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EFFECTIVENESS OF EGG INTERVENTION ON LINEAR GROWTH IN STUNTING CHILDREN: A SYSTEMATIC REVIEW

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ABSTRACT
Complementary feeding of eggs to children is one of the strategies to improve growth in stunted children. It is necessary to develop egg complementary feeding interventions based on local food availability. Whether egg complementary feeding interventions can improve growth in children with growth retardation. Our aim in this systematic review was to assess the effect of egg or complementary feeding interventions on improving linear growth in stunted children. Electronic databases were used to systematically search for articles reviewing the literature using PubMed, Cochrane and base, and garuda databases. The research question was based on PICO. A total of 969 articles were found and only six articles met the inclusion criteria and were published within 10 years (2011-2021). All articles were RCTs and in children aged 6 months and 24 months with growth retardation. From the critical appraisal of the included articles, egg intervention significantly improved linear growth in children with growth retardation. An approach was adopted to identify several well-designed trials that examined the effect of egg interventions on growth. This intervention should be provided as holistic pediatric nutrition.

Keywords: egg intervention; growth promotion; stunting

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INTRODUCTION

According to WHO (2013) and UNICEF (2013) stunting is defined as height attained below -2 standard deviations (SD) the most common form characterized by malnourished children before reaching 5 years of age (Black, Victora, Walker, Bhutta, Christian, Onis, et al., 2013; Islam et al., 2018) . Stunting as part of child malnutrition remains one of the most serious health problems in countries in Sub-Saharan Africa and South Asia (ZA et al., 2013) . It is estimated that nearly 3.1 million children die each year either directly or indirectly due to malnutrition (ZA et al., 2013) , and approximately 165 million children are affected by chronic limitation of linear growth potential (Black, Victora, Walker, Bhutta, Christian, De Onis, et al., 2013). Growth impairment in the early years of life is largely irreversible in terms of human capital development (Dowdney et al., 1998; Shrimpton et al., 2001; Victora et al., 2008) . Even so, until now there has been no known evidence regarding several other factors and risks that contribute to stunting, seen from the physiological mechanism. most of them remain elusive dipaham (Vonaesch et al., 2018) . Meanwhile, according to Gouado (2014) , the stunting and stunted growth observed is due to a lack of knowledge about optimal feeding.

One of the etiologies of stunting is caused by chronic malnutrition due to poor maternal and child nutrition early in life (Silveira et al., 2010) especially unbalanced diet and efficient

intake of vitamins and micronutrients (Stewart et al., 2013). The introduction of safe and nutrient-rich complementary foods for infants is appropriately age-appropriate from about 6 months to 23 months (Bhutta et al., 2013). It is necessary to create a conducive environment for mothers to follow the recommendations in various countries in promoting adequate breastfeeding and complementary feeding by using local foodstuffs as nutrients and animal source foods and formulating complementary foods that are enriched with the required nutrients to overcome the nutritional deficiencies (Lartey, 2015).

Animal source foods (ASF) are bioavailable to provide essential nutrients to young children during the complementary feeding period (L.Iannotti, 2018). ASF is one of the foods that may exhibit an essential function in augmenting body and brain capacity that dates back to human history (Kuipers et al., 2012) . This approach simplifies the nutritional effects of foods, (Blumberg et al., 2010) because macronutrients or micronutrients are consumed separately, most of their effects may be the result of a complex network (Kuipers et al., 2012). Unfortunately, ASF is a non-young food that can be obtained by low-resource households (Headey & Alderman, 2019) so with eggs ASF could be one that could be offered as a holistic nutrition package to stimulate infant growth and development quickly and relatively cheaply given the context and high affordability of complementary foods (LL Iannotti et al., 2014), 2014) In the same vein, research in Ecuador on stunted children found that feeding one egg daily for six months during the early period of complementary feeding was associated with a significant increase in LAZ of 0.63 and a 47% reduction in the prevalence of stunting (LL Iannotti, Lutter, Stewart, dkk., 2017).

This review sought to identify studies on nutrition programs and components where the benefits of interventions could be demonstrated to lead to a reduction in stunting (Hossain et al., 2017) using egg interventions (LL Iannotti et al., 2014) . In addition, we sought to determine the correlation of success between these interventions. Thus, it is necessary to conduct a to summarize, evaluate, and describe the effectiveness of the of egg feeding interventions in improving growth in stunted children. By Therefore, the purpose of this study is to systematically identify and analyze egg feeding interventions on linear growth in stunted children. in stunted children.

METHOD

This study was a systematic review of the PRISMA 2009 checklist guide, which is an evidence-based reporting guide for systematic reviews and meta-analyses (Moher et al., 2009)

Article Criteria

The preparation of article questions using PICO (Population, Intervention, Comparison, Outcomes) (Eriksen & Frandsen, 2018) PICO in this study is P: stunting, I: Eggs in Supplementary Food, C:-, O: increase growth.For inclusion criteria in the review article: (1) focus on egg complementary feeding interventions, (2) applied to stunted children (3) research type Randomized Controlled Trial (RCT), (4) affect growth, and (5) published from 2012-2022. In this article, the research question is whether the effectiveness of egg complementary feeding intervention can improve the growth of stunted children?

Article Search

Literature search using 5 electronic databases: Pubmed, Cochrane, Proquest, base, and garuda. Keywords based on the database P (Population): Stunting, I (Intervention): Eggs in complementary foods, C (Comparison): -, O(Outcome): increased growth.

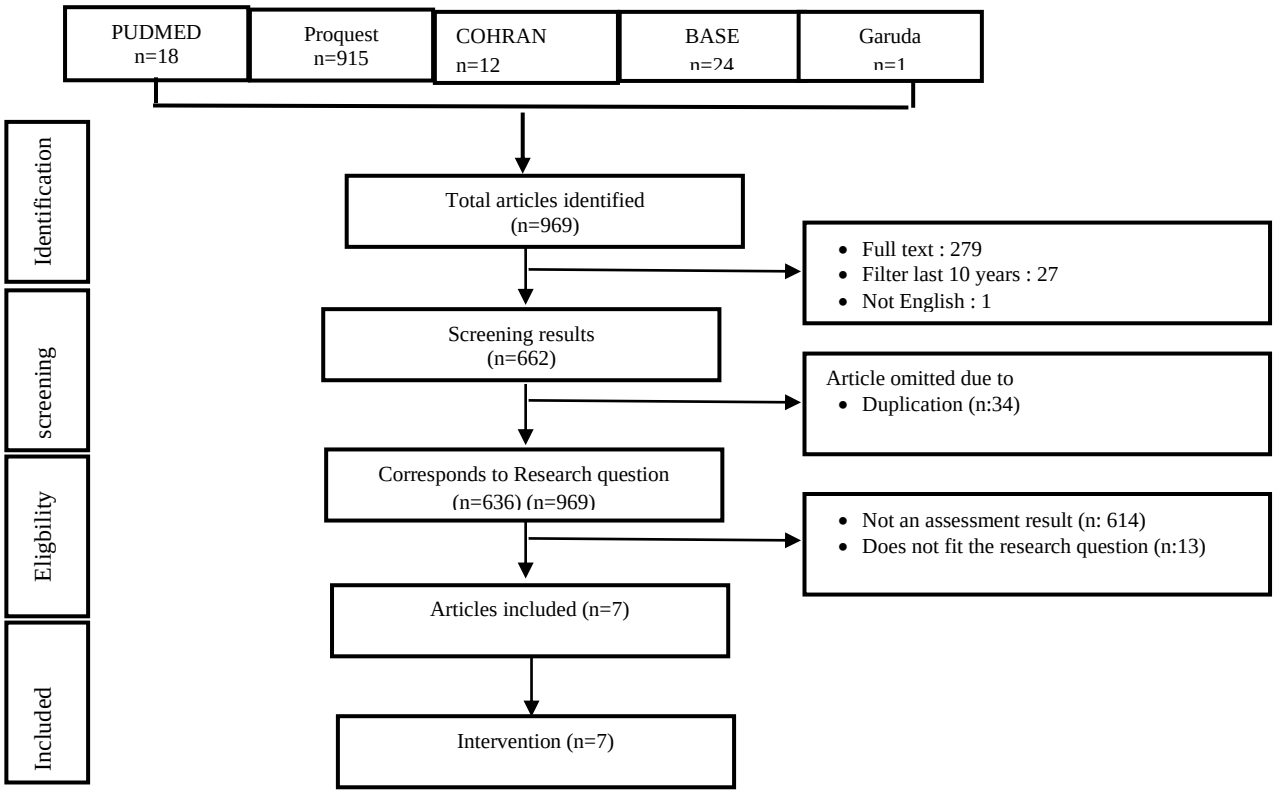

Figure 1. Article selection and exclusion flowchart

Selection Study

This article identified 969 articles from 5 databases. Articles were screened for title and abstract by three people, excluding articles published in the last 10 years, according to the research question, and excluding double-published articles. Of the results, 29 were excluded because of the last 10 years, 27 were excluded because of multiple publications, 279 were excluded because they were not full text, and 614 were excluded because they were not research results. Of the 19 articles, 13 articles did not fit the research question and were excluded. The included articles were 7 intervention studies.

Data Extraction

All authors participated for data extraction and categorization. In this study, the data extracted in each article were the name of the researcher and country, study design, purpose, sample size, intervention, instrument, results, and conclusion (Table, 1). The methods in each article were identified, categorized into themes, summarized, and synthesized systematically.

Article Quality Rating

To assess the eligibility of articles that have been included, screening is carried out using the Critical Appraisal Skills Program (CASP)(CASP, 2018). In CASP there are 11 questions. The initial 3 questions are about the focus of the study and sampling, if it has 2 yes answers the article can be used, and the next 8 questions assess the quality of the article on the blinding sample segment, effect size, precision, and the application of outcome research to the local population The authors checked the risk of bias using the Cochrane Risk Of Bias Assessment Tool which consists of seven domains (Higgins et al., 2019) The tool used consists of 3 levels: (+) low risk of bias, (-) high risk of bias, (?) unclear risk of bias) (Higgins et al., 2019) (table 2).

Tabel 1.

Synthesizing the grid of egg feeding interventions to improve growth in stunted children

No.	Research, Country	Design Learn	Objective	Size Sample	Intervensi	Instrumen	Result	Summary
1	LL Iannotti dkk., (2020) (LL Iannotti dkk., 2020) Spanyol 2	Random Controlled Trial.	to compare the growth effect of the egg intervention group with the control group at more than two years of age	48 sample childr en After 6 month s	Egg intervention	The questionnaire developed Right researcher	Nowadays, consuming eggs can at least reduce the risk of height-for-age Z (HAZ) consumption in the experimental group showed a significant mediating trend for changes in HAZ, explaining about 8.8% of the total effect. There was a significantly higher egg consumption of 76% in the intervention group of mothers with poultry compared to 56% in the control group, p = 0.02.	These findings point to the need for longer-term interventions and a holistic approach to child stunting prevention.
2	LL Iannotti, Lutter, Waters, et al., (2017) (LL Iannotti, Lutter, Waters, et al., 2017) Spanyol 1	Random Controlled Trial.	We aimed to examine the efficacy of introducing eggs at the start of complementary foods on plasma concentrations of biomarkers in the choline pathway, essential fatty acids, vitamins B-12 and A	Total = 163 samples Interv ention group n:80 and contro l group witho ut interv ention ; n: 83 (6-9 month s)	Interventio n 1 eggs/day for 6 months	The questionnaire developed Right researcher	Our previous findings reported that improved linear growth increased the length-for-age Z score by about 0.63 and reduced stunting by 47% with a significant effect on the egg intervention in the Lulu Project. Our results suggest that the positive effects are partially mediated by choline. Now, the potential contribution of choline is a concern in promoting linear growth.	The findings of this study by measuring 3 essential fatty acids showed that eggs can significantly increase plasma DHA concentrations compared to controls with a considerable effect of 0.43. In neural development and growth, DHA is indispensable..
3	Stewart et al., (2017) (Stewart et al., 2017) Spanyol 1	Random Controlled Trial.	To hide efficacy give 1 egg per day	160 Contr ol Sampl e (n=82) Eggs (n=78) (usia 6 sampa i 9 bulan.)	for 6 months per day given 1 egg	The questionnaire developed by the researcher	Linear regression modeling generally showed egg intervention results increased z by 0.63 (95% confidence interval [CI], 0.38-0.88) and z by 0.61 (95% CI, 0.45-0.77). The log-binomial model with strong Poisson showed a 47% reduction in the prevalence of stunting (prevalence ratio [PR], 0.53; 95% CI, 0.37-0.77) and underweight (PR, 0.26; 95% CI, 0.10- 0.70). Children in the treatment group had higher egg intake (PR, 1.57, 95% CI, 1.28-1.92) and reduced sweet intake (PR, 0.71, 95% CI, 0.51-0.97) compared to controls.	Our findings support the hypothesis of this study reporting that growth in children is significantly improved by introducing eggs from the start. In general to reduce stunting where eggs could potentially contribute to vulnerable groups.
4	(Stark et al., 2020) (Stark et al., 2020) Afrika barat 2	Random Controlled Trial.	To increase female sales, egg consumption, poultry production in culturally adapted children aged 6-24 months with BCC strategy	270 childr en	Interventio n group four or more eggs per week in children	The questionnaire developed by the researcher	poultry productivity (total household egg production), household poultry production (number of chickens in the household), women's empowerment (egg consumption decision-making), and nutritional status (z for wasting, underweight, and stunting, obtained from anthropometric measurements and child age) are secondary outcomes.	in vulnerable populations there is still quite little ASF consumption so there needs to be a role for ASF consumption in improving child growth and development which is the evidence base.
5	Stewart et al., (2019) (Stewart et al., 2019) Afrika Selatan 1	Random Controlled Trial.	to assess a child's stunting by consuming 1 egg a day is likely to increase the child's growth in Malawi village.	660 childr en	egg intervention	The questionnaire developed are you a researcher	However, interventions that focused on improving complementary feeding had little effect. In the LAZ relative egg group with higher educated mothers there was an effect of 0.23 (95% CI: 0.04, 0.42) compared to the control group in children whose mothers had lower	The trial results were obtained as additional literature that provides additional benefits in early childhood growth and is easily available anywhere. One of the effects

No.	Research, Country	Design Learn	Objective	Size Sample	Intervensi	Instrumen	Result	Summary
							education there was no effect.	of animal source foods in the form of eggs and similar supplementary foods with other high-quality animal source foods.
6	Marquis et al., (2018) (Marquis et al., 2018) Afrika Barat 2	Random Controlled Trial.	For nutrition health education related to children's nutritional status and diet by raising poultry and gardening at home.	Number of participants 500 pairs of mothers of childr en <18 months of age and 250 per treatment group	Egg consumption and minimum dietary diversity	Question list	During the project period, overall stunting increased (14.0% to 24.3%; P < 0.001 and wasting decreased (6.3% to 2.9%; P < 0.05); underweight did not change (11.9% to 12.2%; P = 0.89); the intervention had a direct effect on linear growth.	Outcomes in this high-quality food intervention resulted in women's nutrition knowledge and increased dietary diversity of children, BAZ/HAZ, and WHZ.
7	Dumas et al., (2018) (Dumas et al., 2018) Afrika	Acak Terkendali Uji coba	The pilot project aims to evaluate the impact of the egg production program (EPC) during the first year on (a) household egg yield, (b) egg consumption among children (aged 6-36 months), and (c) child height-for-age z scores (HAZ).	3,240 samples 6-36 months	Egg production and consumption interventions	Question list	The ASF consumption intervention of native chickens as limited evidence in this intervention can improve productivity and profitability. The results of the egg consumption intervention had significant differences based on proximity to the EPC obtained (OR 2.03, 95% CI [1.03, 2.16]).	The egg consumption program has a short-term impact on children so further evaluation of the program is encouraged as the long-term impact could potentially improve nutritional quality, micronutrient adequacy, and women's empowerment and child development.

Table 2.
Risk of Bias Assessment (Higgins et al., 2019)

(Author, Year)	*Random sequence generation (Selection bias)*	*Allocation concealment (Selection bias)*	*Selective reporting (reporting bias)*	*Other sources of bias (other bias)*	*Blinding of participants and personnel (performance bias)*	*Blinding outcome assessment (detection bias)*	*Incomplete result data (attrition bias)*
LL Iannotti dkk., (2020) (LL Iannotti dkk., 2020)	+	+	+	+	+	+	+
LL Iannotti, Lutter, Waters, et al., (2017) (LL Iannotti, Lutter, Waters, et al., 2017)	+	+	+	+	+	+	+
Stewart et al., (2017) (Stewart et al., 2017)	+	+	+	+	+	+	+
Stark et al., (2020) (Stark et al., 2020)	+	+	+	+	+	+	+
Stewart et al., (2019) (Stewart et al., 2019)	+	+	+	+	+	+	+
Marquis et al., (2018) (Marquis et al., 2018)	+	+	+	+	+	+	+
Dumas et al., (2018) (Dumas et al., 2018)	+	+	*?*	+	*?*	+	+

Notes: (+) low risk of bias, (-) high risk of bias, ?) unclear risk of bias.

Table 3.
Critical Appraisal Skill Quality Assessment

No	*Critical Assessment Questions*	(LL Iannotti et al., 2020)	(LL Iannotti, Lutter, Waters, dkk., 2017)	(Stewart et al., 2017)	(Stark et al., 2020)	(Stewart et al., 2019)	(Marquis et al., 2018)	(Dumas et al., 2018)
1	*Did the trial address a focused problem?*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
2	*Is the assignment of patients to treatments randomized?*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
3	*Were all patients in the trial correctly accounted for in the conclusion?*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
4	*Are patients, healthcare workers and research personnel 'blind' to treatment?*	*TIDAK*	*Yes*	*Yes*	*No*	*Yes*	*TIDAK*	*Don't know*
5	*Were the groups similar at the start of the experiment (baseline characteristics)*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
6	*Aside from the experimental intervention, were the groups treated equally?*	*Don't know*	*Yes*	*Yes*	*Don't know*	*Yes*	*Yes*	*Don't know*
7	*How big is the treatment effect? (p-value)*	*Yes*	*Yes*	*Don't know*	*Don't know*	*Yes*	*Yes*	*Yes*
8	*How precise is the estimate of treatment effect? (MD & CI)*	*Don't know*	*Don't know*	*Don't know*	*Don't know*	*Yes*	*Yes*	*Yes*
9	*Can the results be applied to the local population, or in your context?*	*Don't know*	*Don't know*	*Yes*	*Don't know*	*Yes*	*Yes*	*Yes*
10	*Are all clinically important outcomes considered?*	*Don't know*	*Don't know*	*Don't know*	*Ya*	*Don't know*	*Don't know*	*Ya*
11	*Are the benefits worth the losses and costs?*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

RESULT

In this systematic review, 7 articles were included, which were RCT studies. These articles were published from 2017 to 2020. The studies were conducted in Spain and Africa. All interventions conducted in these articles were in children aged 6-24 years with a sample size of 48 to 3,240 samples. Effect of egg consumption intervention in improving growth of stunted children. The application of mixed mixed models, regression modeling, generalized linear regression modeling, and multilayered intercept logistic regression can significantly improve growth in stunted children (Dumas et al., 2018; LL Iannotti et al., 2020; LL Iannotti, Lutter, Waters, et al., 2017; Marquis et al., 2018; Stewart et al., 2017, 2019)

Several studies have shown the intervention of egg consumption in improving the growth of stunted children. The emergence of several studies analyzed that the impact of egg consumption interventions is almost identical in sensitivity analysis using random effects models and mixed effects models. The results of the analysis showed the opportunity to consume eggs in children compared to children who did not consume eggs. Sensitivity analysis using random effects and mixed effects models showed the applicability of the same estimates for the odds ratio but the association with both models was slightly weaker. However, sensitivity analysis showed similar results for LAZ/HAZ (random effect model: 0.21, 95 % CI (0.09, 0.34) mixed effects model: 0.22, 95 % CI (0.07, 0, 36), treated model = 0.25 95 % CI (0.10, 0.41).The findings on WAZ were identical in the sensitivity analysis using random effects and mixed effects models. The treated analysis gave similar results (ÿ: 0.17, 95% CI, 0.03, 0.31) (Marquis et al., 2018). The factors shown to be associated with anthropometric outcomes in regression models adjusted for group, baseline anthropometry, and age were further processed for mediation using structural equation modeling. Regression

modeling showed that all models had no effect on group for HAZ, WAZ, BMI, and Hz. Children in the egg intervention group showed a significant decrease in final HAZ compared to the control group after adjusting for age and baseline HAZ. However, poultry ownership reported that the proportion of mothers or caregivers in the egg intervention group (76%) was more impactful compared to the control group by approximately (56%; P = 0.02) (LL Iannotti et al., 2020).

Application of adjusted generalized linear regression models that the egg intervention increased plasma concentrations compared to controls with the following effect sizes: choline, 0.35 (95% CI: 0.12, 0.57); betaine, 0.29 (95% CI: 0.01, 0.58); methionine, 0.31 (95% CI: 0.03, 0.60); docosahexaenoic acid, 0.43 (95% CI: 0.13, 0.73); DMA, 0.37 (95% CI: 0.37, 0.69); and TMAO, 0.33 (95% CI: 0.08, 0.58). In addition, vitamin B12, essential fatty acids and choline biomarkers were significantly improved with the intervention of one egg per day for 6 months. Choline is essential for growth and development processes, particularly its conversion to sphingomyelin, phosphatidylcholine, and acetylcholine (LL Iannotti, Lutter, Waters, dkk., 2017).

The egg intervention used generalized linear regression modeling and log-binomial modeling. In generalized linear regression modeling, the egg intervention increased z by a prevalence ratio (PR) of 0.63 (95% confidence interval CI, 0.38-0.88) and z by 0.61 (95% confidence interval CI, 0.45-0.77). The log-binomial model with a robust Poisson ratio showed a 47% reduction in the prevalence of stunting (PR, 0.53; 95% confidence interval CI, 0.37-0.77) and wasting (PR, 0.26; 95% confidence interval CI, 0.10-0.70). Children in the treatment group had higher egg intake (PR, 1.57; 95% confidence interval CI, 1.28-1.92) and reduced sweet food intake (PR, 0.71; 95% confidence interval CI, 0.51-0.97) compared to controls.

Reduction in sugar intake (PR, 0.71; 95% confidence interval CI, 0.51-0.97) compared to the control. There was a significant and positive difference in the prevalence of children in the intervention group who consumed eggs compared to the control group (Stewart et al., 2017). The latest design of the Un Oeuf study application in testing innovative behavior change communication strategies can increase egg consumption in children aged 6-24 months and improve dietary and nutritional diversity in Burkina Faso. Significantly (p:0.00) increased egg consumption among children under 2 years of age in rural communities with very low egg consumption. A nutrition-sensitive behavior change package was designed to increase egg consumption through increased livestock production, women's empowerment and food security at the household level (Stark et al., 2020) .

The intervention of providing one egg per day to children did not have an overall positive effect on linear growth in rural Malawi however, there was a positive effect on head circumference which was significantly higher for age z 0.18 (95% CI: 0.01, 0.34) in the egg group compared to the control group. In addition, highly educated mothers had a significant effect of (P = 0.024) for length z score at child age (Stewart et al., 2019), The children's egg consumption intervention used multilevel random intercept logistic regression models and zero-truncated negative binomial regression. A stratified random intercept logistic regression model was used to model the probability of a child consuming eggs over the past 7 days. While a negative binomial regression model truncated to zero was used to model the number of times a child ate eggs during the last 7 days in the subsample of individuals followed up. Greater egg consumption may affect growth in children but relatively low egg consumption due to insufficient EPC program. In addition, children overall tended to eat a less diverse diet (37.8% vs. 51.4%, $p<0.001$), experienced less morbidity, and had lower weight-for-height z-scores (0.10 vs. 0.29, $p<0.001$) (Dumas et al., 2018)

Article Quality Rating

In this study, we used the Critical Appraisal Program (CASP) to assess the eligibility of the included articles (CASP, 2018). Seven articles were assessed as RCT studies. Of these studies, most articles explained the purpose of the study, randomization of the sample, homogeneity of the sample, and applicability to the local population. However, some articles did not explain how the research results, selective reporting, and blinding of research (LL Iannotti et al., 2020; Marquis et al., 2018; Stark et al., 2020). In addition, to assess the eligibility of articles from quantitative studies, we also used the Cochrane Risk Of Bias Assessment Tool (Higgins et al., 2019). Seven articles were assessed in this study. The risk of bias study revealed the results of six articles having a low risk of bias (LL Iannotti et al., 2020; LL Iannotti, Lutter, Waters, et al., 2017; Marquis et al., 2018; Stark et al., 2020; Stewart et al., 2017, 2019) (Tabel 2) .One article that has an unclear risk of bias (Dumas et al., 2018) (Tabel 3) .

All articles went through the randomization checking process. Therefore, one article did not perform Selective reporting and Blinding of participants and personnel(Dumas et al., 2018). All articles performed Random sequence generation, allocation concealment, selective reporting, Blinding of participants and personnel, blinding of outcome assessments, and incomplete outcome (LL Iannotti et al., 2020; LL Iannotti, Lutter, Waters, et al., 2017; Marquis et al., 2018; Stark et al., 2020; Stewart et al., 2017, 2019) (Table 2).

Instrument

The seven included articles used several instruments to evaluate the effectiveness of egg feeding interventions in children using liquid chromatography tandem mass spectrometry (LC-MS/MS) methods for the measurement of choline, betaine, etc., (LL Iannotti, Lutter, Waters, et al., 2017) anthropometry to measure child growth (Stark et al., 2020; Stewart et al., 2017, 2019) as well as some studies using researcher-developed questionnaires (Dumas et al., 2018; LL Iannotti et al., 2020; Marquis et al., 2018). The validity and reliability test of the COMACO interaction was carried out by Dumas (2018) While some studies test the validity and reliability of the instruments developed by researchers, reliability is carried out with the Interrater reliability test with a value of 0.21, (Marquis et al. ., 2018) interrater reliability test with a value of 0.35, , (LL Iannotti, Lutter, Waters, et al., 2017) Interrater reliability test was carried out with a value of 0. 63 (Stewart et al., 2017) interrater reliability test was carried out with a value of 0.18 (Stewart et al., 2019). However, some studies do not explain the validity and reliability of the instruments used (LL Iannotti et al., 2020; Stark et al., 2020)

DISCUSSION

This systematic review aimed to identify the effectiveness of egg feeding interventions in improving growth in stunted children. There were six articles reviewed that were intervention studies with RCT research designs. Several applications of egg feeding intervention modeling including mixed randomized models, regression modeling, generalized linear regression modeling, and multilevel random intercept logistic regression can significantly improve growth in stunted children (Dumas et al., 2018; LL Iannotti et al., 2020; LL Iannotti, Lutter, Waters, et al., 2017; Marquis et al., 2018; Stewart et al., 2017, 2019) . One article used the Un Oeuf study method to significantly improve growth in stunted children by testing innovative behavior change communication strategies and improving diet diversity and nutrition outcomes (Stark et al., 2020).Researchers explained that the application of randomized and mixed-effects methods showed a tendency to increase the reach of high-quality foods, nutrition education and nutritional improvement in children who tend to eat eggs compared to those who do not eat eggs (Marquis et al., 2018). Regression modeling showed that in the egg intervention group the results were more meaningful in the poultry

group. These regression models were adjusted for group, baseline anthropometry, and age, then tested for mediation using structural modeling (LL Iannotti et al., 2020).

Egg intervention can increase plasma concentrations by applying generalized linear regression modeling. Early egg feeding significantly increased choline and other markers in its methyl group metabolic pathway. Choline is required for several important pathways in child growth and development (LL Iannotti, Lutter, Waters, et al., 2017). Application Generalized linear regression modeling and log-binomial models showed increased growth in young children and decreased prevalence of stunting. Feeding one egg per day to children can also treat any illness experienced, such as skin rashes, diarrhea, fever, or cough (Stewart et al., 2017). The application of the Un Oeuf study can increase egg consumption in children under 2 years of age in rural areas, thereby increasing dietary diversity and nutritional outcomes (Stark et al., 2020). The application of logistic regression models to model the probability of a child consuming eggs over the past 7 days can improve nutritional quality, micronutrient adequacy, child development and women's empowerment after model (Dumas et al., 2018).

Some researchers conducted validity and reliability tests on the instruments developed (Dumas et al., 2018; LL Iannotti, Lutter, Waters, et al., 2017; Marquis et al., 2018; Stewart et al., 2017, 2019) and some did not describe validity and reliability tests (LL Iannotti et al., 2020; Stark et al., 2020). The process of validity testing and reliability testing is particularly important in the relevant population and its reliability among measured examiners, given the many factors that can cause balance and researcher mobility issues (Moore & Barker, 2017). In addition, the research article used CASP. Some studies do not apply blinding methods to respondents, research members, and research (LL Iannotti et al., 2020; Marquis et al., 2018; Stark et al., 2020) . In research, the blinding process is important to prevent identical bias in research results, with this blinding can affect the availability of human resources, equipment, and other factors in conducting research penelitian (Bazi, 2020).

CONCLUSION

The results of this study provide information that the egg feeding intervention implemented can increase growth in stunted children. However, other factors related to participants need to be considered in providing this intervention because stunted children have different conditions and body responses, so that it will affect unexpected results.

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REFERENCES

Bazi, T. (2020). Peer review: single-blind, double-blind, or all the way-blind? *International Urogynecology Journal*, *31*(3), 481–483. https://doi.org/10.1007/s00192-019-04187-2

Bhutta, Z. A., Das, J. K., Rizvi, A., Gaff, M. F., Walker, N., Horton, S., Webb, P., Lartey, A., & Black, R. E. (2013). Maternal and Child Nutrition 2 Evidence-based interventions for improvement of maternal and child nutrition : what can be done and at what cost ? *The Lancet Nutrition Interventions Review Group, and the Maternal and Child Nutrition Study Group*, *382*. https://doi.org/10.1016/S0140-6736(13)60996-4

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. qar A., Christian, P., Onis, M. de, & Ezzati, M. (2013). Maternal and child nutrition 1 maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet*, *6736*(13), 427–451. https://doi.org/10.1016/S0140-6736(13)60937-X

Blumberg, J., Heaney, R. P., Huncharek, M., Scholl, T., Stampfer, M., Vieth, R., Weaver, C. M., & Zeisel, S. H. (2010). Evidence-based criteria in the nutritional context. *Nutrition Reviews*, *68*(8), 478–484. https://doi.org/10.1111/j.1753-4887.2010.00307.x

CASP. (2018). *Critical appraisal skills programme (casp) part of oxford centre for triple value healthcare ltd www.casp-uk.net*. https://doi.org/10.4103/0976-500X.107697

Dowdney, L., Skuse, D., Morris, K., & Pickles, A. (1998). Short normal children and environmental disadvantage: A longitudinal study of growth and cognitive development from 4 to 11 years. *Journal of Child Psychology and Psychiatry and Allied Disciplines*. https://doi.org/10.1017/S0021963098003060

Dumas, S. E., Lewis, D., & Travis, A. J. (2018). *Small-scale egg production centres increase children's egg.pdf*. 1–11. https://doi.org/DOI: 10.1111/mcn.12662

Eriksen, M. B., & Frandsen, T. F. (2018). *The impact of patient , intervention , comparison , outcome (PICO) as a search strategy tool on literature search quality : a systematic review*. *106*(October), 420–431.

Gouado, I. (2014). Feeding Practices, Food and Nutrition Insecurity of infants and their Mothers in Bangang Rural Community, Cameroon. *Journal of Nutrition & Food Sciences*, *04*(03). https://doi.org/10.4172/2155-9600.1000264

Headey, D. D., & Alderman, H. H. (2019). The Relative Caloric Prices of Healthy and Unhealthy Foods Differ Systematically across Income Levels and Continents. *Journal of Nutrition*, *149*(11), 2020–2033. https://doi.org/10.1093/jn/nxz158

Higgins, J. P. T., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (2019). Cochrane Handbook for Systematic Reviews of Interventions. In *Cochrane Handbook for Systematic Reviews of Interventions*. https://doi.org/10.1002/9781119536604

Hossain, M., Choudhury, N., Abdullah, K. A. B., Mondal, P., Jackson, A. A., Walson, J., & Ahmed, T. (2017). Evidence-based approaches to childhood stunting in low and middle income countries: A systematic review. *Archives of Disease in Childhood*, *102*(10), 903–909. https://doi.org/10.1136/archdischild-2016-311050

Iannotti, L. (2018). The benefits of animal products for child nutrition in developing countries. *OIE Scientific and Technical Review*, *37*(1), 37–46. https://doi.org/https://doi.org/10.20506/rst.37.1.2738

Iannotti, L. L., Chapnick, M., Nicholas, J., Gallegos-Riofrio, C. A., Moreno, P., Douglas, K., Habif, D., Cui, Y., Stewart, C., Lutter, C. K., & Waters, W. F. (2020). Egg intervention effect on linear growth no longer present after two years. *Maternal and Child Nutrition*, *16*(2), 1–10. https://doi.org/10.1111/mcn.12925

Iannotti, L. L., Lutter, C. K., Bunn, D. A., & Stewart, C. P. (2014). Eggs: The uncracked potential for improving maternal and young child nutrition among the world's poor. *Nutrition Reviews*, *72*(6), 355–368. https://doi.org/10.1111/nure.12107

Iannotti, L. L., Lutter, C. K., Stewart, C. P., Riofrío, C. A. G., Malo, C., Reinhart, G., Palacios, A., Karp, C., Chapnick, M., Cox, K., & Waters, W. F. (2017). Eggs in early complementary feeding and child growth: A randomized controlled trial. *Pediatrics*, *140*(1). https://doi.org/10.1542/peds.2016-3459

Iannotti, L. L., Lutter, C. K., Waters, W. F., Riofrío, C. A. G., Malo, C., Reinhart, G., Palacios, A., Karp, C., Chapnick, M., Cox, K., Aguirre, S., Narvaez, L., López, F., Sidhu, R., Kell, P., Jiang, X., Fujiwara, H., Ory, D. S., Young, R., & Stewart, C. P. (2017). Eggs early in complementary feeding increase choline pathway biomarkers and DHA: A randomized controlled trial in Ecuador. *American Journal of Clinical Nutrition*, *106*(6), 1482–1489. https://doi.org/10.3945/ajcn.117.160515

Islam, M. M., Sanin, K. I., Mahfuz, M., Ahmed, A. M. S., Mondal, D., Haque, R., & Ahmed, T. (2018). Risk factors of stunting among children living in an urban slum of Bangladesh : findings of a prospective cohort study. *BMC Public Health*, *197*(18), 1–13.

https://doi.org/10.1186/s12889-018-5101-x

Kuipers, R. S., Joordens, J. C. A., & Muskiet, F. A. J. (2012). A multidisciplinary reconstruction of Palaeolithic nutrition that holds promise for the prevention and treatment of diseases of civilisation. *Nutrition Research Reviews*, *25*(1), 96–129. https://doi.org/10.1017/S0954422412000017

Lartey, A. (2015). What would it take to prevent stunted growth in children in sub-Saharan Africa? *Proceedings of the Nutrition Society*, *74*(4), 449–453. https://doi.org/10.1017/S0029665115001688

Marquis, G. S., Colecraft, E. K., Kanlisi, R., Aidam, B. A., Atuobi-Yeboah, A., Pinto, C., & Aryeetey, R. (2018). An agriculture–nutrition intervention improved children's diet and growth in a randomized trial in Ghana. *Maternal and Child Nutrition*, *14*(March), 1–10. https://doi.org/10.1111/mcn.12677

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., Altman, D., Antes, G., Atkins, D., Barbour, V., Barrowman, N., Berlin, J. A., Clark, J., Clarke, M., Cook, D., D'Amico, R., Deeks, J. J., Devereaux, P. J., Dickersin, K., Egger, M., Ernst, E., … Tugwell, P. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine*, *6*(7). https://doi.org/10.1371/journal.pmed.1000097

Moore, M., & Barker, K. (2017). The validity and reliability of the four square step test in different adult populations: A systematic review. *Systematic Reviews*, *6*(1), 1–9. https://doi.org/10.1186/s13643-017-0577-5

Shrimpton, R., Victora, C. G., de Onis, M., Lima, R. C., Blössner, M., & Clugston, G. (2001). Worldwide timing of growth faltering: implications for nutritional interventions. *Pediatrics*, *107*(5), 1–9. https://doi.org/10.1542/peds.107.5.e75

Silveira, K. B. R., Alves, J. F. R., Ferreira, H. S., Sawaya, A. L., & Florêncio, T. M. M. T. (2010). Association between malnutrition in children living in favelas , maternal nutritional status , and environmental factors. *Jornal de Pediatria*, *86*(3), 215–220. https://doi.org/10.2223/JPED.1991

Stark, H., Diaye, A. W. N., Mckune, S. L., Sapp, A. C., & Moore, E. V. (2020). *The Un Oeuf study : Design , methods and baseline data from a cluster randomised controlled trial to increase child egg consumption in Burkina Faso*. *February*, 1–13. https://doi.org/10.1111/mcn.13069

Stewart, C. P., Caswell, B., Iannotti, L., Lutter, C., Arnold, C. D., Chipatala, R., Prado, E. L., & Maleta, K. (2019). The effect of eggs on early child growth in rural Malawi: The Mazira Project randomized controlled trial. *American Journal of Clinical Nutrition*, *110*(4), 1026–1033. https://doi.org/10.1093/ajcn/nqz163

Stewart, C. P., Iannotti, L., Dewey, K. G., Michaelsen, K. F., & Onyango, A. W. (2013). Contextualising complementary feeding in a broader framework for stunting prevention. *Maternal and Child Nutrition*, *9*(S2), 27–45. https://doi.org/10.1111/mcn.12088

Stewart, C. P., Iannotti, L. L., & Malo, C. (2017). *Eggs in Early Complementary Feeding and Child Growth : A Randomized Controlled Trial*. *140*(1).

UNICEF. (2013). Improving child nutrition: The achievable imperative for global progress. In *Division of Communication, UNICEF*. https://doi.org/978-92-806-4686-3

Victora, C. G., Adair, L., Fall, C., Hallal, P. C., Martorell, R., Richter, L., & Sachdev, H. S. (2008). Maternal and child undernutrition 2 maternal and child undernutrition : consequences for adult health and human capital. *Maternal & Child Undernutrition 2*, *371*(9609), 340–357. https://doi.org/10.1016/S0140-6736(07)61692-4

Vonaesch, P., Randremanana, R., Gody, J. C., Collard, J. M., Giles-Vernick, T., Doria, M., Vigan-Womas, I., Rubbo, P. A., Etienne, A., Andriatahirintsoa, E. J., Kapel, N., Brown, E., Huus, K. E., Duffy, D., Finlay, B. B., Hasan, M., Hunald, F. A., Robinson, A., Manirakiza, A., … Gouandjika-Vassilache, I. (2018). Identifying the etiology and pathophysiology underlying stunting and environmental enteropathy: Study protocol of

the AFRIBIOTA project. *BMC Pediatrics*, *18*(1), 1–18. https://doi.org/10.1186/s12887-018-1189-5

Z.A., B., J.K., D., A., R., M.F., G., N., W., S., H., P., W., & A., L. (2013). Evidence-based interventions for improvement of maternal and child nutrition: What can be done and at what cost? *The Lancet*, *382*(9890), 452–477. https://doi.org/10.1016/S0140-6736(13)60996-4