

Healthy Maternal Nutrition for Child Stunting Prevention and its Promotion Through Animated Video-based Education: A Narrative Review

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ABSTRACT

Background: Child stunting remains a persistent public health challenge in Malaysia, despite ongoing efforts to improve maternal and child nutrition. Evidence suggests that maternal nutrition during pregnancy and exclusive breastfeeding plays a pivotal role in shaping fetal growth and early childhood development. This narrative review aimed to synthesize current evidence on maternal dietary requirements and explores the potential of animated video interventions as a strategy for nutrition education and stunting prevention. **Methods:** A literature search was conducted using PubMed, Scopus, ScienceDirect, and Google Scholar, focusing on studies published from 2000 onwards. Keywords included maternal nutrition, stunting, energy and protein intake, micronutrients, and video-based education. Inclusion criteria targeted peer-reviewed studies addressing maternal nutrition during pregnancy and the use of digital tools for health education. Thematic analysis was applied to organize findings into three domains: nutritional determinants of stunting, maternal knowledge and practices, and animated video interventions. **Results:** The findings were thematically organized into three domains: maternal nutrition requirements, maternal knowledge and practices, and the use video-based tools for health education. Studies indicate that inadequate maternal intakes of energy, protein, iron, calcium, folic acid, and vitamins A, C, and D, are associated with intrauterine growth restriction, low birth weight, and small-for-gestational-age outcomes, the key contributors to stunting. Despite national guidelines, gaps in maternal nutrition literacy and practice persist. Animated video interventions have shown potential in improving maternal understanding, engagement, and behavior change. Studies demonstrate their effectiveness in enhancing maternal knowledge and dietary practices. **Conclusion:** Maternal nutrition during pregnancy and exclusive breastfeeding is vital to child growth, with deficiencies in energy, protein, and key micronutrients linked to increased stunting risk. Despite existing guidelines, gaps in maternal knowledge persist. Animated video interventions offer a solution to improve maternal nutrition literacy and support behavior change, with potential to enhance stunting prevention outcomes.

Keywords:

Child stunting; exclusive breastfeeding; maternal nutrition; nutrition education; video animation
Eg: eating behaviour; picky eaters; nutritional status; children

INTRODUCTION

Child stunting, characterised by impaired linear growth due to chronic undernutrition, recurrent infections, and insufficient psychosocial stimulation (World Health Organisation (WHO), 2015) remains a pressing public health concern in Malaysia. Despite global progress in reducing stunting rates from 40% in 1990 to 25% in 2013 (de Onis et al., 2016), Malaysia has experienced a troubling upward trend. Between 2012 and 2022, the prevalence of stunting among children under five rose from 17.6% to 21.9% (United Nations Children's Fund (UNICEF)/WHO/World Bank, 2023), with particularly high rates in the East Coast region, including Kelantan (34%), Terengganu (26.1%), and Pahang (25.7%) (Haron et al., 2023). This divergence from global patterns signals a need for targeted, context-specific interventions.

The first 1,000 days of life, which include the timeframe from conception up until the age of two years, constitute a crucial period for growth and development. Maternal

nutrition during pregnancy plays a pivotal role in shaping foetal outcomes and preventing early childhood stunting. Studies have shown that maternal undernutrition contributes to approximately 20% of stunting cases (Özaltın et al., 2010), with additional risk factors including micronutrient deficiencies, poor dietary diversity, and limited nutrition literacy (Black et al., 2013; Morrison & Regnault, 2016). Inadequate maternal nutrition not only compromises birth outcomes but also affects long-term cognitive development and economic productivity (Mustakim et al., 2022; McGovern et al., 2017).

Despite the availability of national guidelines and supplementation programs, gaps persist in maternal knowledge and practice. Research indicates that many mothers lack awareness of trimester-specific nutrient needs (Renuka et al., 2020; Nana & Zema, 2018). Traditional education tools such as pamphlets and face-to-face counselling, often fail to engage diverse populations effectively, especially in rural or underserved areas. Meanwhile, digital health strategies have gained traction

as scalable, engaging platforms for nutrition education. Animated videos, grounded in Cognitive Load Theory, offer a promising medium for simplifying complex information and enhancing retention (Ab Hamid, 2022; Brame, 2016). Studies have demonstrated that video-based interventions can improve maternal knowledge, attitudes, and practices related to maternal nutrition and complementary feeding (Ramadhani et al., 2023; Schneider et al., 2022; Rodrigues et al., 2017).

This narrative review synthesizes current evidence on maternal nutrition during pregnancy and explores the potential of animated video interventions as a novel strategy for stunting prevention. By integrating nutritional science with digital innovation, this review aims to inform future program design and policy development in maternal and child health.

MATERIALS AND METHODS

Literature Search Strategy

A systematic search was conducted across multiple databases including PubMed, Scopus, ScienceDirect, and Google Scholar. Among the main keywords used included 'maternal nutrition', 'total energy', 'macronutrients', 'micronutrient', 'pregnancy', 'stunting', 'nutrition education', 'video', and 'animation'. Several additional search terms recognized as risk factors for stunting, such as 'low birth weight', 'small-for-gestational age', and 'intrauterine growth retardation' were also used. Boolean operators and truncation were applied to refine the results. The reference lists of selected articles were also scrutinized for any other relevant studies.

Inclusion and Exclusion Criteria

The findings were further refined based on the pre-determined inclusion and exclusion criteria (Table 1). A restriction of date was put on the search where only the year 2000 onwards were included because this timeframe was determined in consideration of the fact that this was the period in which research on information and communication technology adoption in the digital health environment began to be conducted globally. Articles that were not written in Malay or English were excluded from this study. As this review focused primarily on maternal nutrition during pregnancy, articles about non-pregnant mothers were automatically excluded during the initial screening. The search criteria were broadened to encompass the relationship between maternal nutrition and the prevention of stunting and the effectiveness of video animation in delivering the information to expand the range of articles available for review.

Table 1: Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
1. Studies published from year 2000 onwards.	1. Studies published before year 2000
2. Peer-reviewed journal articles, reports, and guidelines published in English or Malay.	2. Non-English or non-Malay publications.
3. Studies focusing on maternal nutrition during pregnancy.	3. Studies not directly related to maternal nutrition or stunting.
4. Studies evaluating digital or video-based nutrition education tools.	4. Studies focused solely on infant feeding without maternal context.

Data Extraction and Thematic Analysis

Key information from the selected studies was organized and synthesized according to common themes. Deductive approach was used to determine the appropriate themes that were relevant to the research questions and aims of the review based on existing findings. The themes were focused on maternal nutrition needs, maternal behaviors, and the use of digital tools like animated videos for nutrition education.

Ethical Considerations

As this review utilized secondary data from published sources, no ethical approval was required. However, all sources were appropriately cited and referenced in accordance with academic integrity standards.

RESULTS AND DISCUSSION

In total, approximately 18 peer-reviewed articles were identified and examined for this review. These publications included both primary research and review papers addressing maternal nutrition requirements during pregnancy, maternal knowledge and practices, and the use of video-based tools for health education. Rather than presenting each article individually, the evidence was synthesised thematically to highlight key findings and trends across the literature (Table 2). Key studies most relevant to Malaysian and regional contexts were emphasised to provide depth and applicability to the discussion. Citations within the discussion are used to illustrate key insights and do not represent an exhaustive listing of all reviewed sources.

Table 2. Key insights from the review according to themes

Theme	Representative Articles	Key Insight
Maternal nutrition during pregnancy	González-Fernández et al. (2024) Mohamed et al. (2022) Eshak et al. (2022) Yang et al. (2022) Souza et al. (2021) Miliku et al. (2016)	Inadequate intakes of energy, protein, and several micronutrients have been associated with key risk factors for child stunting.
Maternal nutrition knowledge and practices	Nguyen et al. (2017) Nana and Zema (2018) Renuka et al. (2020)	Despite availability of guidelines, maternal nutrition literacy is still inadequate and does not consistently translate into practices, highlighting the need for more effective education strategies.
Videos as health education tools	Ab Hamid et al. (2022) Collishaw et al. (2023) Schneider et al. (2022) Ramadhani et al. (2023)	Videos designed by considering factors that capture attention and enhance information retention can provide an effective approach to delivering maternal nutrition education.

Maternal Nutrition During Pregnancy

Children's linear growth is particularly vulnerable to environmental stressors and malnutrition during the first 1,000 days of life, from conception to their second birthdays. During the first 500 days, from conception to about six months of age, the child is entirely dependent on the mother for its nutrition, either via the placenta during pregnancy or via breastmilk during the initial six-month exclusive breastfeeding period (Aguayo & Menon, 2016). Therefore, maternal nutrition is a cornerstone of fetal development and early childhood growth. Evidence from studies have demonstrated that an adequate intake of energy, protein, and selected micronutrients during pregnancy and exclusive breastfeeding to prevent intrauterine growth restriction and postnatal stunting (González-Fernández et al., 2024).

Total Energy and Protein

Poor maternal nutritional status such as low body mass index as well as inadequate energy and nutrients intakes

before and during pregnancy can lead to intrauterine growth restriction (IUGR) (Mohamed et al., 2022; Clark, 2018), resulting in small-for-gestational age (SGA) birth weight and reduced birth length, which are among the key risk factors for stunting in Malaysia (Makbul et al., 2025). On the other hand, maternal total energy intake was positively associated with the offspring's birth weight in a national cohort study involving 78,793 Japanese mothers (Eshak et al., 2020). The total energy intake for pregnant women is slightly higher than that of their non-pregnant counterparts to support optimal gestational weight gain (Most et al., 2019). According to the Nutrition Division (Ministry of Health (MOH), 2022), pregnant mothers need 2,000–2,470 kcal per day for healthy fetal growth, while lactating mothers need 2,500 kcal per day. On the other hand, according to the Recommended Nutrient Intakes for Malaysia (RNI) (National Coordinating Committee on Food and Nutrition (NCCPN), 2017) and Perinatal Care Manual (MOH, 2022), each trimester of pregnancy requires different energy intake to maintain the fetus's healthy growth. Both guidelines advised adding 80 kcal, 280 kcal, and 470 kcal during the first, second, and third trimesters. After delivery, the RNI suggests taking an additional 450 kcal, while the Perinatal Care Manual advises adding 500 kcal from a daily intake of 1,600 kcal to 1,800 kcal to meet the increased requirements of lactation.

Adequate maternal protein intake during pregnancy is associated with healthy birth weight and length. Deficiencies, particularly in animal and dairy protein, have been linked to IUGR, low birth weight (LBW) and SGA (Clark, 2018). On the other hand, higher intake of dietary protein, in particular animal protein and dairy protein, is associated with higher birth weight and lower risks of LBW, SGA, and IUGR (Yang et al., 2022). A cross-sectional study on 7,750 pregnant women in China demonstrated that every 3% increase in calories from total protein, animal protein, and dairy protein was linked to increases in birth weight of 19.4 g (95% CI 6.0–32.9), 20.6 g (4.8–36.5), and 18.2 g (4.7–31.7), respectively. Adequate protein intake is important as it involves structural and functional biological roles. A systematic review by Mohd Shukri et al. (2022) found that protein intake between 0.8–1.1 g/kg body weight and consumption of at least five food groups daily were linked to improved birth weight and length. Pregnant mothers need 62.5 g of protein throughout pregnancy. On the other hand, *Bahagian Pemakanan dan Kesihatan Keluarga* (BPKK) suggests adding 0.5 g, 8 g, and 25 g of protein during the first, second, and third trimesters, respectively, to achieve the daily protein requirement (MOH, 2022). After delivery and exclusive breastfeeding, an additional 19 g of protein is considered sufficient.

Micronutrients

Micronutrients are chemical substances that, when consumed in minimal amounts, enable the regulation of metabolic and biochemical functions of the body. The requirement for micronutrients, which collectively comprise vitamins and minerals, also increases during pregnancy. This is because they are crucial to the growth and development of the unborn child in the womb as well as the health of expectant mothers. A few vitamins and minerals deficiencies in mothers have been associated with the prevalence of low birth weight and SGA in their babies such as vitamin D, iron and calcium (González-Fernández et al., 2024).

Iron is a vital mineral that is integral to haemoglobin, thereby facilitating oxygen transfer. Iron requirements during pregnancy increase dramatically as the mother's blood volume expands and the fetus grows and develops (Georgieff, 2020). In fact, the most prevalent nutritional deficiency among expectant mothers is iron deficiency anemia. During pregnancy, 30–60 mg of iron is required to avoid anemia (NCCPN, 2017). Examples of iron-rich foods are liver, lean meats, egg yolks, legumes (such as chickpeas and peas), and dried fruits (raisins and dates), as well as iron-fortified foods (iron-fortified bread and breakfast cereals). Iron deficiency is associated with adverse birth outcomes including low birth weight, intrauterine growth restriction and premature delivery (Georgieff, 2020).

Maternal Vitamin C or ascorbic acid intake during pregnancy has been associated with increased birth weight at term in a cross-sectional study involving 626 mother-infant pairs (Souza et al., 2021). Vitamin C supports antioxidant defenses against oxidative stress during pregnancy. These defenses protect maternal and fetal tissues from damage, and their imbalance can impair outcomes such as fetal growth. It also serves as a co-factor in collagen synthesis, supporting cartilage and bone development in the newborn (Jang et al., 2018). The requirement for vitamin C during pregnancy is 80 mg (NCCPN, 2017). Food sources that are easily available and contain high levels of vitamin C, such as guava, lemon, and papaya, should be taken by pregnant or lactating mothers.

Vitamin D is a fat-soluble vitamin that plays an important role in maintaining musculoskeletal health. During pregnancy, the foetus is totally dependent on maternal supply of vitamin D. A review on 43 review articles, and 31 original articles found that a pregnancy-related 25(OH)D deficit would raise the risk of preterm birth, LBW, and SGA (Tsenkova-Toncheva et al., 2024). Miliku and colleagues (2016) conducted a prospective cohort study in Rotterdam, Netherlands, and discovered that offspring of

mothers with lower 25(OH)D levels had increased foetal growth restriction in the third trimester. This restriction resulted in a significantly smaller head circumference, shorter body length, and a lower birth weight compared to mothers in the highest quartile. Pregnant mothers require a daily dose of 15 µg of vitamin D (NCCPN 2017). Food sources rich in vitamin D are sardines, eggs, meat, and mackerel. Exposure to the sun also helps mothers get enough vitamin D every day.

A systematic review on 30 articles indicates that calcium is among the nutrients that affect birth weight (Mousa et al., 2019). As for calcium requirements, pregnant mothers need 1,000 mg daily to form the baby's bones and teeth, especially in the third trimester (NCCPN, 2017; MOH, 2022). It also helps prevent muscle spasms in pregnant women. This requirement is 200 mg higher than for women who are not pregnant (NCCPN, 2017). Examples of foods high in calcium are milk and dairy products, anchovies, sardines, beans, and green leafy vegetables. Mothers should drink two glasses of milk daily to complete the calcium requirement.

Maternal Nutrition Knowledge and Practices

Despite the availability of national guidelines, gaps persist in maternal nutrition literacy. Studies show that while many mothers possess basic dietary knowledge, fewer translate it into practice. Based on a study by Nguyen et al. (2017), the intake of iron and folic acid supplementation showed a significant gap in the knowledge and practice of pregnant mothers, where at least 20% of women in the childbearing period are underweight. This study proves that there are still a high number of people who lack the self-awareness to start healthy practices during pregnancy and breastfeeding. Therefore, the delivery of maternal interventions should be improved to reduce the high burden of maternal and child undernutrition and mortality (Bhutta et al., 2013).

In addition, Nana and Zema (2018) found that only 39.3% of pregnant women practiced good dietary habits despite over half demonstrating adequate knowledge. On the other hand, a study was carried out by Renuka and colleagues (2020) on the effectiveness of educational interventions on breastfeeding among pregnant women. They gave a booklet to pregnant mothers and later followed them up regarding knowledge, attitude, and practices during the first week of delivery, the third month, and the sixth month of post-delivery. The results showed that only 2.8% of the participants knew that breastfeeding should begin within one hour of birth, and more than half did not know the right time to start breastfeeding after delivery. In addition, just 22.8% of the women understood

the importance of exclusive breastfeeding for six months. These findings underscore the need for more engaging, accessible education strategies to bridge the knowledge–practice gap.

Videos as Health Education Tools

Digital transformation for delivering health information must be done to achieve effectiveness in health education (WHO, 2021). These worldwide plans aim to maintain digital health technologies aligned with the national health sector and health strategies. It is anticipated that by 2025, a digital health ecosystem will be established in the country, encompassing a variety of digital information technology infrastructure primarily utilized by healthcare providers, health service providers, and patients (WHO, 2021). Public health authorities, universities, and research institutions are also expected to use this infrastructure. Videos and images can attract viewer interest, enhance learning, and reach more people worldwide without boundaries or limitations. In contrast, traditional nutrition education tools (face-to-face counseling, printed booklets, and pamphlets) have limited outreach and can only be targeted at certain places.

Digital health tools, particularly animated videos, offer a promising solution to enhance maternal nutrition education. Nowadays, video education is more practical than other hardcopy tools such as pamphlets, flyers, or newspapers. This is because animated videos can simplify complex information, reduce extraneous cognitive burden, and improve retention. According to the Cognitive Load Theory, there are some significant extra values in educational videos that can attract viewers' interest. These include signaling, segmenting, weeding, and modality matching (Brame, 2016).

Signaling, or cueing, effectively uses on-screen text or signs to draw attention to important information and enhance information retention. This can be achieved through use of keywords, a change in color or contrast, or a symbol like an arrow that guides the viewer's gaze to a specific area of the screen (Brame, 2016). Emphasizing critical information helps the learner's explicit engagement and reduces the extraneous load. Research by Clark & Mayer (2016) has indicated that this approach enhances students' capacity to retain and apply new knowledge acquired from animations.

To create an impactful video, segmenting information into smaller chunks is important. This segmentation allows learners to engage with new information at their own pace and retain it more effectively. Additionally, it is beneficial to eliminate distracting elements such as music, complex

backgrounds, or unnecessary features that might divert the learner's attention. This video animation gives them better control over the flow of information and helps them focus on what is important. In fact, the study conducted by Ab Hamid and team (2022) revealed that the developed videos on dietary management are highly understandable, actionable, and suitable for use as educational videos.

In certain countries, nurses have used educational videos as an effective education and health promotion strategy due to their versatility and applicability (Rodrigues et al., 2017). In brief, the combination of educational videos and interventions by healthcare professionals is thought to enhance public understanding of the issues, leading to the early identification and resolution of health problems (Rodrigues et al., 2017). As determined by Collishaw et al. (2023), students exposed to video treatment improved their nutrition knowledge scores compared to those who received traditional classroom instruction. The above studies proved that education can be delivered more conveniently and practically through video to reach more people effectively.

Referring to Schneider et al. (2022), 12 community health workers (CHW) were given educational videos on nutrition based on the WHO's recommendation to support their work during their visits with the families. Three months later, they conducted interviews individually with eight CHW and 16 mothers to investigate the effectiveness of the education videos in delivering information. In fact, the study revealed that learning from nutrition education videos was easier compared with traditional education and showed improvement in their daily practices.

In relation to the study by Ramadhani et al. (2023), education using animated videos and leaflets has a significant effect on increasing the knowledge of mothers who had babies aged 4–5 months to prepare complementary feeding. The researchers conducted pre- and post-tests to gauge the mother's understanding of how to prepare complementary feeding for stunting prevention. The results showed significant improvements in the knowledge and attitude of mothers after an animated video intervention on complementary feeding.

In Malaysia, the digital health ecosystem is expanding, with national strategies aiming to integrate digital tools into maternal and child health services by 2025 (WHO, 2021). Leveraging animated videos within this framework could enhance outreach, especially in underserved regions with limited access to face-to-face counseling.

As a narrative review, this study is limited by the absence of a systematic search strategy and formal quality

appraisal, which may introduce selection bias and restrict the reproducibility of findings. Additionally, the lack of quantitative synthesis limits the ability to draw definitive conclusions on the magnitude of associations reported. However, despite these limitations, the review provides a valuable overview to inform future research and intervention design in maternal nutrition and stunting prevention by leveraging digital platforms for health education.

CONCLUSION

Maternal nutrition during pregnancy and exclusive breastfeeding is essential for optimal fetal growth and early childhood development. Deficiencies in energy, protein, and selected micronutrients such as iron, calcium, folic acid, and vitamins A and D, are associated with key risk factors for child stunting. Despite existing guidelines, gaps in maternal knowledge and practice persist. Animated video interventions offer a promising approach to enhance nutrition literacy and support behavior change. Integrating such tools into maternal health programs may strengthen child stunting prevention efforts and improve long-term outcomes.

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REFERENCES

- Aguayo, V. M., & Menon, P. (2016). Stop stunting: improving child feeding, women's nutrition and household sanitation in South Asia. *Maternal & child nutrition*, 12 Suppl 1(Suppl 1), 3–11. <https://doi.org/10.1111/mcn.12283>
- Ab Hamid, M.R., Mohd Yusof, N.D., Buhari, S.S. (2022). Understandability, actionability and suitability of educational videos on dietary management for hypertension. *Health Educ J* 81(2):238–247. <https://doi.org/10.1177/00178969211072275>
- Bhutta, Z. A., Das, J. K., Rizvi, A., Gaffey, M. F., Walker, N., Horton, S., Webb, P., Lartey, A., Black, R. E., & Lancet Nutrition Interventions Review Group, the Maternal and Child Nutrition Study Group (2013). Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost?. *Lancet* (London, England), 382(9890), 452–477.

[https://doi.org/10.1016/S0140-6736\(13\)60996-4](https://doi.org/10.1016/S0140-6736(13)60996-4)

- Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., de Onis, M., Ezzati, M., Grantham-McGregor, S., Katz, J., Martorell, R., Uauy, R., & Maternal and Child Nutrition Study Group (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet* (London, England), 382(9890), 427–451. [https://doi.org/10.1016/S0140-6736\(13\)60937-X](https://doi.org/10.1016/S0140-6736(13)60937-X)
- Brame, C. J. (2016). Effective Educational Videos: Principles and Guidelines for Maximizing Student Learning from Video Content. *CBE life sciences education*, 15(4), es6. <https://doi.org/10.1187/cbe.16-03-0125>
- Clark, D. C. (2018). Association of Dairy Protein Intake During Pregnancy with Birth Weight. *Food and nutrition bulletin*, 39(2_suppl), S54–S59. <https://doi.org/10.1177/0379572118775824>
- Clark, R. C., & Mayer, R. E. (2016). *E-Learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning*. Wiley
- Collishaw, A., Snider, A., McNamara, P., Nuvaga, S., & Bilame, A. F. (2024). Impact of a video-based nutrition education program on the nutrition knowledge of students and parents: evidence from the North Region of Cameroon. *Global health promotion*, 31(3), 60–69. <https://doi.org/10.1177/17579759231206795>
- de Onis, M., & Branca, F. (2016). Childhood stunting: a global perspective. *Maternal & child nutrition*, 12 Suppl 1(Suppl 1), 12–26. <https://doi.org/10.1111/mcn.12231>
- Eshak, E. S., Okada, C., Baba, S., Kimura, T., Ikehara, S., Sato, T., Shirai, K., Iso, H., & Japan Environment and Children's Study Group (2020). Maternal total energy, macronutrient and vitamin intakes during pregnancy associated with the offspring's birth size in the Japan Environment and Children's Study. *The British journal of nutrition*, 124(6), 558–566. <https://doi.org/10.1017/S0007114520001397>
- Georgieff M. K. (2020). Iron deficiency in pregnancy. *American journal of obstetrics and gynecology*, 223(4), 516–524. <https://doi.org/10.1016/j.ajog.2020.03.006>
- González-Fernández, D., Muralidharan, O., Neves, P. A., & Bhutta, Z. A. (2024). Associations of Maternal Nutritional Status and Supplementation with Fetal, Newborn, and Infant Outcomes in Low-Income and Middle-Income Settings: An Overview of Reviews.

- Nutrients, 16(21), 3725. <https://doi.org/10.3390/nu16213725>
- Haron, M. Z., Rohana, A. J., Hamid, N. A. A., Omar, M. A., & Abdullah, N. H. (2023). Stunting and Its Associated Factors among Children Below 5 Years Old on the East Coast of Peninsular Malaysia: Evidence from the National Health and Morbidity Survey. *The Malaysian journal of medical sciences : MJMS*, 30(5), 155–168. <https://doi.org/10.21315/mjms2023.30.5.13>
- Jang, W., Kim, H., Lee, B. E., & Chang, N. (2018). Maternal fruit and vegetable or vitamin C consumption during pregnancy is associated with fetal growth and infant growth up to 6 months: results from the Korean Mothers and Children's Environmental Health (MOCEH) cohort study. *Nutrition journal*, 17(1), 105. <https://doi.org/10.1186/s12937-018-0410-6>
- Makbul, I. A. A., Yeo, G. S., Sharif, R., Lim, S. M., Mediani, A., Geurts, J., Poh, B. K., & On Behalf Of The Seanuts Ii Malaysia Study Group (2025). Determinants of Stunting Among Children Aged 0.5 to 12 Years in Peninsular Malaysia: Findings from the SEANUTS II Study. *Nutrients*, 17(14), 2348. <https://doi.org/10.3390/nu17142348>
- McGovern, M. E., Krishna, A., Aguayo, V. M., & Subramanian, S. V. (2017). A review of the evidence linking child stunting to economic outcomes. *International journal of epidemiology*, 46(4), 1171–1191. <https://doi.org/10.1093/ije/dyx017>
- Miliku, K., Vinkhuyzen, A., Blanken, L. M., McGrath, J. J., Eyles, D. W., Burne, T. H., Hofman, A., Tiemeier, H., Steegers, E. A., Gaillard, R., & Jaddoe, V. W. (2016). Maternal vitamin D concentrations during pregnancy, fetal growth patterns, and risks of adverse birth outcomes. *The American journal of clinical nutrition*, 103(6), 1514–1522. <https://doi.org/10.3945/ajcn.115.123752>
- Ministry of Health Malaysia. (2022). *Perinatal Care Manual 4th Edition*. Putrajaya (KL): MoH.
- Mohamed, H. J. J., Loy, S. L., Mitra, A. K., Kaur, S., Teoh, A. N., Rahman, S. H. A., & Amarra, M. S. (2022). Maternal diet, nutritional status and infant birth weight in Malaysia: a scoping review. *BMC pregnancy and childbirth*, 22(1), 294. <https://doi.org/10.1186/s12884-022-04616-z>
- Mohd Shukri, N. A., Mohamed Nor, N., Mustafa, N., Azizan, A. F., Rostam, M. A., Abu Seman, M. S., Ab Hamid, M. R., & Romli, R. N. (2023). A Systematic Review of Maternal Dietary Intake and its Association with Childhood Stunting. *IIUM Medical Journal Malaysia*, 22(1). <https://doi.org/10.31436/imjm.v22i1.2141>
- Most, J., Dervis, S., Haman, F., Adamo, K. B., & Redman, L. M. (2019). Energy Intake Requirements in Pregnancy. *Nutrients*, 11(8), 1812. <https://doi.org/10.3390/nu11081812>
- Mousa, A., Naqash, A., & Lim, S. (2019). Macronutrient and Micronutrient Intake during Pregnancy: An Overview of Recent Evidence. *Nutrients*, 11(2), 443. <https://doi.org/10.3390/nu11020443>
- Morrison, J. L., & Regnault, T. R. (2016). Nutrition in Pregnancy: Optimising Maternal Diet and Fetal Adaptations to Altered Nutrient Supply. *Nutrients*, 8(6), 342. <https://doi.org/10.3390/nu8060342>
- Mustakim, M. R. D., Irwanto, Irawan, R., Irmawati, M., & Setyoboedi, B. (2022). Impact of Stunting on Development of Children between 1-3 Years of Age. *Ethiopian journal of health sciences*, 32(3), 569–578. <https://doi.org/10.4314/ejhs.v32i3.13>
- Nana, A., & Zema, T. (2018). Dietary practices and associated factors during pregnancy in northwestern Ethiopia. *BMC pregnancy and childbirth*, 18(1), 183. <https://doi.org/10.1186/s12884-018-1822-1>
- National Coordinating Committee on Food and Nutrition (NCCFN). (2017). *Recommended Nutrient Intakes (RNI)*. Putrajaya (KL): Ministry of Health Malaysia.
- Nguyen, P. H., Sanghvi, T., Kim, S. S., Tran, L. M., Afsana, K., Mahmud, Z., Aktar, B., & Menon, P. (2017). Factors influencing maternal nutrition practices in a large scale maternal, newborn and child health program in Bangladesh. *PloS one*, 12(7), e0179873. <https://doi.org/10.1371/journal.pone.0179873>
- Özaltın, E., Hill, K., & Subramanian, S. V. (2010). Association of maternal stature with offspring mortality, underweight, and stunting in low- to middle-income countries. *JAMA*, 303(15), 1507–1516. <https://doi.org/10.1001/jama.2010.450>
- Ramadhani, D.W., Setianingsih, D., Wahyuni, N. (2023). The effect of early education using animation video and leaflets on preparation of complementary feedings as stunting prevention. *KnE Medicine* 31(1):64–75. <https://doi.org/10.18502/kme.v3i1.12699>
- Renuka, M., Shabadi, N., Kulkarni, P., Kumar, D.S., Anup, G., Murthy, M.N. (2020). Effectiveness of educational

- intervention on breastfeeding among primi pregnant women - A longitudinal study. *Clin Epidemiol Glob Health* 8(4):1306-1311. <https://doi.org/10.1016/j.cegh.2020.05.002>
- Rodrigues, J.C., Rebouças, C.B., Castro, R.C., Oliveira, P.M., Almeida, P.C., Pagliuca, L.M. (2017). Development of an educational video for the promotion of eye health in school children. *Texto Contexto Enferm* 26(2):e06760015. <https://doi.org/10.1590/0104-07072017006760015>
- Schneider, L., Ollila, S., & Mutanen, M. (2022). The usefulness of nutrition and health videos displayed on mobile phones in rural Uganda: Experiences of community health workers and mothers. *Maternal & child nutrition*, 18(2), e13322. <https://doi.org/10.1111/mcn.13322>
- Souza, R. C. V. E., Miranda, C., & Dos Santos, L. C. (2021). Maternal vitamin B3 and C intake in pregnancy influence birth weight at term. *Nutrition (Burbank, Los Angeles County, Calif.)*, 91-92, 111444. <https://doi.org/10.1016/j.nut.2021.111444>
- Tsenkova-Toncheva, L., Hristova-Atanasova, E., Iskrov, G., & Stefanov, R. (2024). Prenatal Vitamin D Deficiency and Maternal and Fetal Health Outcomes. *Cureus*, 16(9), e69508. <https://doi.org/10.7759/cureus.69508>
- UNICEF/WHO/International Bank for Reconstruction and Development/The World Bank (2023). United Nations Children's Fund, World Health Organization, International Bank for Reconstruction and Development/The World Bank. Levels and trends in child malnutrition. New York (USA): UNICEF and WHO.
- World Health Organization (2015). Stunting in a nutshell. <https://www.who.int/news/item/19-11-2015-stunting-in-a-nutshell> [Accessed 21st November 2022].
- World Health Organization (2021) Global strategy on digital Health 2020–2025. Geneva (CH): World Health Organization.
- Yang, J., Chang, Q., Tian, X., Zhang, B., Zeng, L., Yan, H., Dang, S., & Li, Y. H. (2022). Dietary protein intake during pregnancy and birth weight among Chinese pregnant women with low intake of protein. *Nutrition & metabolism*, 19(1), 43. <https://doi.org/10.1186/s12986-022-00678-0>