Health Risks and Welfare Transformation in Indonesia's Free Nutritious Meal Program: A *One Health* Analysis

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Abstract: Indonesia's Free Nutritious Meals Program (*Makan Bergizi Gratis/MBG*) targets 82.9 million beneficiaries at a cost of Rp 420 trillion to address stunting, which currently affects 21.6% of children. This study analyzes hidden health threats through a *One Health* lens, identifies surveillance system gaps, and formulates evidence-based recommendations. An integrative review compiled data from the National Monitoring System, poisoning incident reports, laboratory results, and institutional audits using a *One Health* framework integrating human, animal, and environmental health dimensions. The analysis revealed 340 food poisoning incidents affecting 11,390 students in 28 provinces (January–November 2025), with *Bacillus cereus* (34%), *Staphylococcus aureus* (28%), and *Salmonella* spp. (18%) as primary pathogens. In 42% of the locations, 42% of the audits failed technical specifications, 63% exposed food to dangerous temperatures, and 52% lacked adequate storage. Fragmented authority creates supervision gaps, whereas inadequate surveillance increases foodborne disease vulnerability. The program faces systemic food safety challenges that threaten health benefits. Urgent transformation requires technology-based integrated surveillance, strict standardization for vulnerable populations, increased supervisor ratios, cold chain infrastructure investment, and *One Health* coordination committee establishment for multisectoral collaboration, ensuring program sustainability without creating new health burdens.

Keywords: Food safety, Foodborne diseases, *One health,* Free nutritious meals, Indonesia, Intersectoral collaboration, Nutritional wellbeing, Community health wellbeing.

INTRODUCTION

The free nutritious meals program (*Makan Bergizi Gratis/MBG*) is a policy initiative by the Indonesian government to address stunting and malnutrition, which constitute a national health burden in Indonesia. Based on data from the 2022 Indonesian Nutrition Status Survey, the prevalence of stunting reached 21.6%, placing Indonesia in the category of serious public health problems according to the World Health Organization standards (WHO, 2023). This program is designed to reach beneficiaries in stages, with initial implementation in November 2025, covering 2,406,772 students from 11,669 educational units, including school children, toddlers, and pregnant women, with a projected expansion to 82.9 million beneficiaries and a budget allocation of Rp 420 trillion for full implementation (Kementerian Pendidikan Dasar dan Menengah, 2024).

The MBG programme represents a direct intervention in nutritional wellbeing, defined as sustained access to safe, nutritious food that supports physical growth, cognitive development, and disease prevention. Well-being extends beyond nutritional adequacy to encompass food safety assurance to protect physical health, the emergence of psychological security from trust in food systems, and social equity in program access (Swinburn *et al*., 2019). This study examines how implementation failure

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threatens these multidimensional well-being outcomes despite program intentions.

The implementation of this massive program involves a complex food supply chain, ranging from raw material procurement and production processes to distribution and final-stage serving. Mass media reports, Wikipedia, 2025, and Tempo, 2024 indicate various food safety incidents. The Institute for Development of Economics and Finance reported that approximately 4,000 students experienced poisoning in the first eight months, whereas the Indonesian Education Monitoring Network reported that 6,452 students were affected by September 2025. This incident raises a fundamental question: how can a program designed to improve welfare create new health risks for vulnerable populations?

The *One Health* theoretical framework offers an integrative perspective that links human, animal, and environmental health as a single ecosystem (Mackenzie & Jeggo, 2019; Zinsstag *et al*., 2011). This approach recognizes that 60% of infectious diseases in humans originate from animals (zoonotic) and that 75% of emerging infectious diseases originate from animals, with the food supply chain being one of the main transmission routes (WHO, 2017). In the MBG program, the supply chain involves complex interactions between agricultural and livestock production systems, environmental management, and beneficiaries. The *One Health* approach has proven effective in managing food safety in similar programs in developing countries, such as Brazil and Thailand, where integrated veterinary surveillance, environmental monitoring, and public health surveillance reduced foodborne diseases by 40–50% within three years (Grace *et al*., 2012; Häsler *et al*., 2011).

Previous research on food safety in school feeding programs has focused largely on nutritional aspects and program coverage, with limited attention given to food safety dimensions and foodborne disease risk (Galvez *et al*., 2018; Powell *et al*., 2011). Schlundt *et al*. (2004) identified modern food systems as potential amplifiers of large-scale pathogen transmission but did not explore government nutrition intervention programs in middle-income countries. Sianturi (2025) and Soma *et al*. (2024) have begun to document microbiological safety issues in institutional food supply chains, but comprehensive analyses integrating epidemiological perspectives, institutional governance, and the *One Health* framework for the MBG program remain limited. Despite extensive documentation of school feeding programs globally, no comprehensive analysis has integrated *One Health* perspectives with wellbeing outcomes to assess food safety risks in Indonesia's MBG program, leaving a critical knowledge void in how large-scale nutrition interventions may inadvertently compromise the very populations they intend to protect.

Using the *One Health* approach as a lens of analysis, this study provides a holistic understanding of the systemic determinants of food safety issues involving animal health in upstream production, environmental health in the distribution chain, and human health as the final outcome. This review aims to analyze hidden health threats in the implementation of the MBG program through the *One Health* lens, identify gaps in the food safety surveillance system via actual implementation data and incident reports, evaluate potential risks of foodborne and emerging diseases by compiling available epidemiological and microbiological evidence, and formulate evidence-based recommendations for program improvements integrated with *One Health* principles. Practical implications include the development of an integrated surveillance framework involving the health, agriculture, education, and environment sectors; the formulation of specific food safety standards that consider the vulnerability of target populations; and the identification of priority investments in infrastructure and human resource capacity to ensure safe and effective programs without creating new health burdens.

METHODS

Study Design

This integrative review employed a convergent mixed-methods approach, synthesizing quantitative epidemiological data with qualitative institutional documents and media reports. The study framework integrated One Health principles (human–animal–environment interface) with wellbeing dimensions (physical–psychological–social) to evaluate food safety challenges in the MBG program.

Data Sources

The data were compiled from five primary sources: (1) the National MBG Monitoring System dashboard (https://mbg.pdm.kemendikdasmen.go.id), which provides real-time coverage data accessed November 19, 2025; (2) the Ministry of Health food poisoning surveillance reports (January–November 2025); (3) the National Agency for Drug and Food Control Laboratory confirmation results; (4) the Supreme Audit Agency institutional audit findings (2025); and (5) national media reports from 15 outlets, including Kompas, Tempo, and Detik, which were verified against official institutional sources.

Inclusion and Exclusion Criteria

The included materials included documented incidents occurring between January 1 to November 30, 2025; laboratory-confirmed foodborne illness cases; official institutional documents and audit reports; and verified media reports corroborated by government sources. The exclusion materials were as follows: unverified social media claims; incidents occurring before January 2025 or unrelated to the MBG program; and nonpeer-reviewed opinion pieces without empirical data.

Analytical Framework

The themes are organized based on (1) one health (human health threats, animal health issues, environmental health issues, and interface vulnerabilities); (2) welfare dimensions (physical welfare impacts, psychological welfare effects, and social welfare implications); and (3) monitoring system evaluation (detection capacity, response mechanisms, and coordination frameworks). The quantitative data were analyzed descriptively via frequencies, proportions, and narratives.

RESULTS

Overview of the MBG Program in Indonesia

Program Objectives and Legal Framework

The MBG Program was initiated through Presidential Regulation number 83 of 2024 concerning the National Nutrition Agency and Presidential Regulation number 72 of 2021 concerning the acceleration of stunting reduction. This legal basis establishes the program implementation mechanism, involving coordination between ministries and institutions, with the Ministry of Health as the technical coordinator, together with the Ministry of Education, Culture, Research, and Technology, now known as the Ministry of Education, Science, and Technology for the school component (Sekretariat Wakil Presiden, 2024).

Target populations and welfare intentions

The program's target beneficiaries include three priority categories with the following distributions: 14.8 million elementary and junior high school children, 5.2 million toddlers aged 6–59 months, and 2.4 million pregnant women, especially those from families receiving the Family Hope Program. The geographical coverage includes 514 districts/cities in 34 provinces, with priority for gradual implementation starting from areas with the highest prevalence of stunting (Badan Gizi Nasional, 2025). The menu is designed to meet 30% of daily energy requirements and 40% of protein requirements on the basis of nutritional standards set by the Ministry of Health.

Budget and Implementation Structure

Program delivery models vary according to regional capacity and cover three main mechanisms: a catering system by certified service providers, school kitchens with trained food processing personnel, and a combination of both for optimal coverage. Data from the Ministry of Education, Culture, Research, and Technology show that 68% of schools implement a catering system, 22% use school kitchens, and 10% implement a combination system (Kemendikbudristek, 2025). The choice of model is influenced by the availability of infrastructure, human resource capacity, and operational cost efficiency.

Program Delivery Models and Supply Chain

The MBG program supply chain involves various actors at the national and local levels. Raw materials are procured through a tender mechanism, with priority given to local products to support the regional economy. Catering providers are required to have a risk-based business license number certification from the Investment and Integrated Services Agency and to meet hygiene standards in accordance with the Food and Drug Supervisory Agency regulations (Badan Pengawas Obat dan Makanan, 2016). Food distribution is carried out with a maximum travel time of 2 h from the production site to the service location to maintain quality and microbiological safety.

The program's financing mechanism is sourced from the State Revenue and Expenditure Budget, with a transfer scheme to the regions through special allocation funds. The cost allocation per serving is set between IDR 10,000 and IDR 15,000, depending on the beneficiary category and geographical difficulty of the region. The total program budget reached IDR 71 trillion in the first year of implementation, with a projected increase in budg*et al*location as the coverage expanded. To date, the coverage and characteristics of the beneficiaries of the Indonesian Free Nutritious Meals Program (real-time data as of November 19, 2025) are shown in Table **1**.

Food Safety Governance and Monitoring System

The food safety regulatory framework for the MBG program is based on Law No. 18 of 2012 concerning food and Government Regulation No. 86 of 2019 concerning food safety. Technical implementation is regulated by Food and Drug Supervisory Agency Regulation number 16 of 2016 concerning microbiological criteria in processed food, which sets

Table 1: Coverage and Characteristics of beneficiaries of the Free Nutritious Meal Program

Overall program coverage					
Indicator		**Number (n)**		**Percentage (%)**	
Total Number of Participating Educational Institutions		11,669		10	
Public Educational Institutions		6,922		59.3	
Private Educational Institutions		4,747		40.7	
Total Beneficiaries		2,406,772		100	
Beneficiaries with Special Conditions		66,437		2.8	
Distribution of beneficiaries based on education level and gender					
Level	Educational Institution	Public	Private	Beneficiaries	Special Conditions
Early Childhood Education	3,645	223	3,422	149,305	4,821
Elementary	5,371	4,912	459	1,051,970	21,181
Junior High School	1,561	1,107	454	650,174	20,493
High School	599	464	135	347,806	15,916
Vocational High School	410	174	236	197,568	3,793
SLB	70	36	34	5,945	220
PKBM	7	0	7	2,178	3
SKB	6	6	0	1,826	10
Total	**11,669**	**6,922**	**4,747**	**2,406,772**	**66,437**
Distribution of student characteristics based on specific health conditions					
Level	Female	Male	Allergies	Phobia	Intolerant
Early Childhood Education	72,468	76,837	2,088	485	2,248
Elementary	509,298	542,672	13,998	1,598	5,585
Junior High School	319,752	330,422	13,450	2,470	4,573
High School	198,084	149,722	8,954	1,508	5,454
Vocational High School	92,184	105,384	2,621	193	979
SLB	2,271	3,674	76	6	138
PKBM	1,058	1,120	3	0	0
SKB	801	1,025	8	0	2
Total	**1,195,916**	**1,210,856**	**41,198**	**6,260**	**18,979**

Remarks: The data source is the Free Nutritious Meal Program Monitoring System of the Ministry of Primary and Secondary Education of the Republic of Indonesia. Data were accessed on November 19, 2025, at 13:32:58 WIB. URL: https://mbg.pdm.kemendikdasmen.go.id/portal

thresholds for pathogenic microbial contamination, such as that by *Salmonella*, *Escherichia coli*, and *Staphylococcus aureus*. Physicochemical standards and maximum pesticide residue limits are regulated separately according to the type of food commodity analyzed.

The MBG program monitoring system involves a layered institutional hierarchy with defined divisions of authority. At the central level, BPOM is responsible for the certification and periodic inspections of catering provider production facilities. The Ministry of Health, through the Directorate General of Public Health, supervises nutritional aspects and monitors extraordinary incidents of food poisoning. The Ministry of Education, Science, and Technology oversees the operational aspects at the school level, including food reception and serving.

The Food and Drug Monitoring Agency in 33 provinces conducts field inspections at least twice per semester for each registered catering provider. Inspections cover personnel hygiene, facility sanitation, implementation of a hazard analysis critical control point-based food safety management system, and product sampling for laboratory testing of food products. The inspection results are documented in an integrated information system that is accessible to relevant stakeholders.

Participatory monitoring involves school committees and parents through organoleptic sampling before

serving. The technical guidelines published by the Ministry of Education, Science and Technology require the formation of a monitoring team consisting of teachers, school health workers, and parent representatives to conduct daily checks on the quality of the food received. The effectiveness of this mechanism varies across schools, depending on the level of understanding and commitment of the field implementers.

The reporting system for adverse events related to food safety in the MBG program is integrated with the national surveillance system through an early warning and food poisoning response system. Every food poisoning incident must be reported within a maximum of 24 hours to enable an immediate investigative response. Data from the Ministry of Health show that the reporting compliance rate was 67%.

Characteristics of Problems and Findings in Implementation

The audit board's identified systemic problems in the implementation of the MBG program in 156 audited districts and cities. The findings included noncompliance with the technical specifications of the food served with the established standards in 42% of the sample locations, delivery delays exceeding the safe time limit in 31% of the cases, and noncompliance with production facility hygiene requirements in 28% of the food providers inspected. These problems were spread evenly across various regions, without any specific geographical patterns.

Table 2: Matrix of Authority and Responsibilities in MBG Program Oversight

Supervisory Agency	Provider certification	Periodic facility inspections	Laboratory testing	Health surveillance	Daily operational supervision	Outbreak investigation	Enforcement of sanctions
BPOM (Indonesian Food and Drug Administration)	●●● **Primary:** Catering provider certification, HACCP audit	●●● **Primary:** Inspection of production facilities at least twice per semester	●●● **Primary:** Testing of food samples and raw materials	○○○ None	○○○ None	●●○ **Secondary:** Laboratory testing of KLB samples	●●● **Primary:** Administrative sanctions against suppliers
Ministry of Health	●●○ **Secondary:** Hygiene and Sanitation Compliance Certificate (SLHS)	●●○ **Secondary:** Environmental sanitation inspection	●●○ **Secondary:** Regional health laboratories	●●● **Primary:** Foodborne disease surveillance, nutritional status monitoring	○○○ None	●●● **Primary:** Rapid Response Team (RRT), epidemiological investigation	●●○ **Secondary:** Recommendations for facility closure
Ministry of Education, Culture, Research, and Technology	○○○ None	●●○ **Secondary:** Supervision of implementation in schools	○○○ None	○○○ None	●●● **Primary:** Operational coordination, monitoring distribution	●●○ **Secondary:** Reporting incidents to the Ministry of Health	●●○ **Secondary:** Evaluation of provider performance
Local Government (Health Office, Education Office)	●●○ **Secondary:** Operational permits for food business establishments	●●● **Primary:** Routine inspections at the district/city level	●●○ **Secondary:** Regional health laboratories	●●● **Primary:** Implementation of surveillance at the regional level	●●○ **Secondary:** Coordination with schools	●●● **Primary:** Initial response and coordination of outbreak management	●●● **Primary:** Enforcement of local regulations related to food safety
School & Parent Committee	○○○ None	○○○ None	○○○ None	○○○ None	●●● **Primary:** Daily organoleptic testing, food intake monitoring	●●○ **Secondary:** Reporting suspected poisoning	○○○ None
National Nutrition Agency (BGN)	●●○ **Secondary:** Setting menu and nutrition standards	●●○ **Secondary:** Supervision of program implementation	○○○ None	●●○ **Secondary:** Monitoring of nutrition target achievement	●●● **Primary:** Cross-sector coordination, program policy	●●○ **Secondary:** System evaluation and improvement	●●○ **Secondary:** Policy recommendations

Remarks: ●●● = Primary Authority (primary responsibility with an explicit legal mandate); ●●○ = Secondary Authority (supporting or coordinating function); ○○○ = No Authority (not involved in this function).

At the raw material procurement stage, the practice of using products nearing their expiration dates to reduce operational costs was found. An investigation in 45 districts revealed that 23% of food providers used raw animal protein materials with a remaining shelf life of less than 3 days, increasing the risk of microbiological contamination. Procurement from uncertified suppliers was found in 18% of the cases, indicating weak verification of compliance with tender requirements.

The food production process faces challenges related to inadequate production capacity to meet demand. A survey revealed that 56% of catering providers increased their production volumes beyond their registered capacity to fulfill MBG program contracts, which resulted in reduced quality control and an increased risk of cross-contamination. The limited number of trained personnel in food safety was identified as a contributing factor, with only 41% of food processing workers having food handler certifications from accredited institutions.

Temperature management in the distribution chain is a recurring weakness. Temperature measurements during distribution in 12 cities revealed that 63% of high-risk food samples were exposed to dangerous temperatures (5–60°C) for longer than the safe 2-hour limit. Limited distribution fleets with refrigeration and long distances in difficult geographical areas are the main causes of this problem. Simple refrigerated containers without automatic temperature monitoring were used in 74% of the cases.

Storage facilities at the school level do not always meet food safety standards. Health Department inspections of 2,847 schools revealed that 52% did not have refrigerators with adequate capacity, 38% did not have separate storage areas for food, and 29% used storage spaces with substandard sanitation. These conditions increase the risk of contamination and the proliferation of pathogenic microorganisms before food is consumed by beneficiaries.

The competence of school food recipients in verifying food quality is limited. An evaluation by the school monitoring team revealed that 67% of the officers did not understand basic food safety indicators, such as checking food temperature, signs of spoilage, and procedures for handling suspicious food. These limitations reduce the effectiveness of the final layer of supervision prior to consumption.

Epidemiology of Foodborne Diseases in the MBG Program

Between January and November 2025, Indonesia's Indonesia's Free Nutritious Meal Program recorded at least 340 cases of food poisoning, affecting 11,390 students across 28 provinces. The distribution of incidents showed a striking temporal pattern, peaking in September 2025, with 134 incidents affecting 4,283 victims, coinciding with the program's intensification phase after its launch. Java Island dominated both the frequency of incidents (45.3% of the total) and the absolute number of victims, with West Java recording 76 incidents affecting 4,187+ students.

Elementary schools bore a disproportionate burden, accounting for 50% of incidents, although high schools presented a higher attack rate per incident (51.8 students/incident compared with 28.3 for elementary schools), indicating greater cluster exposure at higher educational levels. Seven major incidents exceeded 500 victims each, with the largest incident in West Bandung Regency affecting 1,333 students across eight institutions simultaneously. The monthly attack rates varied substantially, ranging from 10.0-162.6 per incident across different months. The absence of fatalities across all documented incidents suggests relatively low pathogen virulence or prompt medical interventions. The geographical distribution showed a concentration in Java (154 incidents), followed by Sumatra (34 incidents), with lower frequencies in Kalimantan (12 incidents), Sulawesi-Maluku (20 incidents), and Nusa Tenggara-Papua (16 incidents).

Etiology of Foodborne Diseases

Laboratory findings from 89 incidents where etiology confirmation was successful identified biological contaminants as the dominant cause of infection. *Bacillus cereus* was detected in 34% of the food and clinical samples, making it the most common pathogen, followed by *Staphylococcus aureus* (28%), Salmonella spp. (18%), and *Clostridium perfringens* (12%). Pathogenic *Escherichia coli* was detected in 5% of the cases, whereas the remaining 3% had unidentified causative agents.

Supply chain analysis revealed that *Bacillus cereus* contamination occurred predominantly at the postcooking stage when food was left at room temperature beyond the safe time, allowing for spore germination and toxin production. Rice dishes were found to be the optimal growth medium for 82% of the *B. cereus* cases. *Staphylococcus aureus* contamination mainly originates from food handling by personnel, with epidemiological investigations revealing that 76% of food processing workers at outbreak locations did not practice proper hand washing, and 43% were found to have skin lesions or upper respiratory tract infections.

Table 3: Chronology of Food Poisoning Incidents in Indonesia's Free Nutritious Meal Program on the Basis of Media Reports, January–November 2025

Temporal distribution of food poisoning incidents					
Month	**Number of incidents**	**Affected victims**	**Province**	**Average victims/incident**	
January 2025	7	242	5	34.6	
February 2025	4	66	4	16.5	
April 20	9	1,057	5	117.4	
May 2025	5	813	3	162.6	
June 2025	1	10	1	10.0	
July 2025	5	294+	4	58.8+	
August 2025	27	1,447	12	53.6	
September 2025	134	4,283+	25	32.0+	
October 2025	96	2,145+	19	22.3+	
November 2025	8	833	6	104.1	
Total	**≥340**	**≥11,390**	**28**	**33.5**	
Geographic Distribution by Region					
Region	**Incidents**	**Casualties**	**% of Total**	**Regencies/Cities**	
Java					
West Java	76	4,187+	36.8	18	
Central Java	31	2,948+	25.9	13	
East Java	21	1,342	11.8%	12	
Yogyakarta	15	3,601	31.6	5	
Jakarta	8	151+	1.3	4	
Banten	3	55	0.5	3	
Subtotal	**154**	**≥12,284**	**45.3**	**55**	
Sumatera					
Lampung	13	481+	4.2	7	
South Sumatra	8	328	2.9	5	
West Sumatra	2	151	1.3	2	
North Sumatra	3	147	1.3	2	
Riau Islands	3	262	2.3	2	
Riau	2	46	0.4	2	
Bengkulu	1	539	4.7	1	
Bangka Belitung	1	TBA	-	1	
Nanggroe Aceh Darussalam	1	3	0.03	1	
Jambi	IN	-	-	-	
Subtotal	**34**	**≥1,957**	**10.0**	**27**	
Kalimantan					
West Kalimantan	5	84	0.7%	5	
North Kalimantan	3	204+	1.8	2	
South Kalimantan	2	174	1.5	2	
Central Kalimantan	1	27	0.2%	1	
East Kalimantan	1	5	0.04%	1	
Subtotal	**12**	**≥494**	**3.5**	**12**	
Sulawesi & Maluku					

Central Sulawesi		5	534	4.7	3
Southeast Sulawesi		4	76	0.7	4
West Sulawesi		2	51	0.4%	1
South Sulawesi		1	12	0.1	1
Gorontalo		1	11	0.1	1
Maluku		5	309	2.7	4
North Maluku		2	68	0.6	1
Subtotal		**20**	**≥1,061**	**6.1**	**15**
Nusa Tenggara & Papua					
West Nusa Tenggara		8	308+	2.7	5
East Nusa Tenggara		7	952	8.4%	5
West Papua		1	13	0.1%	1
Bali		NA	-	-	-
Subtotal		**16**	**≥1,273**	**7.3**	**11**
Distribution based on education level					
Level of education		**Incidence**	**Percentage**	**Average number of victims/incidents**	
Elementary School (SD/SDN/MI)		≥170	50.0	28.3	
Junior High School/MTs		≥85	25.0	42.7	
High School/Vocational School/Islamic High School		≥55	16.2	51.8	
Early childhood education/kindergarten		≥20	5.9	21.4	
Islamic boarding school		≥10	2.9	38.5	
Ten largest incidents (>100 victims)					
Rank	**Date/Month**	**Province**	**Location**	**School**	**Victims**
1	September 22, 2025	West Java	West Bandung Regency	Cipari State Elementary School + 7 schools	1,333
2	October 31, 2025	Central Java	Batang Regency	Kandeman Vocational School	800
3	October 28, 2025	DI Yogyakarta	Gunungkidul Regency	SMPN 1 Saptosari + SMKN 1	695
4	September 17, 2025	West Java	Garut Regency	SDN 2 Mandalasari + 4 schools	657
5	November 3, 2025	DI Yogyakarta	Gunungkidul Regency	Several schools	547
6	October 1, 2025	East Java	Bojonegoro Regency	Kedungadem State Senior High School 1	544
7	August 28, 2025	Bengkulu	Lebong Regency	Al-Azhar Islamic Kindergarten + 10 schools	539
8	October 14, 2025	West Java	West Bandung Regency	SMPN 1 Cisarua + 5 schools	518
9	July 31, 2025	Yogyakarta	Kulon Progo Regency	SMPN 2 Wates + 3 schools	497
10	October 15, 2025	Daerah Istimewa Yogyakarta	Yogyakarta	State Senior High School 1 Yogyakarta + Muhammadiyah Senior High School 7	491
Provincial Ranking Based on Incident Frequency					
Rank	**Province**	**Incidents**	**Casualties**	**Regencies/Cities**	**Incidents/District**
1	West Java	76	4,187+	18	4.2
2	Central Java	31	2,948+	13	2.4
3	East Java	21	1,342	12	1.8
4	DI Yogyakarta	15	3,601	5	3.0
5	Lampung	13	481+	7	1.9
6	South Sumatra	8	328	5	1.6
7	Jakarta	8	151	4	2.0

8	West Nusa Tenggara	8	308	5	1.6

Remarks: These data were compiled from mass media reports. The figures represent reported cases; the actual burden is likely to be greater because of the underreporting of mild cases and incomplete data from several provinces. Annotations (+) indicate minimum data because some incidents were recorded as "dozens of students" or "IN/incomplete data."

The isolation of *Salmonella* spp. indicates contamination at the upstream stage of the supply chain, particularly in raw animal protein raw materials. Tests on chicken and egg samples from food suppliers revealed that the prevalence of *Salmonella* was 32% in broiler chickens and 18% in eggs. The *S. enteritidis* and *S. typhimurium* serotypes were the dominant variants detected. Chemical contamination testing of 156 food samples by BPOM laboratories revealed that 12% of the samples were positive for pesticide residues exceeding the maximum limit, especially leafy vegetables. Lead was detected in 8% of the samples at concentrations ranging from 0.3–0.8 mg/kg, exceeding the regulatory threshold of 0.25 mg/kg. Nonfood textile dyes were found in 3% of the flour-based processed product samples, indicating the adulteration of the raw materials. Physical contaminants in the form of foreign objects, including plastic packaging fragments, hair, and other foreign materials, were reported in 47 complaints. Although they do not cause direct health effects, such as biological or chemical contaminants, the presence of physical contaminants indicates weak quality control in the production process.

DISCUSSION

Fragmentation and Gaps in Food Safety Governance

The matrix of institutional authority presented in Table 2 identifies three systemic problems in the governance of the MBG program's supervision. There is a clear fragmentation of primary authority, with no single institution having full authority over all stages of supervision. The BPOM has a primary authority for the certification and inspection of production facilities but does not have access to health surveillance data managed by the Ministry of Health. Conversely, the

Table 4: Etiology of Foodborne Diseases Identified by the Food and Drug Administration

Etiology category	Specific agent	Number of positive cases	Percentage of total confirmed cases	Dominant vehicle menu	Identified contamination routes	Main risk factors
Bacterial		81	91			
	Bacillus cereus	30	34.0	Rice, fried rice	Postcooking, unsafe storage temperature	Spore germination, toxin production at room temperature >4 hours
	Staphylococcus aureus	25	28	Protein side dishes, soupy foods	Direct handling by workers	Poor personal hygiene, skin lesions in workers
	Salmonella spp.	16	18	Chicken, eggs	Contaminated raw materials	Incomplete processing, cross-contamination
	Clostridium perfringens	11	12.0	Soupy meat, curry	Postcooking, slow cooling	Unsafe mass storage temperature
	Pathogenic *Escherichia coli*	4	5.0	Raw vegetables, salad	Raw materials, washing water	Fecal contamination, inadequate washing
Chemical		5	6.0			
	Pesticide residues (>BMR)	3	3.4	Leafy vegetables	Raw materials	Agricultural practices do not meet standards
	Heavy metals (Pb >0.25 mg/kg)	2	2.2	Processed flour products	Raw materials, packaging	Uncertified raw material sources
Unidentified		3	3.0	Varied	-	Inadequate samples, delayed investigation
Total Confirmed Cases		89	100			
Cases without Laboratory Confirmation		58	-			

Remarks: Cases without laboratory confirmation are due to sample limitations, delayed sample collection or limited regional laboratory capacity. MRL: Maximum residue limit. Some cases involve multiple pathogen detections; therefore, the number of detected agents may exceed the number of confirmed cases. Source: National Agency for Drug and Food Control, National Veterinary Agency, 2024.

Ministry of Health, which manages health surveillance and outbreak response, does not have the authority to impose sanctions on problematic food providers. This situation creates a coordination gap that can hinder rapid responses to food safety threats, which is consistent with findings from WHO assessments of fragmented food safety systems in developing countries (WHO, 2022).

Overlapping secondary authority occurs mainly in the function of periodic inspections, where BPOM, the Ministry of Health, the Ministry of Education, and local governments all have inspection roles with different focuses but without a clear coordination mechanism. The Indonesian ombudsman's evaluation revealed that public complaints are often not handled optimally because of uncertainty about which agency should respond first (Ombudsman Republik Indonesia, 2024). In some cases, food providers receive inspections from four different agencies within the same period with checklists that are not fully harmonized, creating a high administrative burden without a proportional increase in supervision effectiveness.

Critical authority gaps were identified in two domains. No agency has the primary authority to conduct daily operational oversight at the stage of food distribution from production facilities to schools, even though the data show that the distribution stage is a critical risk point for temperature abuse and secondary contamination. The traceability mechanism in the MBG program supply chain faces significant limitations in its implementation. Waldhans *et al*. (2024) reported that only 34% of food providers implemented a comprehensive digital tracking system, whereas the majority still relied on manual documentation, which is prone to data inconsistencies. These limitations hamper the ability to conduct rapid investigations when food safety incidents occur and make it difficult to identify contamination sources, challenges documented in similar large-scale feeding programs in Brazil and India (Grace, 2023; United States Department of Agriculture Food and Nutrition Service, 2024; USDA, 2005)

School committees responsible for daily operational oversight at the serving level lack adequate technical capacity to verify food safety, with data showing that only 33% of school committees understand basic food safety indicators (USDA, 2005). This gap exposes the system's vulnerability to oversight failures at the stage closest to the end consumers. This fragmented authority structure indicates the need to establish stronger formal coordination mechanisms, ideally through a *One Health* coordination committee at the national and regional levels with explicit mandates to integrate cross-sectoral oversight functions, establish clear communication and reporting protocols, and eliminate duplication and gaps in oversight implementation (Zinsstag *et al*., 2011).

Vulnerability to Foodborne Diseases and Implications for Physical Well-being

The vulnerability of children to foodborne diseases has a pathophysiological basis that distinguishes them from adults, underscoring the urgency of stricter food safety standards in MBG programs. The immune system of school-aged children, especially those under five years of age, is still developing, with suboptimal production of secretory immunoglobulin A and immature intestinal mucosal barrier function (Gerner-Smidt *et al*., 2019; Goma *et al*., 2019; González *et al*., 2025). This results in the infectious dose of enteric pathogens, such as *Shigella* and *E. coli* O157:H7, required to cause disease in children being 100–1,000 times lower than that in adults. The FAO (2024) reported that the 50% infectious dose for Shigella in children is 10–100 organisms, whereas in adults, it reaches 100–200 organisms.

The clinical consequences of this susceptibility are reflected in disease severity, where children with *Salmonella* infection have a fivefold greater risk of bacteremia and a threefold greater risk of hospitalization than adults (Silva *et al*., 2014). Acute dehydration due to diarrhea can occur more quickly in children because of their greater body fluid proportion and increased basal metabolic rate, with an estimated 10% weight loss in 24 h potentially leading to life-threatening hypovolemic shock (Brander *et al*., 2019; Wang *et al*., 2021).

The long-term impact of foodborne disease episodes in children includes postinfection nutrient absorption disorders that can last up to six months, known as environmental enteric dysfunction, which results in decreased linear growth velocity and micronutrient deficiencies (Abdullahi *et al*., 2025; Grace, 2023; Levy *et al*., 2022; Viator *et al*., 2015; WHO, 2015b). In the context of MBG programs targeting populations with high malnutrition prevalence, episodes of food poisoning can worsen already marginal nutritional status and undermine the program's primary goal of improving child growth, creating a situation in which nutritional interventions contribute to health deterioration.

Emerging Disease Threats and Extraordinary Event Risks

A national-scale MBG program with centralized distribution systems increases the risk of pathogen transmission to humans. A simulation model by Soma *et al*. (2024) revealed that contamination at a single

central production facility has the potential to cause simultaneous exposure to thousands of beneficiaries within a distribution radius of 50–100 km. A worst-case scenario with contamination by virulent pathogens, such as Salmonella typhi or *Shigella dysenteriae*, could trigger a multiregional outbreak with an estimated 5,000–15,000 cases within 7–14 days before effective detection and intervention.

Antimicrobial resistance in foodborne pathogens is an emerging threat with serious implications for the efficacy of treatment and human health (Allen *et al*., 2017; Garcia *et al*., 2020; Meisner *et al*., 2025; Mekonnen *et al*., 2025; WHO, 2015a, 2017). González *et al*. (2025) and Puspandari *et al*. (2021) detected extended-spectrum beta-lactamase-producing *E. coli* in 24% of chicken samples from food suppliers, indicating the dissemination of resistant strains through the food supply chain. Excessive antibiotic use on commercial farms without adequate supervision contributes to the selection and persistence of resistant strains that can be transmitted to humans through the consumption of contaminated products (Garcia *et al*., 2020). This finding aligns with global concerns regarding agricultural antibiotic use as a major driver of antimicrobial resistance, which threatens human health (Adnyana *et al*., 2026).

Climate change affects the epidemiology of foodborne diseases through various mechanisms. Increased average temperatures and changes in rainfall patterns have expanded the geographic distribution of vectors and zoonotic pathogens (Adiwinoto *et al*., 2024; Adnyana *et al*., 2023; Adnyana, Utomo, *et al*., 2025; Khalida Shaikh *et al*., 2026). Modeling research by the center for public health research shows that a 2°C increase in temperature is predicted to increase the risk of Vibrio parahaemolyticus contamination in fishery products by 34% and shorten the shelf life of animal protein products by up to 28%, putting additional pressure on an already limited cold chain system (Rockström *et al*., 2025).

Urbanization and intensification of livestock production create conditions conducive to the transmission of zoonotic pathogens (Díaz-Gavidia *et al*., 2022; McAllister & Topp, 2012; Paramitadevi *et al*., 2023). The concentration of chicken and cattle farms in peri-urban areas with inadequate environmental sanitation increases the risk of water and soil contamination by pathogens such as *Campylobacter* and *Cryptosporidium*. Wulandari *et al*. (2024) reported that 41% of the water sources used by farms were positive for indicator *E. coli* contamination, exceeding standards and indicating a risk of enteric pathogens entering the food chain. The melamine contamination of milk products in China in 2008 and the *E. coli* O104:H4 outbreak in Europe in 2011 demonstrated how modern food systems can become vectors for mass transmission with large-scale public health consequences (Das *et al*., 2024; Grudlewska-Buda *et al*., 2023; Insfran-Rivarola *et al*., 2020; Schlundt *et al*., 2004; WHO, 2015b). Similar patterns have been documented in intensive livestock systems globally, highlighting the need for integrated animal health and environmental monitoring (Karina *et al*., 2025).

Multidimensional Wellbeing Implications

Physical Wellbeing: Nutritional Status and Disease Burden

The burden of disease due to food poisoning has multidimensional implications for the physical well-being of beneficiaries. Recurrent episodes of acute diarrhea in school-aged children interfere with nutrient absorption and can worsen the already marginal nutritional status. A cohort study by Amir-ud-Din *et al*. (2022) revealed that children who experienced food poisoning had a 2.3-fold greater risk of growth faltering in the six months following the incident than unexposed children did, directly undermining the fundamental goal of the program to improve their nutritional status. This finding is consistent with longitudinal studies demonstrating persistent growth deficits following diarrheal episodes in malnourished populations (Brander *et al*., 2019; Karina *et al*., 2025).

Disruption of the learning process is a direct consequence of student absenteeism due to illness. Attendance data from 124 schools that experienced poisoning incidents revealed an average loss of 4.2 school days per affected student, equivalent to a cumulative loss of 16,144 learning days. Educational research has demonstrated that even short-term absences correlate with decreased academic achievement and long-term educational attainment, particularly in resource-constrained settings (Kemendikbudristek, 2025; Mertens *et al*., 2023; Victora *et al*., 2021). Hence, food safety failures not only compromise physical health but also obstruct the educational benefits that school feeding programs aim to provide.

Psychological Wellbeing: Trust Erosion and Trauma

Psychological impacts in the form of trauma and anxiety toward school meals were reported in 34% of children who experienced severe poisoning, requiring psychosocial intervention for their recovery. Food-related trauma in children can manifest as feeding difficulties, anxiety disorders, and school avoidance behaviors that persist long after the

resolution of physical symptoms (Al-Beltagi *et al*., 2025; Nocerino *et al*., 2024; Saravia *et al*., 2022; Victora *et al*., 2021). Such psychological consequences extend beyond individual well-being to affect family dynamics and parental employment, as caregivers must provide extended support to traumatized children.

The erosion of public trust in government programs represents an intangible but significant effect with far-reaching implications for the government. A public perception survey by the Indonesian Survey Institute revealed that 62% of parents expressed concerns about the safety of MBG program food, with 18% choosing not to allow their children to consume program food despite meeting the beneficiary criteria (LSI, 2024). This decline in participation reduces the program's effective coverage and ironically harms children from the neediest families, who depend most on nutritional support. Research on public health program acceptance has demonstrated that trust is a critical determinant of program uptake and effectiveness (Azak & Gözen, 2025; Yang, 2017). Once eroded, trust requires substantial time and resources to rebuild, potentially undermining not only the MBG programme but also broader public health initiatives in the future.

Social Wellbeing: Equity, Economic Burden, and Community Resilience

Inequality in risk distribution creates a critical dimension of health equity. Spatial analysis revealed that food poisoning incidents are concentrated in schools in areas with limited monitoring capacity and inadequate infrastructure, which are ironically the priority target areas of the program with the highest malnutrition prevalence rates. This phenomenon creates an inequitable situation in which the most vulnerable populations bear the greatest risk burden, contrary to the principle of distributive justice in public health policy (Qomarrullah *et al*., 2025; Stärk *et al*., 2006; Wall *et al*., 2022). Such disparities reflect broader patterns of environmental injustice, where marginalized communities disproportionately experience environmental and health hazards (Abdullahi *et al*., 2025; Finance, 2025; Häsler *et al*., 2011).

The economic burden on poor households has increased due to unexpected health expenditures for treating poisoning incidents. Although treatment at primary health facilities is covered by the National Health Insurance, transportation costs, loss of income due to parents having to care for sick children, and expenses for additional nutritious food during recovery reach an average IDR of 342,000 per episode, equivalent to 12% of the monthly income of poor households (BPS, 2024). This financial burden can push households into poverty traps, where health shocks deplete savings and force them into debt or asset sales, with long-term consequences for economic security (Jalili *et al*., 2025). The irony that a welfare program intended to reduce the economic burden on poor families may inadvertently create new financial stress through inadequate safety measures represents a fundamental failure to protect social well-being.

Institutional Governance Challenges and Implementation Barriers

The vertical coordination mechanism from the central to the regional level faces several structural obstacles. The cross-sector coordination forum mandated by regulations functions effectively in only 34% of the surveyed districts/cities, with irregular meeting frequencies and low attendance rates among authorized officials. The absence of an integrated information system accessible to all stakeholders hinders transparency and accountability in program implementation, which is consistent with the governance challenges identified in large-scale social programs in decentralized systems.

Indonesia faces a deficit of food safety inspectors, with a ratio of one officer per 2.4 million residents, which is far below the WHO standard of at least one per 250,000 residents (WHO, 2022). For the specific MBG program, only 1,247 trained inspectors oversee 15,682 registered food providers, creating a ratio of 1:12.6 that does not allow for adequate periodic inspections of all food providers. This compares unfavorably with inspector-to-establishment ratios in developed countries (typically 1:50-100) and even some middle-income countries that have prioritized food safety infrastructure (Collineau *et al*., 2023; Hopson, 2025; Nurul Azzahra *et al*., 2025; B. RI, 2024; World Food Programme, 2024).

The turnover rate of inspectors reaches 28% per year because high workloads and compensation are not competitive with the private sector. A job satisfaction survey revealed that 67% of food inspectors expressed dissatisfaction with career progression and capacity-building opportunities, with 42% considering moving to another sector within two years. High turnover results in the loss of institutional memory and requires continuous investment in training new officers, creating a persistent capacity deficit (Powell *et al*., 2011; Sianturi, 2025; Soma *et al*., 2024).

The limited food safety testing laboratory infrastructure is a bottleneck in surveillance systems. Of the 514 districts/cities implementing the program, only 187 have accredited testing laboratories with adequate capacity. The waiting time for test results

ranges from 7-14 days, which is too slow for responding to suspected contamination that requires immediate action. Reliance on provincial or national reference laboratories increases time and cost burdens. Similar laboratory capacity constraints have been identified as critical weaknesses in food safety systems across low- and middle-income countries (Soma *et al*., 2024; Wall *et al*., 2022).

The national cold chain system is inadequate for supporting fresh food distribution at the scale required by the MBG Program. Refrigeration infrastructure is available on only 42% of distribution routes, forcing the use of conventional transportation that cannot maintain safe temperatures during transport. Investment in cold-chain infrastructure requires significant capital that has not been allocated to the program budget. A feasibility study by the Ministry of Transportation estimated that IDR 2.8 trillion in investment is required to build a comprehensive refrigerated distribution network. The absence of adequate cold chain infrastructure is a common challenge in tropical developing countries, where temperature abuse during distribution is a leading cause of food-borne disease outbreaks (Akram *et al*., 2023; Käferstein, 2003).

One Health Approach as an Integrated Evaluation Framework

The *One Health* framework offers an integrative paradigm that recognizes the interconnections between human, animal, and environmental health as holistic determinants of food security and safety. This approach was developed in response to the complexity of modern health challenges that cannot be addressed via traditional sectoral approaches (Adnyana *et al*., 2026; Zinsstag *et al*., 2011). In MBG programs, the food supply chain necessarily involves livestock and agricultural production systems that interact with environmental conditions and culminate in health outcomes for the beneficiary population (López-Gálvez *et al*., 2021; Raab *et al*., 2011).

The *One Health* approach to evaluating the MBG program begins at the upstream end of the supply chain with animal health surveillance of supplier farms. The implementation of integrated zoonotic surveillance systems can detect pathogens such as *Salmonella*, *Campylobacter*, and pathogenic *E. coli* in livestock populations before products enter the human supply chain. Livestock vaccination programs and farm biosecurity measures reduce pathogen prevalence at the source, lowering the contamination risk of animal products consumed by program beneficiaries (Brander *et al*., 2019; Grace, 2023; Grace *et al*., 2012). Evidence from integrated surveillance systems in Europe and North America demonstrates that farm-level interventions significantly reduce the prevalence of foodborne pathogens in food products (USDA, 2005; WHO, 2021, 2022).

Responsible antimicrobial stewardship in the livestock sector is a critical component of *One Health*. The use of antibiotics as growth promoters in commercial livestock farms contributes to the selection and dissemination of resistant strains that can be transmitted to humans through the food supply (Adiwinoto *et al*., 2024; Khalida Shaikh *et al*., 2026). The implementation of policies that restrict nontherapeutic antibiotics, monitor antibiotic residues in animal products, and integrate antimicrobial resistance surveillance between the veterinary and human health sectors can reduce the transmission risk of resistant pathogens (Adnyana, Astuti, *et al*., 2025; Talukder *et al*., 2024). Countries that have implemented comprehensive antimicrobial stewardship in agriculture, such as Denmark and the Netherlands, have achieved substantial reductions in the prevalence of resistance (Khalida Shaikh *et al*., 2026).

The environmental health dimension includes water resource management, sanitation in food production facilities, and waste management systems (Wyasena *et al*., 2022). Contamination of water sources by fecal pathogens from farms or inadequate waste disposal can contaminate agricultural and fishery products in the MBG program supply chain. The *One Health* approach encourages the integration of watershed management, the application of good agricultural practices, and the treatment of livestock waste to protect the environmental quality underpinning food safety (Lerner & Berg, 2017). Integrated watershed management programs have been effective in reducing foodborne pathogen transmission through environmental routes (Stärk *et al*., 2006).

Integrated surveillance is an operational pillar of the *One Health* approach. Systems that link human health, animal health, and environmental quality data enable early detection of health threats and coordinated responses. Integrating human foodborne disease surveillance data with livestock pathogen surveillance and environmental contamination monitoring can identify spatiotemporal clusters that indicate common contamination sources. Digital surveillance platforms using machine learning algorithms can accelerate the detection of anomalous patterns requiring investigation (Şengönül *et al*., 2023).

The required multisectoral collaboration model includes the establishment of a *One Health* coordination committee at the national and regional levels, involving the ministries of health, agriculture, and the environment, as well as academic institutions and civil society (Adnyana, 2024; Adnyana, Astuti, *et*

al., 2025; Adnyana *et al*., 2023; Rüegg *et al*., 2018). This committee serves as a forum for policy coordination, joint planning, resource mobilization, and cross-sectoral program evaluations (Figure **1**). The experiences of countries such as Vietnam and Thailand demonstrate the effectiveness of multisectoral coordination structures in responding to zoonotic threats and improving food security (Häsler *et al*., 2011).

Public Health Implications and Evidence-Based Recommendations

Health Safety Measures and Risk-Based Surveillance

This review underscores the need to accelerate the transformation of the food safety approach in the MBG programme from a reactive response to risk-based prevention. Strengthening integrated surveillance systems should be a priority, with the development of

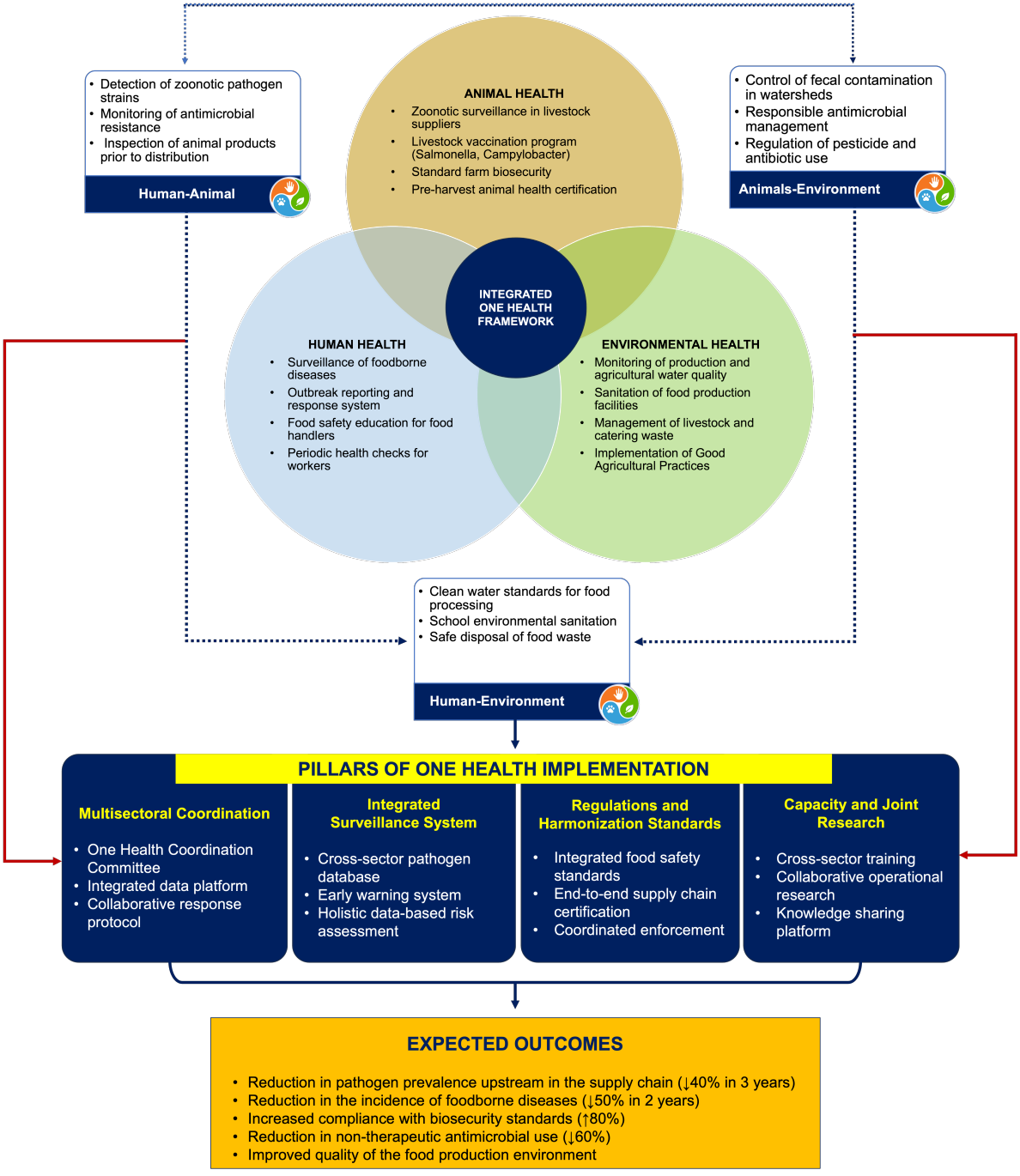

Figure 1: *One health* integration model in the MBG program evaluation. Conceptual diagram showing interconnections between (1) animal health surveillance → livestock farms, veterinary systems, and zoonotic monitoring; (2) environmental health → water quality, sanitation, and climate factors; (3) human health outcomes → disease burden, nutritional status, and well-being dimensions; and (4) integrated coordination → *one health* committee linking all domains with bidirectional feedback loops.

Remarks: This model adapts the framework of Zinsstag *et al*. (Zinsstag *et al*., 2011) and the WHO Tripartite Guide (WHO, 2019) with contextualization for the Indonesian MBG program.

digital platforms that connect data from health facilities, laboratories, schools, and catering providers in real-time systems. Investment in blockchain technology for supply chain traceability can enable the tracking of raw materials from their origin to the point of service, facilitating the rapid investigation and recall of contaminated products (Ellahi *et al*., 2024; Keramati *et al*., 2025). Similar technologies have been successfully implemented in food safety systems in developed countries and show promise for adapting to the context of developing countries (Choffnes *et al*., 2012; ISO, 2018).

The development of specific food safety standards for the MBG program that are stricter than general standards is necessary, given the vulnerable target population and the large-scale distribution. These standards must include biosecurity requirements for production facilities, ISO 22000:2018-based food safety management system certification, cold chain requirements with automatic temperature monitoring, and regular laboratory testing. The implementation of tiered certification with financial incentives for high-performing providers can encourage continuous quality improvement, an approach that has proven effective in upgrading food safety practices in other contexts (ISO, 2018).

Development of Human Resource Capacity

Increasing human resource capacity requires a systemic approach, including the recruitment of new inspectors to achieve ideal ratios, comprehensive training programs with competency certification, and retention incentives to reduce staff turnover. Partnerships with educational institutions to integrate food safety and *One Health* curricula could create a pipeline of trained professionals entering the workforce. Mandatory continuing professional development programs to maintain inspector competency must be institutionalized, following models established in countries with robust food safety systems (Grace, 2023).

Empowering school communities by training school committees in participatory supervision can expand the monitoring scope without relying solely on formal inspectors. The development of simple mobile applications for reporting complaints and photographing food conditions can facilitate community participation and enhance transparency. Responsive feedback mechanisms and visible follow-up are necessary to maintain public trust and sustained participation, principles that are well established in the community-based health surveillance literature (Adnyana *et al*., 2024).

Governance Transparency and Accountability Mechanisms

Strengthening accountability through the regular publication of inspection results and food safety ratings of providers can encourage quality competition and provide information to the public, which is consistent with the principles of transparency in public health governance (Mega *et al*., 2025). A transparent reward and punishment system with strict sanctions for repeated violations and incentives for high-performing providers can change the behavior of supply chain actors. The legal framework and enforcement of sanctions must have sufficient deterrent effects; current administrative fines ranging from IDR 5-50 million are not commensurate with the potential economic benefits of noncompliance or harm caused by violations. Whistleblower protection mechanisms are required to protect individuals who report safety violations from retaliation, enabling the early detection of systemic problems. International experience has demonstrated that effective whistleblower protection is an essential component of food safety governance, particularly in contexts where informal pressure may discourage the reporting of violations.

Operational Research and Impact Assessment

Sustained operational research is needed to identify the most effective and cost-effective interventions. Microbiological risk assessment studies at various supply chain stages can identify critical control points that require close monitoring. Research evaluating the effectiveness of various monitoring and intervention models can inform the scalability of the best approaches. Investment in applied public health research should be an integral program component with adequate budg*et al*location, following the examples of research-integrated implementation in successful school feeding programs globally.

Future Research Directions

Future research should prioritize longitudinal impact assessment studies that examine the program's long-term effects on children’s growth trajectories, cognitive development, and educational outcomes, employing rigorous quasiexperimental designs with appropriate comparison groups. Cost–benefit analyses that integrate both health benefits from improved nutrition and health costs from foodborne disease incidents are essential for informing resource allocation decisions and program modifications. Research on well-being outcomes should develop and validate culturally appropriate instruments for assessing the physical, psychological, and social well-being dimensions of program beneficiaries and their families.

Research examining the effectiveness of various governance models, surveillance systems, and community participation mechanisms across diverse Indonesian contexts will identify scalable best practices. Microbiological risk assessment studies at critical control points throughout the supply chain can help inform targeted interventions. Climate change impact modeling, which projects future foodborne disease risk under various temperature and precipitation scenarios, will enable proactive adaptation strategies. Antimicrobial resistance surveillance, which integrates human, animal, and environmental monitoring, can identify emerging threats that require coordinated responses. Finally, qualitative research exploring community perceptions, trust dynamics, and participation barriers will inform culturally appropriate strategies for rebuilding public confidence and enhancing program acceptance.

Limitations

Methodological limitations include the absence of analytical case–control or prospective cohort studies that can establish a definitive causality between specific exposures and health outcomes. Most data were obtained from retrospective outbreak investigations of varying quality, with limited laboratory confirmation. The unavailability of comprehensive baseline data prior to program implementation limits the ability to analyze temporal changes that could be causally attributed to this program. The review focused on food safety and health, with limited attention given to the socioeconomic and political dimensions that influence program implementation.

Long-term impact assessments of child growth and development and family welfare could not be conducted, given the relatively new nature of the program and the limitations of the longitudinal follow-up data. Wide variations in program implementation models across regions may not be fully captured in this synthesis, thus limiting the generalizability of the findings. Limited access to proprietary data from food providers regarding operational processes and raw material quality limits the depth of the analysis at specific stages in the supply chain. Information on procurement practices, specific suppliers, and internal quality control procedures is often unavailable for external reviews. This review could also not access confidential regulatory investigation data or data still under law enforcement, and the website published by the National Nutrition Agency does not fully document the MBG program clearly and explicitly.

CONCLUSION

Indonesia's Free Nutritious Meals Program demonstrates the transformative potential for addressing child malnutrition and advancing multidimensional well-being; however, it faces critical food safety challenges that threaten these objectives. This evaluation identified 340 foodborne disease incidents affecting 11390 students, driven by fragmented institutional authority, inadequate infrastructure (58% of routes lack a cold chain, 1:12.6 inspector-to-provider ratio), and systemic surveillance gaps. The dominant pathogens *Bacillus cereus* and *Staphylococcus aureus* are associated with temperature abuse and hygiene failure. Well-being implications extend beyond physical health to encompass psychological impacts (62% parental trust erosion) and social inequities disproportionately burdening vulnerable populations. The *One Health* framework offers essential integration of animal health surveillance, environmental monitoring, and human disease tracking, addressing pathogen sources rather than consequences alone. Systemic transformation requires multisectoral coordination mechanisms, risk-based prevention strategies, technology-enabled surveillance, and sustained political commitment with adequate resource allocation for cold-chain infrastructure, laboratory capacity, and human resource development. Program success demands the measurement of sustainable health outcomes without creating new burdens, positioning food safety investment as essential rather than supplementary. The program stands at a critical juncture implement integrated *One Health* governance to realize its transformative potential or perpetuate a paradox in which nutritional interventions inadvertently harm the populations they aim to serve.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as potential conflicts of interest.

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DECLARATION OF ARTIFICIAL INTELLIGENCE USE

We hereby confirm that no artificial intelligence (AI) tools or methodologies were utilized at any stage of this

study, including during data collection, analysis, visualization, or manuscript preparation. All the work presented in this study was conducted manually by the authors without the assistance of AI-based tools or systems.

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