

REVIEW ARTICLE

Utilization of biscuits as nutritional intervention to reduce stunting among children: A systematic review

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Abstract

Childhood stunting remains a global health issue with significant consequences for the growth, long-term health, and development of children. Poor nutrition is a well-established contributor to childhood stunting. This study aims to investigate the potential of utilizing biscuits as a nutritional intervention to improve the child's stunting condition. This systematic review was conducted through a literature search in several databases: Scopus, Web of Science, ScienceDirect, PubMed, and Springer, following the PRISMA methodology. Our search yielded a total of 836 records, while 11 studies were finally included after the screening. The studies revealed critical findings regarding the utilization of biscuits as a carrier in providing essential nutrients. Nevertheless, more well-designed and standardized studies are required to establish clear guidelines for the formulation and implementation of biscuit-based interventions. Policymakers and health practitioners should consider incorporating fortified biscuits into strategies aimed at reducing stunting, especially in regions with a high prevalence of stunting. (*Afr J Reprod Health 2024; 28 [10s]: 376-385*).

Keywords: Biscuits; child development; childhood stunting; dietary interventions; growth improvement

Résumé

Le retard de croissance chez les enfants demeure un problème de santé mondial avec des conséquences significatives pour la croissance, la santé à long terme et le développement des enfants. Une mauvaise nutrition est un facteur bien établi contribuant au retard de croissance chez les enfants. Cette étude vise à explorer le potentiel d'utilisation des biscuits comme intervention nutritionnelle pour améliorer la condition des enfants souffrant de retard de croissance. Cette revue systématique a consisté en une recherche bibliographique dans plusieurs bases de données : Scopus, Web of Science, ScienceDirect, PubMed et Springer, suivant la méthodologie PRISMA. Notre recherche a permis d'identifier un total de 836 documents, dont 11 études ont finalement été incluses après le tri. Les études ont révélé des résultats critiques concernant l'utilisation des biscuits comme vecteur pour fournir des nutriments essentiels. Néanmoins, des études mieux conçues et standardisées sont nécessaires pour établir des directives claires pour la formulation et la mise en œuvre d'interventions à base de biscuits. Les décideurs politiques et les professionnels de la santé devraient envisager d'incorporer des biscuits enrichis dans les stratégies visant à réduire le retard de croissance, en particulier dans les régions où la prévalence du retard de croissance est élevée. (*Afr J Reprod Health 2024; 28 [10s]: 376-385*).

Mots-clés: Biscuits; développement de l'enfant; retard de croissance chez les enfants; interventions alimentaires; amélioration de la croissance.

Introduction

Child stunting is one of the significant global health issues which is defined as impaired physical growth and development of children due to several factors including poor nutrition, lack of sanitation, and inadequate healthcare. According to the World

Health Organization (WHO), more than 149 million children suffer from stunting problems all over the world, with maximum numbers recorded in South Asia and sub-Saharan Africa¹. Stunting among children must receive special attention from parents, family members, health authorities, government, policymakers, and researchers as this

nutrition problem is an indicator of chronic malnutrition^{2,3}.

The consequences of stunting may result in several immediate and long-term effects including low body immunity, mortality, less cognitive development, late schooling, low economic productivity, reduced physical and development, low birth weight, and other consequences⁴. There may also a link between deprivation of proper nutrition at the early stage of life and a higher chance of chronic diseases at the adult age⁵. Therefore, combatting stunting is important as it not only affects the person but also affects the overall health and economic index of a country.

To combat child stunting, it is important to focus on the factors behind child malnutrition. Implementation of nutrition-specific food intervention can reduce the stunting prevalence. Targeted and controlled food intervention can be achieved by supplying well-defined complementary foods to vulnerable groups. For linear growth, children need both macronutrients, representing building blocks, and also micronutrients for proper body functioning⁶. In the last few years, there has been growing interest in utilizing innovative and new approaches to deal with child stunting by improving the existing nutritional supplements.

Biscuits are one of the popular baked products that generally contains flour, sugar, fat, water, and other miscellaneous ingredients⁷. Biscuits are considered a major category of snacks due to the variety of tastes, general acceptability among all age groups, and long shelf life. In these perspectives, biscuits can be a good vehicle for nutrients and different essential compounds for children. Innovation in biscuit recipes considers the important nutrients and different raw materials, and the final products can be designed to address the target consumers with specific objectives. The optimal formulation of new biscuit products can be developed based on the target group of children and the required nutrients that need to be supplemented. Biscuits or cookies offer a promising avenue as a carrier of essential nutrients due to their potential for nutrient fortification especially in limited resource settings.

The purpose of this study was to provide an overview of the potential of biscuits as a carrier for

essential nutrient supply to stunted children. The study outputs will help to understand the effectiveness of biscuit-based food interventions to reduce the prevalence of stunting in children. In addition, the review will identify the gaps in current research and opportunities for future research in the application of biscuits in stunting-related intervention programs. By addressing the above-mentioned objectives, this study seeks to contribute to the combined efforts from different bodies to combat global child stunting, related programs, and policies.

Methods

Search strategy

This systematic review was performed according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines⁸. The findings of this study are based on the research articles published in peer-reviewed international journals. We performed literature searches in several databases including Scopus, Web of Science, ScienceDirect, PubMed, and Springer. The target literature was searched by using relevant keywords or MeSH terms such as “Biscuit”, “cookie”, “cracker”, “High quality biscuit”, “food intervention”, “nutritional intervention”, “food supplement”, “clinical trial”, “Health benefit”, “nutritional development”, “Child development”, “child growth”, “Stunting”, “linear growth”, “child linear growth”, “nutritional benefit”, and all the prospective keyword combinations using Boolean operators in different databases (Table S1). The last search was conducted on December 20, 2023.

Eligibility criteria

The records included in this study were based on several inclusion criteria as shown in Table 1. We selected original research that focused on the use of biscuits or cookies as food intervention for improving stunting conditions among children.

Identification of relevant study

Two evaluators carried out independent and standardized eligibility evaluation. The titles and abstracts were the parts of the first phase of

Table 1: The study selection criterion for this systematic review

Inclusion criteria	Exclusion criteria
1. Biscuits or cookies used as food intervention or supplement	1. Other nutritional intervention except biscuits or fortified biscuits
2. Study population: children	2. Not for elderly or other hospitalized patients or any other specific disease group
3. The study objectives or output is the effect on stunting condition	3. Other health outcomes except stunting condition
4. Original research	4. Review, proceedings, or any other paper except original research
5. Full paper availability	5. Unavailable of full paper (PDF)
6. English language article	6. Other than English language

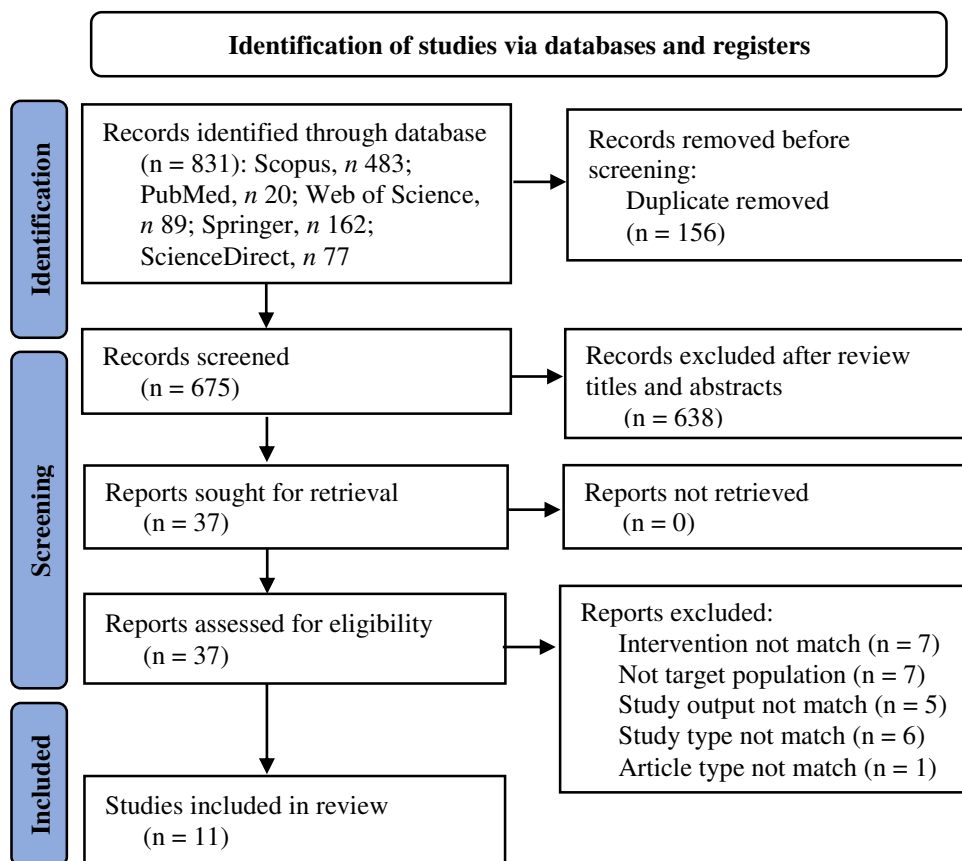


Figure 1: Flow diagram of the PRISMA guideline for the study selection

screening that were subjected to the selection criteria. After that, the complete texts of all potentially qualifying research articles were retrieved. The full-text articles served as the basis for selection in the second step of screening. Articles were removed from the literature review process if any of the selection criteria were not met.

Data extraction

The data extraction and collection process started after the screening steps. Data was extracted from each included study as per the following: authors, title, study design, study population, study location, intervention, biscuits composition, intervention

frequency, important findings, study conclusions, and study limitations.

Summary measures

This study provides a synthesis of the findings from the included studies: structured about the individual study characteristics and promising findings regarding the utilization of biscuits as a carrier in providing essential nutrients.

Reporting the study selection

The primary literature search from five different databases retrieved 831 records, 675 of which remained for screening after removing the duplicates (156 records). During the first step of screening (titles and abstracts), 638 records were removed due to not matching with the study interest. Then, the remaining 37 records were retrieved for full paper download. During the second step of screening, 26 records were excluded due to the inability to fulfill the eligibility criteria. As a result, finally, 11 studies were included in this review study (Figure 1).

Results

Study characteristics

A summary of the general characteristics of 11 studies included in this review are presented in Table 2. The studies were from five different countries: 1 from Brazil, 1 from China, 1 from India, 7 from Indonesia, and 1 from Mexico. The types of study designs included quasi-experiments, randomized control trials, non-randomized controlled trial, longitudinal food-based intervention, cross-sectional studies, pretest-post-test design, and simple blind trial. The study participants were children in different age groups. From Table 2, different kinds of food supplements used in the studies included micronutrients fortified biscuits, eel biscuits, premix flour cookies, Mocaf tempeh date biscuits, biscuits fortified with iron sulphate, Ready-to-Use Food (RUF) biscuits, potato flour biscuits, wheat biscuits, ragi biscuits, biscuits fortified with vitamin A, etc. The supplementation duration also varied from two to nine months.

Biscuits as nutrition carrier to improve stunting condition

The supplemented biscuit-based food intervention and their contributing outputs are represented in Table 3. From the review summary, it is obvious that not all studies were effective in combatting child stunting. Some studies showed significant output to reduce the stunting prevalence, while some had improvement but not significant, lastly, few studies had no contribution at all.

Several supplemented biscuits focused on stunting prevention that showed significant improvement included eel biscuits¹², Mocaf tempeh date biscuit¹³, potato flour biscuits, wheat flour biscuits, and ragi flour biscuits¹⁸. All showed significant increases in height growth and HAZ score (height for age z-score). Several types of biscuit supplementations also helped to gain good nutritional status including cookies from mung bean⁹ and the biscuit provided by Indonesian Ministry of Health for the national food supplementation program¹⁶. Other studies using biscuits fortified with several micronutrients especially vitamins and/or minerals didn't show any significant improvement in HAZ score or height gain^{10,14,15,17,19}.

One of the studies focused on nutritional supplementation together with psychological parenting education. Based on the HAZ index, the study demonstrated that providing psychosocial parenting education greatly enhanced height and improved toddlers' cognitive development¹¹. Toddlers with psychosocial parenting instruction and multiple-nutrient biscuits had considerably higher heights and cognitive development. The authors recommended that nutritional treatments must be implemented together with educating children about mother parenting to address the growth and development issues that children face. However, the sample size of the study was too low. However, some studies also had some limitations or adverse effects during the study. Study limitations included small sample sizes, short follow-up periods, non-randomization, etc. One study reported adverse health effects on participants such as vomiting, diarrhea, stained teeth, constipation, and cramps after taking the micronutrients fortified biscuit¹⁵.

Table 2: Characteristics of included studies

Study	Study design	Population	Study location	Intervention	Intervention frequency
Nasution <i>et al.</i> (2023) ⁹	Quasi-experiment	1-2 years old children	North Sumatera, Indonesia	Premix flour cookies	4 pieces cookies a day for 3 months
Setyawati <i>et al.</i> (2023) ¹⁰	Cross-sectional study	586 children	Different islands in Indonesia	Supplementary biscuits	Biscuit supplementation for 3 months
Pusparini <i>et al.</i> (2020) ¹¹	Quasi-experiment	28 stunted children	Cimahi, Indonesia	Micronutrients fortified biscuits	12 pieces a day for 2 months
Herawati <i>et al.</i> (2020) ¹²	Pretest-post-test design	56 children (aged 3-5 years)	West Java, Indonesia	Eel biscuit	10 pieces cookies a day (morning and afternoon) for 3 months
Fatmah (2017) ¹³	Quasi-experiment	50 toddlers	Depok, Indonesia	Mocaf Tempeh Date Biscuit	50 g of biscuits within 90 days
Quintero-Gutiérrez <i>et al.</i> (2016) ¹⁴	Simple blind trial	47 children	Morelos State, Central Mexico	Biscuits fortified with iron sulphate	7 biscuits per week for 72 days
Landim <i>et al.</i> (2016) ¹⁵	Randomized control trial	262 pre-school children (aged 2 to 5 years)	Piauí, Brazil	Iron fortified cookies	30 g of cookies for two months, three times a week
Muslihah <i>et al.</i> (2016) ¹⁶	Non-randomised, controlled trial	168 infants	Madura Island, Indonesia	Group 1: SQ-LNSs Group 2: Biscuits Control: No intervention	Group 1: 3 pieces or 30 g of biscuits a day (1 35 kcal) for 6 months Group 2: 20 g sachet a day (118 kcal) for 6 months
Purwestri <i>et al.</i> (2012) ¹⁷	Longitudinal food-based intervention	51 children (aged 6 to 59 months)	Nias Island, Indonesia	Biscuits as locally-produced Ready-to-Use Food (RUF)	About 60% of daily energy requirements (by calculating body weight)
Nazni <i>et al.</i> (2010) ¹⁸	Randomized control trial	150 pre-school children	Tamilnadu, India	Group 1: Potato flour biscuit Group 2: wheat biscuits Group 3: ragi biscuits	6 biscuits (60 grams) per day
Zhang <i>et al.</i> (2010) ¹⁹	Randomized control trial	580 pre-school children	Chongqing, China	Group 1: Biscuits fortified with vitamin A at 30% RDA Group 2: Biscuits fortified with vitamin A at 100% RDA Group 3: Biscuits fortified with 20000 IU of vitamin A	Group 1: Once a day for 9 months Group 2: Once a day for 3 months Group 3: Once a week for 3 months

Table 3: Supplemented biscuit composition and important findings regarding

Study	Biscuits composition	Important findings	Conclusions	Study limitations or adverse effect
Nasution <i>et al.</i> (2023) ⁹	Cookies produced using mung bean (<i>Vigna radiata</i> L)	Provided biscuits were effective in achieving good nutritional status, thus, it helped to improve from stunting condition	Supplemented premix cookies are considered effective for linear growth	Follow-up was relatively short
Setyawati <i>et al.</i> (2023) ¹⁰	Biscuits contain calories, protein, fat, and fortified with vitamins and minerals	Nutritional status according to the HAZ score was not statistically significant	Almost 3 times the higher possibility of having a normal nutritional status after consuming the supplementary biscuits	NR
Pusparini <i>et al.</i> (2020) ¹¹	Biscuits (developed for national supplementary feeding programme) provided by the Indonesian Ministry of Health	Fortified biscuits with psychological parenting education can significantly improve stunting condition	Nutrition intervention need to be carried out along with maternal parenting to children	NR
Herawati <i>et al.</i> (2020) ¹²	Eel bone flour and cilembu sweet potato flour	Significant increase in the HAZ score between both groups	Supplemented eel biscuits helped to increase the HAZ score of children with stunting aged 36–60 months	Sample size was small Duration of intervention may not have been long enough
Fatmah (2017) ¹³	Soybeans, glucose from date, vitamins A and C, and Fe	Toddlers' means weight increased by 0.2 kg and height increased by 1.9 cm Intake of food supplement resulted in an increase of height of short toddlers to normal height	Supplemented biscuit can decrease the prevalence of stunting in toddlers	NA
Quintero-Gutiérrez <i>et al.</i> (2016) ¹⁴	Rice flour, modified corn starch, glucose, glycerine, added wheat flour, etc.	No significant different in height change	Processed food fortified with iron can be effective for anaemia	Small sample size

Study	Biscuits composition	Important findings	Conclusions	Study limitations or adverse effect
Landim <i>et al.</i> (2016) ¹⁵	Intervention: Cookies prepared with cowpea flour fortified with iron and zinc Control: Wheat flour fortified with iron and folic acid	No significant difference in height change Haemoglobin level significantly increased	Both cookies helped to decreased the anaemia prevalence	Adverse effects: vomiting, diarrhoea, stained teeth, constipation, and cramps
Muslihah <i>et al.</i> (2016) ¹⁶	Biscuits (developed for national supplementary feeding programme) provided by the Indonesian Ministry of Health	Change of height and HAZ score were higher in the SQ-LNS group compared to other groups	SQ-LNSs helped in linear growth and reduced the stunting incidence	Not randomised and no blinding
Purwestri <i>et al.</i> (2012) ¹⁷	Fortified biscuits from cereal / nut / legume (± 500 kcal and 8-10% protein per 100 g)	HAZ score and height gain was not clearly affected by the biscuit intervention	Locally produced RUF biscuits demonstrated promising results for treatment of mild wasting, but not for stunting	Randomization could not be applied due to the rural remote regions, where the nutrition centre was far away from the respondent's house NR
Nazni <i>et al.</i> (2010) ¹⁸	Flour obtained from potato or wheat or ragi and mixed with soya flour (ratio 80:30), sugar and fat	All groups showed significant increase in height growth	Weaning biscuits made with potato flour, wheat and Ragi can bring out better all-round development of the children	
Zhang <i>et al.</i> (2010) ¹⁹	100 g of biscuit containing 71.3 g carbohydrate, 8.0g protein, 16.0 g fat, 2.2 g fibre and 1856.8 kJ energy	The HAZ score in all groups increased markedly compared with baseline, but no significant difference The prevalence of anaemia and vit A deficiency (VAD) were decreased in all groups	Consuming supplemented biscuits (with 100% RDA) has the same effect on the improvement of VAD, anaemia, and physical growth	Protective packaging needed to used Anthropometric status needed to check and consider Needed to evaluate other confounding factors like other important nutrients

Discussion

This study was conducted by searching articles in online databases using multiple keyword combinations to obtain the studies focusing on biscuit-based food intervention among children to prevent stunting. The review showed several biscuit-based interventions and their contribution to reducing stunting prevalence. Ready-to-use food (RUF) or fortified food could improve the HAZ score for stunted children.

In addition to the food or nutritional adequacy, the quality of food or nutrition also needs to be considered for improvement in child linear growth²⁰. Accordingly, the quality biscuit-based supplement should be made with a standard formula containing all essential nutrients including carbohydrate, protein, fat, required energy, and fortified with important vitamins and minerals²¹. Lack of required or recommended energy content may cause different nutritional disorders including stunting as energy is mandatory for all metabolic functions¹². One of the important nutrients for linear growth is protein. It is important to ensure high-quality protein for food supplements because high-quality protein contains essential amino acids, the main element of protein, which play a significant role in growth²². Some other micronutrients are also significant for child linear growth including zinc, vitamin A, iron, and calcium²³.

The effectiveness of fortified foods, especially biscuits, in preventing stunting in children is well-established worldwide. However, the taste of fortified biscuits may affect their acceptance and impact²⁴. To address the issue of reducing stunting among children, it is important to ensure they have a diverse and balanced daily food intake and to consider biscuit interventions as a complementary food option, ensuring high in protein and calories and modified into appealing forms to encourage consumption²⁵. It is important to revise intervention policies to incorporate local foods in the production of fortified products to better meet nutrient needs and reduce stunting²⁶.

Considering the study limitation from the included studies, this review suggests that researchers conduct future research with standard sample size, study design, and intervention duration. The follow-up study also needs to be

conducted timely to obtain the actual output of food intervention. The duration of follow-up, too short or long period, after a nutrition intervention can significantly impact the assessment of the effectiveness of the programme. In addition, practicing food safety needs to ensure during the entire food supplementation programme including protective packaging of food. Considering required essential nutrients and anthropometric status would help to better understand the gaps between existing factors and designing innovative food supplements.

Policymakers should consider integrating fortified biscuits into existing nutritional programs for children, particularly in regions with high stunting prevalence. This integration should include the incorporation of local foods to ensure food diversity and meet desired nutritional needs^{27,28}. Additionally, it is important to customize these biscuits to local dietary preferences and needs by collaborating with nutritionists and food scientists to develop culturally acceptable formulations that address specific micronutrient deficiencies. Moreover, policymakers should integrate fortified biscuit interventions with broader projects addressing other stunting factors, such as improving clean water, sanitation, and hygiene (WASH), as research shows that addressing multiple factors simultaneously is necessary for a more significant and sustainable impact^{29,30}.

Practitioners should enhance the production and distribution of fortified biscuits by maintaining nutrient integrity during manufacturing and ensuring that distribution networks effectively reach vulnerable populations³¹. Additionally, engaging with communities and educating parents about the benefits of fortified biscuits through awareness campaigns can improve program acceptance and consumption. Collaboration among stakeholders, including government agencies, NGOs, and local businesses, is essential for successful implementation, enabling resource sharing, capacity building, and scaling up of interventions³².

Our review study also has some limitations that we want to mention for future study. In this review, the keywords used for literature search in databases may not be accurate or perfect to obtain all existing literature. Future research may focus on strong keyword combinations, also possible to use

the power of artificial intelligence or data mining approach to obtain the prospective keywords. Another limitation of this study was the inability to conduct the meta-analysis due to the heterogeneity of data obtained from the included studies.

Conclusion

Child stunting is still a major health problem globally which results in several problems during the entire life. Providing all essential macro- and micronutrients as food supplements could help to reduce the stunting prevalence. Biscuit-based nutrition intervention with essential fortified nutrients is one of the prominent ways to decrease chronic nutritional problem or stunting. Future research needs to focus on the innovation of food supplement to ensure the fulfillment of nutritional requirements by food supplements for the linear growth of children.

Conflict of interest

The authors declare there is no conflict of interest

Contribution of authors

Abdullah Al Mamun (AAM): Conceptualization, methodology, investigation, resources, writing—original draft preparation

Ririh Yudhastuti (RY): Validation, investigation, writing—review and editing, supervision

Trias Mahmudiono (TM): Conceptualization, methodology, investigation, writing—review and editing, supervision

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