

Food security, nutrition, and health nexus on undernutrition reduction in Indonesia: Enabling resilience system into emergency preparedness

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ABSTRACT

Introduction: Evidence on the integration of nutrition interventions into existing health system programs needs to be further explored. The study examined the influence of food security, essential nutritional intervention, and health coverage towards undernutrition reduction in Indonesia during the emergency situation (in the context of the COVID-19 pandemic). In addition, the study also identified the collaborative role in reducing undernutrition, followed by the existing theoretical concepts.

Methods: The design of the study was an ecological study using secondary data from the Indonesian Health Profile, Food Security Statistics, and the National Socio-economic Survey between 2020 and 2021. The total unit of analysis was 68, representing all provinces in Indonesia with resampling bootstrapping approach. The analysis was conducted using partial-least square structural equation modeling (PLS-SEM).

Results: Reduction of undernutrition status was statistically driven by essential nutrition intervention ($t=1.981$; $p=0.048$) and food security ($t=2.377$; $p=0.018$). The Finding also shows that food security was influenced by food accessibility ($t=2.867$; $p=0.004$) and food consumption ($t=4.800$; $p=0.000$). Furthermore, the health service coverage significantly influenced essential nutrition intervention ($t=5.350$; $p=0.000$), and health service coverage must be supported by health financing coverage ($t=6.042$; $p=0.000$).

Conclusion: Integrating food security, essential nutrition intervention, and health coverage may strongly build a resilience system during a pandemic based on predictive relevance ($Q^2=94\%$). These three components can also be applied during emergency preparedness.

Keywords: COVID-19; nutrition intervention; food security; undernutrition; universal health coverage.

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INTRODUCTION

SDGs (Sustainable Development Goals) represent a global collaboration framework for fostering sustainable development. Nutrition directly affects two targets of SDGs (2nd and 3rd target) and is essential for accomplishing other targets. Overall, the nutritional aspects of the SDGs promote healthy lifestyles, sustainable diets, and ensure food security in a global context.¹ Extreme malnutrition remains a barrier that creates a trap from which people are challenged to escape. Malnutrition, which encompasses undernutrition (leading to stunting and underweight), is a worldwide

health concern that disproportionately affects infants, children, women, and other vulnerable populations.²

Hunger and undernutrition are the leading causes of poor health status and are among the most complex conditions threatening the quality of life.³ It is a major public health concern for under-five children, which is still the primary underlying factor of child mortality in many LMICs.⁴ Furthermore, the disruptions caused by the COVID-19 pandemic to the nutrition, food, and health systems are projected to exacerbate all forms of malnutrition, including stunting and underweight. The COVID-19

pandemic was exposed humanity's worst disaster. COVID-19 affected the world's socioeconomic and food security more than other infectious diseases.⁵

The World Food Programme reported that acute food insecurity in LMICs will nearly double to 265 million by the end of 2020.⁶ Sharp declines are expected in access to child health and nutritional interventions. During the early outbreak, UNICEF estimated a 30% reduction in essential nutrition intervention coverage, dropping around 70 to 100 percent in lockdown situations, especially in vulnerable countries facing humanitarian crises.⁷ Previous outbreaks

have demonstrated that when an epidemic evolves, there is a critical necessity to expand public health activities beyond direct clinical management to incorporate fundamental health management concepts.⁸ Since the COVID-19 pandemic, individual and public resilience have become crucial frontline resources in emergency preparedness.⁹

At the onset of the pandemic, UNICEF reported that the prevalence of undernutrition children in Indonesia would increase unless interventions were made.¹⁰ The demand for primary healthcare facilities and public health services decreased in some nations due to virus transmission, travel restrictions, and financial losses. The limited visits of public healthcare providers as well as disruptions in screening and treatment have resulted in lower coverage of nutrition interventions, including breastfeeding practice and feeding programs for infants and young children. Furthermore, decreases in micronutrient supplementation, immunization programs, and services for preventing infectious diseases and malnutrition could significantly increase child mortality.¹¹ However, the Indonesian Government still makes crucial efforts to implement a prioritized set of policies and actions to establish food security, nutrition, and health resilience systems during the COVID-19 pandemic.

Additional evidence on the integration of nutrition interventions into existing health system programs needs to be further explored. Previous studies have indicated that integrating nutritional interventions into health systems improves nutritional and health status.^{12,13} Determining integration points is important in relation to the complexity of health system programs, and their operational setting is challenging. Furthermore, scaling food and nutrition systems could potentially serve as a sustainability to tackling undernutrition during the COVID-19 pandemic. The present study aims to examine the resiliency of food security, essential nutrition interventions, and universal health coverage into undernutrition reduction in Indonesia during the emergency situation (in the context of the COVID-19 pandemic). Additionally, the study identified the collaborative role of food security,

essential nutrition intervention, and health coverage in reducing undernutrition.

METHOD

This ecological study used secondary data from the Indonesian Health Profile (Ministry of Health), National Socio-Economic Survey/SUSENAS (Central Statistics Agency), and Food Security Statistics (National Food Agency) for 2020-2021. The total unit of analysis was 68, representing all provinces in Indonesia. Multiple-year data (two years) was used, 2020 and 2021 data. The database was determined in terms of the completeness, availability, and update of existing data.

The research data were analyzed using PLS-SEM, a multivariate statistical technique to analyze response and explanatory variables simultaneously. Multivariate analysis was performed using SmartPLS 3.0. A PLS path model that consists of two elements. The first is the measuring models known as the outer models. The second is a structural or inner model, which connects the construct

(variables that are not directly measurable) and shows the correlations (paths) between constructs. The measurement model illustrates the correlation between the constructs and the indicators. There are two types of measuring models, the exogenous latent variables and the endogenous latent variables.^{14,15}

A path model was developed based on the Resilient Food Systems Strategy (FAO 2021), Integrating Essential Nutrition Actions in Universal Health Coverage (SUN, UN Nutrition, and WHO 2023), and Conceptual Framework of Maternal and Child Nutrition (UNICEF 1990) with the supporting literature. However, the composites produced by PLS-SEM must not be assumed to be identical with the theoretical concepts they represent. They are explicitly recognized as approximations.¹⁶ Two measurement models were used in this study, reflective measuring models and formative measuring models. The process of path modelling analysis is as follows on Figure 1.¹⁵

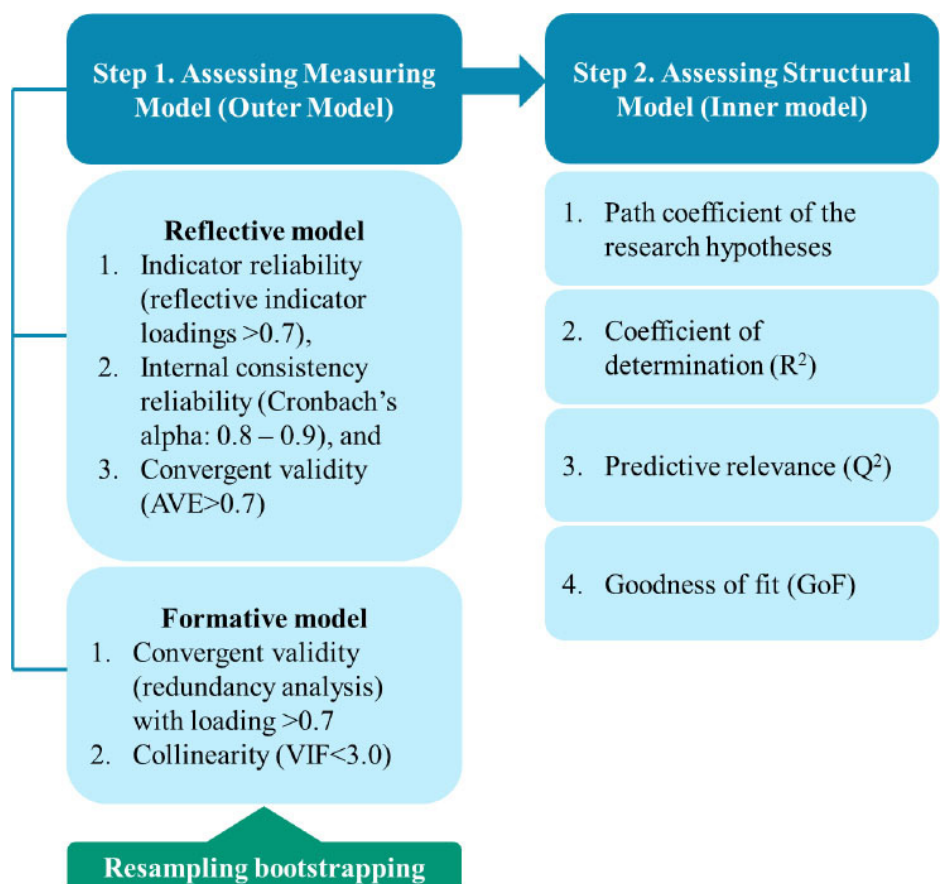


Figure 1. Process of path modelling analysis.

RESULT

Evaluation of measurement (outer) models

Reliability and validity test

Table 1 describes the result of the reliability and validity analysis of the reflective model.

Reliability analysis was conducted using Cronbach's alpha. According to

Hair et al. Cronbach's alpha between 0.8 and 0.9 indicates a good representation. Thus, the indicators in this study satisfied the requirements. Composite reliability outperforms Cronbach's alpha as a convergent validity test in a reflective model. Because Cronbach's alpha might exaggerate scale dependability, it may be determined as a reliability measurement. To be acceptable for confirmatory purposes,

a model's composite reliability must be at least 0.7 and the results show that all variables had more than 0.8 of Cronbach's alpha. Thus, these indicators satisfied the requirements. Moreover, the finding demonstrates that all reflective indicators have higher internal consistency reliability, with a composite reliability value of more than 0.7. Furthermore, all variables' AVE values satisfy the requirement of being more significant than 0.5, which indicates that the construct accounts for at least 50 percent of the variance of the indicators.

Table 1. Evaluation of the reflective measurement model

Latent variable	Cronbach's alpha	Composite reliability	AVE
Undernutrition status	0.974	0.987	0.987
Food security	1.000	1.000	1.000
Food consumption	0.899	0.937	0.832

Table 2. Evaluation of outer model based on outer loading value

Latent variables	Indicators	Outer loading	t-statistics	p-value
Food consumption	Dietary energy supply (%)	0.909	44.080	0.000*
	Dietary protein supply (%)	0.920	45.407	0.000*
	DDS (point)	0.907	41.453	0.000*
Food accessibility	Poverty rate (%)	0.961	9.070	0.000*
	Coverage of food expenditure over 65% (%)	0.194	0.842	0.400
Essential nutrition intervention	Coverage of EBI (%)	0.071	0.412	0.681
	Coverage of EB (%)	0.249	1.380	0.168
	Coverage of food complementary for underweight children (%)	0.704	4.671	0.000*
	Coverage of food supplement for undernourished pregnant women (%)	0.666	4.270	0.000*
	Coverage IFA (%)	0.932	11.090	0.000*
Health service coverage	Coverage of VAS (%)	0.764	4.934	0.000*
	Coverage of weight monitoring (%)	0.458	2.613	0.009*
	Coverage of ANC (%)	0.896	13.426	0.000*
	Coverage of basic immunization (%)	0.660	8.100	0.000*
Health financing coverage	Coverage of <i>Kelas ibu hamil</i> (%)	0.773	4.641	0.000*
	Coverage of birth delivery practices (%)	0.870	13.813	0.000*
	Coverage of DAK on physical aspect	0.963	12.805	0.000*
	Coverage of DAK on non-physical aspect	0.400	1.644	0.101

Significant level: *Significantly based on outer loading test (t -statistics > 1.960 ($\alpha=0.05$), p -value < 0.05). **Abbreviations:** DDS= dietary diversity score; EBI= early breastfeeding initiation; EB= exclusive breastfeeding practice; IFA= iron and folic acid supplementation; VAS: vitamin A supplementation; ANC= ante-natal care; *Kelas Ibu Hamil*= prenatal education and training; DAK= *dana alokasi khusus* (specific allocation fund in health sectors)

Table 3. Evaluation of the inner model

Exogenous variable	Endogenous variable	Path coefficient	t-statistics	p-value
Essential nutrition intervention	Undernutrition status	-0.450	1.981	0.048*
Food security	Undernutrition status	0.381	2.377	0.018*
Food accessibility	Food security	-0.406	2.867	0.004*
	Food consumption	-0.567	4.800	0.000*
Food consumption	Food security	0.357	4.099	0.000*
	Undernutrition status	-0.277	1.539	0.125
Health service coverage	Essential nutrition intervention	0.703	5.350	0.000*
	Undernutrition status	-0.233	1.213	0.226
Health financing coverage	Essential nutrition intervention	0.130	0.725	0.469
	Health services coverage	0.577	6.042	0.000*

*Path coefficient: t -statistics > 1.960 ($\alpha=0.05$), p -value < 0.05

Outer loading test

Table 2 shows the validity test for indicators reflective among indicator values with the constructed value.

Reflective indicators in this study are suitable for measuring perception. The loading factor of the study exceeds the recommended value of 0.7, suggesting that the indicators used in this study are valid and meet the criteria for convergent validity, with exception on food expenditure over 65 percent (0.194), EB (0.249), EBI (0.071), and the realization of non-physical DAK (0.400). These four indicators are maintained in the model,

considering the VIF value is <3.0, which means there are no multiple collinearity problems in the construct.

Evaluation of structure or inner model Path coefficient

The structural model can be evaluated using the path coefficient parameter values. Table 3 illustrates the results of the structural model evaluation of food security, essential nutrition interventions, and universal health coverage in tackling undernutrition.

Essential nutrition interventions significantly affect under-nutritional

status with a path coefficient value of -0.450 (*p*-value <0.05), which means that increasing 10 percent of essential nutritional interventions can decrease 4.50 percent of under-nutritional status. The results also show that there is a statistically significant correlation between food consumption and food security (coefficient value of 0.357; *p*-value <0.05), which means a 10 percent-increase of food consumption, both in quantity and quality, will increase food security by 3.57 percent.

The influence of health service coverage on essential nutrition interventions is significant with a path coefficient value of 0.703 (*p*-value <0.05), which means that increasing 10 percent of health service coverage will significantly increase 7.03 percent of essential nutrition interventions. Furthermore, health financing coverage also significantly influences health service coverage (path coefficient value of 0.577; *p*-value <0.05), which indicates that increasing 10 percent of health financing coverage will increase 5.77 percent of health service coverage.

Table 4. Evaluation of fit modeling

Latent variable	R ²	Q ²	Goodness of Fit (GoF)
Undernutrition status	0.364		
Health service coverage	0.333		
Food consumption	0.321	0.940	0.627
Food security	0.456		
Essential nutrition intervention	0.616		
	Categorization	Strong	Powerful

Interpretation: Q-square (0.02≤Q²<0.15: weak predictive power; 0.15≤Q²<0.35: moderate predictive power; Q²≥0.35: strong predictive power); Goodness of Fit (0.1≤GoF<0.25: weak; 0.25≤GoF<0.36: moderate; GoF≥0.36: strong)

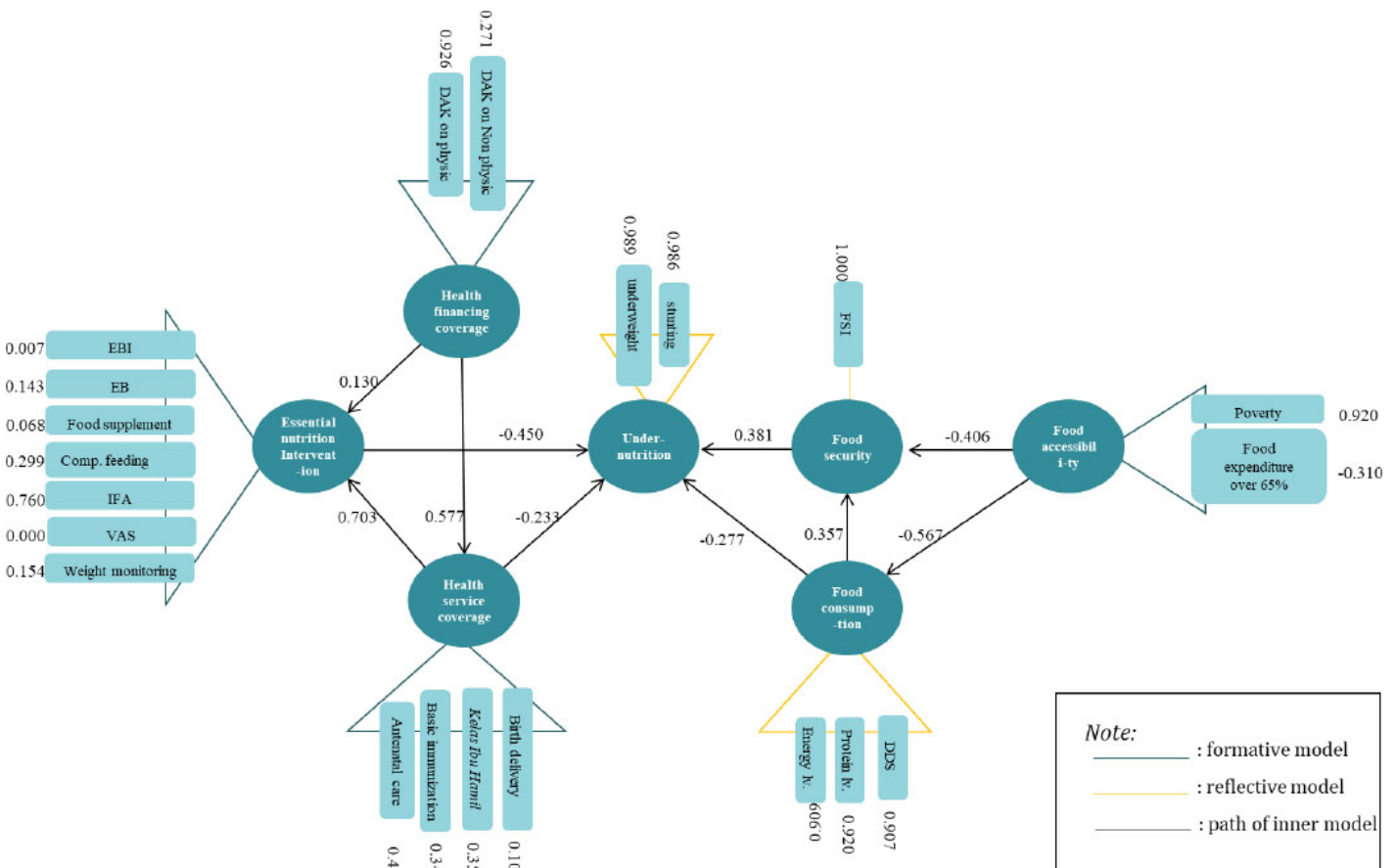


Figure 2. Path modelling of the present study.

Model Fit Evaluation

The predictive relevance examines the quality of observation values produced by the model and its parameter estimates (Table 4).

As Table 4 indicates, the predictive relevance value is classified as strong/powerful ($Q^2=0.94$), which means that 94 percent of undernutrition problems among children under five years can be overcome by strengthening food security, essential nutritional interventions, and universal health coverage. Furthermore, the goodness of fit value shows the overall quality of the model. In this study, the goodness of fit value was obtained at 0.627, which means that the prediction value in the model was 62.7 percent and was powerful to illustrate the built model's goodness. Overall, the model can be seen in Figure 2.

DISCUSSION

At the onset of the pandemic, lockdowns may cause people to flock to food sales centers, leading to shortages in LMICs.¹⁷ Alongside widespread job losses, income declines, and rising food prices, these challenges worsen food insecurity, exacerbating poverty.¹⁸ The International Food Policy Research Institute reports that current food security risks result more from the devastating impact of COVID-19 on employment and livelihoods than from supply chain disruptions. Particularly affecting LMICs with limited social safety nets, the pandemic has the potential to significantly worsen poverty and hunger. Nearly 29 million individuals, about 14% of the working-age population, have been impacted by changes in employment due to the pandemic crisis, leading to hunger, food shortages, and a further decline in existing food insecurity.¹⁹

In November 2020, the annual inflation rate rose to 1.6%, marking the third consecutive monthly increase after a steady decline since March 2020. However, this does not signify a recovery in purchasing power. Higher food prices mainly drove the increase during the onset of the rainy season. The subsequent easing of social and travel restrictions, coupled with year-end vacations, likely contributed to a slight uptick in consumer spending.²⁰ The World Bank noted that agricultural and food

exports in Indonesia during January to September 2020 reached approximately USD 23.2 billion, a 9.8% increase from the same period in 2019.²¹

To alleviate the stock, the government implemented food distribution through a subsidy program scheme. However, this study's scope was confined to food supply and distribution monitoring. Furthermore, the necessity of cash transfer in the food assistance (subsidy) programme should provide access to a diverse diet that meets the nutritional requirements. The delivery method must conform to maintaining that the intended beneficiaries have access to a diverse, balanced, and healthy diet. Data utilization and monitoring for food prices should be valuable and reliable for making policy and programme decisions.²¹ The COVID-19 pandemic highlighted the dependence on global food systems and provided an opportunity for innovation and transformation. It is crucial to develop resilient food system mechanisms. A recent study emphasized the need for a comprehensive strategy, showcasing the interconnectedness of agriculture, food, health, and economic systems in responding to such crises.²²

Addressing undernutrition is a global challenge that cuts across various sectors, especially during the pandemic, impacting food and health domains. A comprehensive approach involving health coverage is crucial in combating undernutrition in restrictive conditions. Strengthening health systems can significantly reduce morbidity and mortality by improving maternal and child nutritional status. Results indicate that a 10% increase in health service coverage leads to a 7.03% boost in essential nutrition interventions. Furthermore, enhancing essential nutrition interventions by 10% reduces undernutrition by 4.50% (t -statistic=1.981; p -value=0.048). The review highlighted a lack of information on integrating nutrition interventions across health and social sectors. Effective implementation of nutrition-specific interventions necessitates robust health systems.

However, the coverage rate for nutrition interventions could be higher in several LMICs, sometimes excluded from essential services. There is a necessity for better global consensus on defining, framing,

and establishing minimum standards for integrating nutrition interventions into health service delivery, especially in emergencies. Previous research indicates that significant value can be gained from integrated nutrition initiatives.²³ Essential nutrition interventions aim to broaden the coverage of evidence-based strategies to enhance the nutritional status of women and children. This integrated approach includes preventive measures such as infant and young child feeding, micronutrient supplementation, and maternal nutrition. The study outlines various interventions to combat child undernutrition, including iron and folic acid and vitamin A supplementation, food supplements for undernourished pregnant women, early breastfeeding initiation, optimal breastfeeding practices, and appropriate complementary feeding practices. These interventions can be integrated into health services.

Iron and folic acid supplementation (IFA). Numerous maternal nutrition programs, including IFA, have been implemented in Indonesia. The proposed IFA program for pregnant women involves daily tablet intake for at least 90 days during pregnancy, aligning with WHO recommendations for supplementation throughout pregnancy. Adherence presents a challenge with IFA intake as women need to remember to take the supplements regularly as advised by healthcare providers. During the COVID-19 pandemic, previous research has raised concerns about the safety and efficacy of IFA supplementation, noting potential immune enhancement benefits for individuals with anemia, along with risks of infections and inflammation.²⁴

Vitamin A supplementation (VAS). A previous study found a correlation between vitamin A deficiency and increased odds of stunting at individual, household, and community levels.²⁵ It showed that Vitamin A supplementation modestly improved linear growth, particularly in deficient children. Integration of Vitamin A and IFA supplementation with existing health services, such as Posyandu, is crucial. Posyandu plays a key role in addressing major health challenges for women and children in Indonesia, offering an integrated health program covering

mother and child health, nutrition, immunization, and diarrheal control at the community level.²⁶ During a pandemic, developing strategies for nutritional education is essential for infection prevention and overall health. Leveraging digital platforms for education can enhance coverage, campaign effectiveness, and progress monitoring.²⁷

Food supplementation for undernourished pregnant women. Pregnant women identified as undernourished in the first trimester (based on MUAC) should receive supplementary feeding, nutrition education, and counseling. A 90-day recovery program, involving food supplementation, is typically provided through public health centers or Posyandu during ANC across the country. Before the pandemic, individuals facing food insecurity needed careful planning and coordination, sourcing food from various markets and budgeting for meals. The crisis has amplified these challenges. Disruptions in the food supply chain during the pandemic led to a global surge in food prices.²⁸ While there is a lack of specific literature on food supplementation for undernourished pregnant women, it is crucial for emergency preparedness to ensure the delivery of food supplementation. Undernourished pregnant women are particularly vulnerable to viral infections and are linked to undernutrition in children.²⁹

Early breastfeeding initiation (EBI). Early breastfeeding offers improved infection resistance, reduced diarrheal risks, and increased child survival chances, with various health benefits.³⁰ Enhanced breastfeeding initiation rates are observed among women with four or more ANC visits and those delivering in healthcare facilities. Intermediate-quality ANC, as Lima dos Santos et al investigated, positively correlates with EBI in Haitian women, highlighting the impact of ANC on breastfeeding outcomes.³¹ Additionally, participation in prenatal breastfeeding classes significantly improves breastfeeding rates at six months compared to controls.³² Promoting breastfeeding practices and maternal health service utilization are key objectives in enhancing public maternal health services. Early breastfeeding within

an hour is more prevalent among mothers delivering in healthcare facilities as per previous research.³³ Home deliveries pose a considerable barrier to early breastfeeding initiation, as reported in various studies.^{34,35}

Exclusive breastfeeding practices (EB). Infants, young children, pregnant women, and breastfeeding mothers face nutritional risks in settings with limited access to essential health and nutrition interventions. Ensuring proper breastfeeding support for mothers is crucial for optimal nutritional outcomes. Breastfeeding practices, along with complementary feeding, are vital in preventing undernutrition. The finding also noted that children not breastfed had a higher rate of short stature (27.5%) compared to breastfed children (12.0%).³⁶ In South Korea, breastfeeding empowerment programs help mothers independently address breastfeeding issues, enhancing empowerment, problem-solving, and practice rates. These programs serve as valuable postpartum nursing interventions in clinical settings.³⁷ The Ministry of Health in Indonesia has introduced prenatal education and training (*Kelas Ibu Hamil*) focusing on nutrition education, exclusive breastfeeding promotion, and early initiation. Implementing alternative counseling methods during lockdowns, such as telephone and online services, is essential for broadening access to education and support.

Complementary feeding practices. In Malawian children, higher weight-for-age z-scores are linked to complementary feeding frequency and diet quality, as Walters et al. demonstrated. Strategies to meet the minimum acceptable diet and meal frequency can reduce underweight rates. The timing of introducing complementary feeding is critical for a child's development, impacting their nutrient intake for growth. Ensuring appropriate and safe feeding practices with strong hygiene standards is essential.³⁶

Universal Health Coverage, a WHO initiative, encompasses service and financing indicators. Embracing UHC presents a significant opportunity to tackle undernutrition by integrating nutrition interventions within primary health services. While progress has been

made, more coverage is needed. Concerns persist over the adequacy of resources allocated by Indonesia for stunting-related interventions and their effectiveness. Despite capacity challenges and movement restrictions, primary healthcare remains essential for achieving universal health coverage, especially during the COVID-19 pandemic. Recognizing nutrition's significance for overall health is paramount within primary healthcare, focusing on promotion, prevention, addressing determinants, and a people-centered approach. Health ministry plays regulatory, advocacy, and stewardship roles in supporting multisectoral initiatives beyond the health system to foster healthier populations. Nutrition interventions integrated within health systems play a crucial role in public health improvement. Further investigation should analyze the interplay between food security, nutrition, and health services to enhance Indonesia's undernutrition reduction program efficiently.

CONCLUSION

The present research concludes that integrating food security, essential nutrition intervention, and health coverage can build a resilience system during a pandemic based on predictive relevance (Q2=94%). These three components can also be applied during disaster preparedness. The PLS-SEM is generally used to evaluate the existing model of structure and analyze the correlation among driving factors. It provides references for following up the theoretical research and does not generate a new concept or model.

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CONFLICT OF INTERESTS

the study was conducted in the absence of any commercial or financial relationship that could be constructed as a potential conflict of interest.

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AUTHOR CONTRIBUTION

The author contributes a conceptualization, methods, data collection and analysis, writing-original draft, review, and editing.

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