kementerian Kesehatan Republik Indonesia. *Survei Kesehatan Indonesia (SKI) 2023 Dalam Angka*. Jakarta: Kemenkes RI; 2024. Available from: <https://repository.badankebijakan.kemkes.go.id/id/eprint/5539/>
16. Galgamuwa LS, Iddawela D, Dharmaratne SD, Galgamuwa G. Nutritional status and correlated socio-economic factors among preschool and school children in plantation

- communities, Sri Lanka. *BMC Public Health*. 2017;17:4311. <https://doi.org/10.1186/s12889-017-4311-y>
17. Piernas C, Wang D, Du S, Zhang B, Wang Z, Su C, et al. The double burden of under- and overnutrition and nutrient adequacy among Chinese preschool and school-aged children in 2009-2011. *Eur J Clin Nutr*. 2015 Dec;69(12):1323-1329. <https://doi.org/10.1038/ejcn.2015.106>
 18. Min J, Zhao Y, Slivka L, Wang Y. Double burden of diseases worldwide: coexistence of undernutrition and overnutrition-related non-communicable chronic diseases. *Obes Rev*. 2018;19:49–61. <https://doi.org/10.1111/obr.12605>
 19. Ali MS, Kassahun CW, Wubneh CA. Overnutrition and associated factors: a comparative cross-sectional study between government and private primary school students in Gondar Town, Northwest Ethiopia. *J Nutr Metab*. 2020;2020:3670895. <https://doi.org/10.1155/2020/3670895>
 20. Corvalán C, Garmendia ML, Jones-Smith J, Lutter CK, Miranda JJ, Pedraza LS, et al. Nutrition status of children in Latin America. *Obes Rev*. 2017 Jul;18(Suppl 2):7-18. <https://doi.org/10.1111/obr.12571>
 21. Mondon C, Tan PY, Chan CL, Tran TN, Gong YY. Prevalence, determinants, intervention strategies and current gaps in addressing childhood malnutrition in Vietnam: a systematic review. *BMC Public Health*. 2024;24:960. <https://doi.org/10.1186/s12889-024-18444-9>
 22. Tan Chee How E, Maluda M, Ibrahim MYH, Joo LK, Binti Mohd Yusuff AS, Awang Lukman K. Intervention to Address Childhood Undernutrition: A Systematic Review. *Borneo Epidemiol J*. 2021;2(1):4-12. Available from: <https://jurcon.ums.edu.my/ojums/index.php/bej>
 23. Lelijveld N, Wrottesley SV, Aburmishan D, Hemler EC, Fentahun N, Ali Z, et al. Research priorities for nutrition of school-aged children and adolescents in low- and middle-income countries. *PLoS ONE*. 2023;18(1):e0280510. <https://doi.org/10.1371/journal.pone.0280510>
 24. Aboagye RG, Kugbey N, Ahinkorah BO, Seidu AA, Cadri A, Bosoka SA, et al. Nutritional status of school children in the South Tongu District, Ghana. *PLoS ONE*. 2022;17(8):e0269718. <https://doi.org/10.1371/journal.pone.0269718>
 25. Newson L, Abayomi J. Reframing interventions for optimal child nutrition and childhood obesity: the importance of considering psychological factors. *Proc Nutr Soc*. 2025;84:53-64. <https://doi.org/10.1017/S0029665124000028>
 26. Bradley M, Melchor J, Carr R, Karjoo S. Obesity and malnutrition in children and adults: a clinical review. *Obesity Pillars*. 2023;8:100087. <https://doi.org/10.1016/j.obpill.2023.100087>