



Global evidence on nutritious meal programs: A PRISMA-compliant systematic review of health outcomes and pharmacoeconomic implications

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ABSTRACT

Background: Nutritious meal programs (NMPs) have been widely implemented as public health strategies to address malnutrition, enhance learning outcomes, and strengthen economic well-being. Although numerous studies have evaluated their nutritional and educational effects, global evidence integrating both health and pharmacoeconomic outcomes remains limited. This study aimed to systematically review global findings on the health and economic efficiency of NMPs published between 2020 and 2025. **Methods:** This review followed the preferred reporting items for systematic reviews and meta-analyses (PRISMA 2020) guidelines using a narrative synthesis approach. A comprehensive search was conducted across PubMed, PMC, Scopus, and grey literature from international organizations. Eligible studies included interventional or quasi-experimental designs that reported quantitative health and economic indicators. Data were analyzed descriptively and categorized into three domains: study characteristics, health outcomes, and pharmacoeconomic implications. **Findings:** Overall, NMPs demonstrated meaningful improvements in health indicators such as nutritional status, cognitive performance, and school attendance, which collectively contribute to long-term productivity and quality of life. From an economic perspective, most studies reported favorable cost-efficiency and positive social value, with cost-benefit ratios remaining within acceptable economic thresholds. Cross-study comparisons indicated that programs emphasizing balanced or fortified meals tended to yield the most significant health and economic advantages, reflecting strong synergy between clinical and fiscal outcomes. **Conclusion:** NMPs are effective and cost-efficient interventions that generate mutually reinforcing health and economic benefits. **Novelty/Originality of this article:** This review provides a comprehensive synthesis of global evidence on the health outcomes and pharmacoeconomic implications of NMPs, offering a valuable foundation for evidence-based nutrition and public health policy development across diverse national contexts.

KEYWORDS: cost-effectiveness; health outcomes; nutrition intervention; pharmacoeconomic evaluation; public health policy.

1. Introduction

Malnutrition remains one of the most persistent global health and economic challenges of the 21st century. The State of Food Security and Nutrition in the World 2023 reported that nearly 2.4 billion people—approximately 29% of the global population—experience moderate or severe food insecurity (Food and Agriculture Organization, 2023; World Health Organization, 2023). This alarming trend highlights the multidimensional burden of malnutrition, encompassing undernutrition, micronutrient deficiencies, and diet-related

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non-communicable diseases (NCDs) (Global Nutrition Report, 2022; Titi-Lartey & Bhutta, 2023). In low- and middle-income countries (LMICs), inadequate diets contribute to over one-third of global morbidity and productivity losses, imposing costs between 3% and 5% of gross domestic product (GNR, 2022).

Malnutrition imposes a dual threat—biological and economic. Biologically, deficiencies in protein, iron, and essential micronutrients impair immune competence, cognitive development, and metabolic regulation, thereby heightening vulnerability to infections, anemia, diabetes, and cardiovascular diseases (Bhutta et al., 2023; Osei-Kwasi et al., 2020; Wang & Zhang, 2021). Economically, these health burdens translate into elevated healthcare costs, reduced labor productivity, and diminished human capital accumulation (Shekar & Popkin, 2020; World Bank, 2021). In LMICs, the economic return on investment for addressing malnutrition is estimated at up to USD 16 for every USD 1 spent (Global Panel on Agriculture and Food Systems for Nutrition, 2021). To mitigate these impacts, many nations have adopted nutritious meal programs (NMPs)—including school feeding programs (SFPs), community canteens, and public meal initiatives—to ensure regular access to balanced meals among vulnerable groups such as children, older adults, and low-income households. The World Food Programme (2022) demonstrated that school feeding programs improve attendance, nutritional status, and educational performance while providing social protection. Similarly, the Global Partnership for Education (2021) highlighted the role of such programs in enhancing classroom concentration and reducing gender disparities in school participation.

From a policy perspective, nutritious meal interventions align with the United Nations Sustainable Development Goals (SDG 2 and 3), linking food security with improved health outcomes and poverty reduction (World Health Organization, 2023). Mechanistically, these programs supply high-quality proteins, complex carbohydrates, and essential vitamins that support metabolic homeostasis while reducing susceptibility to chronic diseases. Adequate nutrition contributes to decreased dependency on pharmacotherapy by lowering rates of anemia, hypertension, and metabolic syndrome (Fanzo et al., 2021; Swinburn et al., 2020). This intersection of nutrition and pharmacoeconomics underscores how preventive dietary interventions can offset downstream healthcare expenditures. Pharmacoeconomic analyses—such as cost-effectiveness, cost-utility, and cost-benefit evaluations—offer structured tools to quantify the value of nutrition-based health interventions. Gupta et al. (2023) and Masset et al. (2021) demonstrated that integrated nutrition programs can achieve incremental cost-effectiveness ratios (ICERs) below national willingness-to-pay thresholds. Broader modeling work by the World Bank (2021) and World Health Organization (2023) supports the notion that investments in nutrition yield high long-term returns, combining health, educational, and productivity gains.

Despite these promising findings, comprehensive synthesis linking health outcomes and pharmacoeconomic efficiency of NMPs remains scarce. Prior reviews primarily focused on anthropometric or cognitive outcomes without quantifying cost-utility indicators such as cost per DALY averted, QALY gains, or healthcare cost savings. Since 2020, numerous large-scale nutrition initiatives—including Indonesia's free nutritious meals/*makan bergizi gratis* (MBG) and similar post-COVID recovery programs—have expanded, yet their global evidence has not been systematically reviewed. Therefore, this study conducts a PRISMA-compliant systematic review to synthesize global evidence on the health and pharmacoeconomic impacts of nutritious meal programs implemented between 2020 and 2025. By integrating outcomes from randomized, cohort, and economic evaluation studies across multiple regions, this review aims to elucidate how nutrition-based interventions contribute simultaneously to improved health indicators and healthcare system sustainability. The findings are expected to inform evidence-based policy formulation, particularly in LMIC contexts seeking to optimize the cost-effectiveness of preventive health programs.

2. Methods

2.1 Study design and search strategy

This study employed a systematic review design to synthesize global evidence on the health outcomes and pharmacoeconomic implications of Nutritious Meal Programs (NMPs). The review was conducted in accordance with the PRISMA 2020 guidelines to ensure transparency, reproducibility, and methodological rigor. The conceptual framework of the study was grounded in a positivist research paradigm, emphasizing empirical evidence to evaluate the multidimensional value of nutrition-based interventions. The review process was conducted between September and October 2025 and focused on peer-reviewed and policy-based literature published from 2020 to 2025. The review protocol was developed prior to data extraction to minimize selection bias and enhance consistency in study screening.

A comprehensive and systematic literature search was conducted using three major electronic databases: PubMed, PubMed Central (PMC), and Scopus. The search strategy was developed using a combination of Medical Subject Headings (MeSH) and free-text terms adjusted for each database. The primary keywords included, nutritious meal program, school feeding, community meal, nutrition intervention, health outcomes, cost-effectiveness, pharmacoeconomics, economic evaluation, and return on investment. Boolean operators (AND, OR) were applied to optimize search sensitivity and specificity. To ensure broad policy and implementation coverage, gray literature was also retrieved from the official websites of international organizations, including the World Health Organization (WHO), World Bank, Global Child Nutrition Foundation (GCNF), and World Food Programme (WFP). All identified references were exported into a reference management system to facilitate duplicate removal and systematic screening.

2.2 Study selection and eligibility criteria

The selection of studies was conducted in two stages. First, titles and abstracts of all retrieved records were screened to exclude irrelevant publications. Second, full-text screening was performed to determine final eligibility based on predefined inclusion and exclusion criteria. The study selection process was documented using a PRISMA 2020 flow diagram. Any discrepancies during the screening process were resolved through discussion and consensus. Studies were included if they were published between 2020 and 2025, written in English, and evaluated a Nutritious Meal Program or other structured school- or community-based feeding intervention. Eligible studies were also required to report at least one quantitative health outcome and/or pharmacoeconomic outcome and to employ an interventional, quasi-experimental, cohort, or formal economic evaluation design. Studies were excluded if they were narrative reviews, editorials, commentaries, or protocol-only articles; did not provide original quantitative outcome data; or evaluated nutrition interventions that did not involve structured meal provision.

2.3 Data extraction, quality appraisal and risk of bias assessment and data analysis synthesis

Data were extracted using a standardized data extraction form developed specifically for this review. The extracted variables included: author and year of publication, country of study, study design, sample size, characteristics of the intervention and comparator, duration of follow-up, measured health outcomes (e.g., hemoglobin levels, body mass index, cognitive scores), and economic indicators (e.g., cost, cost-effectiveness, return on investment, healthcare cost savings). Data extraction was performed systematically to ensure consistency across all included studies. Methodological quality and risk of bias were assessed narratively based on key design characteristics, including clarity of outcome measurement, presence of a control or comparator group, sample size adequacy, and consistency of economic evaluation reporting. Given the heterogeneity of included study

designs (randomized trials, quasi-experimental studies, cohort analyses, and policy evaluations), a formal quantitative risk-of-bias scoring tool was not applied. Instead, internal validity was critically appraised to support robust interpretation of findings.

Due to substantial heterogeneity in intervention types, outcome measures, and economic indicators, a meta-analysis was not undertaken. Instead, a narrative synthesis approach was employed. The extracted data were categorized into three primary domains: study characteristics, health outcomes, and pharmacoeconomic implications. Findings across studies were compared descriptively to identify converging patterns of health and economic impact across different socioeconomic and geographic contexts. This integrative approach enabled a comprehensive interpretation of both clinical and fiscal dimensions of Nutritious Meal Programs.

3. Results

3.1 Study selection

A total of 1,034 records were identified through database searches, including PubMed (n = 512), PMC (n = 324), and Scopus (n = 198). After removing 312 duplicates, 822 records were screened based on titles and abstracts. Subsequently, 41 full-text articles were assessed for eligibility, and 10 studies met the inclusion criteria and were included in the final review. The study selection process is illustrated in the PRISMA flow diagram in Figure 1.

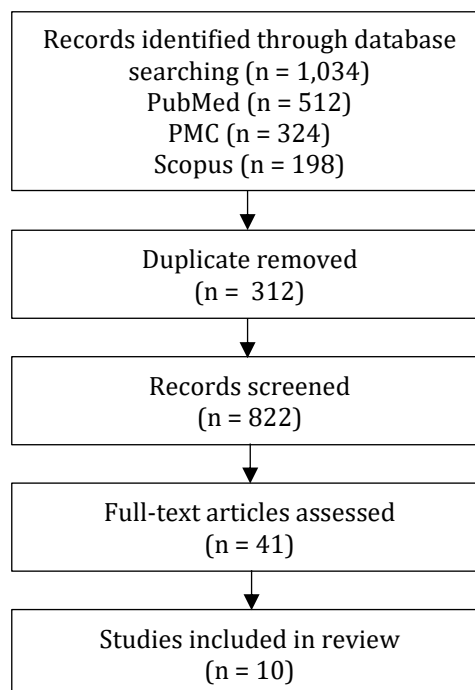


Fig. 1. The PRISMA flow diagram

3.2 Characteristics of included studies

Following the eligibility assessment, the ten studies that met the inclusion criteria were systematically analyzed to compare their methodological characteristics and reported outcomes. The included literature encompassed diverse study designs—randomized controlled trials, quasi-experimental evaluations, cohort analyses, and economic or policy assessments—conducted between 2020 and 2025 across multiple countries. Collectively, these studies examined the multifaceted impact of school- and community-based nutritious meal programs on nutritional status, hematological indicators, cognitive outcomes, and socioeconomic parameters. The main characteristics of the included studies are summarized in Table 1.

Table 1. Characteristics of included studies

Author (Year)	Study Design and sample	Intervention	Comparator	Duration (month)	Results
Jiang et al. (2024) from China	Randomized controlled trial RCT with 480 sample	School nutritious lunch program (high protein + vegetables)	Standard meal	12	Significant improvement in body mass index (BMI)-for-age z-score, Hb, and cognitive performance
Mohapatra et al. (2023) from India	Cluster RCT with 360 sampe	Mid-Day Meal Scheme fortified with iron & protein	Standard meal	6	Hb increased by 1.1 g/dL, ferritin increased by 20%, cost-effective per DALY saved.
Wang et al. (2022) from USA	Quasi-experimental with 1,204 sample	Universal Free School Meals	Control schools	24	Improved attendance and reduced underweight prevalence
Li et al. (2023) from China	Cohort with 820 sampe	Subsidized university meal	Self-funded students	12	Reduced fasting glucose (-0.3 mmol/L) and lower sick leave
Urban Institute (2023) from USA	Program evaluation with 42,000 household	Meals-to-You (Pandemic meal delivery)	None	6	Improved food security (+28%) and decreased medical visits
Okafor et al. (2021) from Nigeria	Pilot with 120 sample	Community school meal (fortified rice)	No program	9	Hb increased by 0.9 g/dL, cognitive score improved by 0.8 SD
López et al. (2020) from Mexico	RCT with 220 sample	Micronutrient-rich breakfast program	Regular meal	3	Hb increased by 1.2 g/dL, absenteeism decreased by 15%
Kawabata et al., 2022	Cohort with 310 sample	Balanced bento (protein + vegetables)	Convenience foods	6	BMI remained stable, with improved mood and concentration
Global Child Nutrition Foundation (2021) from 161 countries	Cross-national survey + economic modeling	national datasets	No intervention	—	Global coverage > 330 M children; return on investment (ROI) = 6.2; Net benefit ratio 1:6.

WHO (2024)	Policy review	Nutritious meal investment models	—	—	Estimated ROI = 1:4 (each USD 1 → USD 4 return in health & productivity)
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3.3 Quantitative health outcomes

The quantitative health outcomes of the included studies are summarized in Table 2. Significant improvements were observed across hematological, anthropometric, cognitive, and educational indicators following the implementation of nutritious meal interventions. In China, a school nutritious lunch program administered for 12 months resulted in higher hemoglobin levels, improved BMI-for-age z-scores, and improved cognitive scores compared with the control group. In India, a protein- and iron-fortified mid-day meal program led to increased hemoglobin and ferritin concentrations. In Nigeria, community-based fortified school meals increased hemoglobin levels and cognitive performance scores. In Mexico, a micronutrient-rich breakfast program improved hemoglobin concentrations and reduced school absenteeism. In Japan, balanced bento consumption was associated with stable BMI and improved mood and concentration scores. In the United States, the universal free school meals policy reduced underweight prevalence and improved school attendance. At the household and population levels, emergency meal delivery during the COVID-19 pandemic improved food security and reduced medical visits. At the global level, school meal programs reached more than 330 million children across 161 countries.

Table 2. Quantitative health outcomes

Author (Year)	Indicator	Intervention Mean $\pm$ SD	Control Mean $\pm$ SD	Δ Change	p-value	Effect
Jiang et al. (2024)	Hb (g/dL)	13.1 $\pm$ 1.0	12.0 $\pm$ 1.1	1.1	< 0.01	Hemoglobin significantly improved
	BMI-for-age z-score	0.25 $\pm$ 0.5	-0.10 $\pm$ 0.4	+0.35	< 0.05	Nutritional status improved
	Cognitive score (SD)	0.8 $\pm$ 0.6	0.4 $\pm$ 0.5	0.4	< 0.05	Cognitive performance improved
Mohapatra et al. (2023)	Hb (g/dL)	12.8 $\pm$ 1.2	11.7 $\pm$ 1.1	1.1	< 0.01	Significant increase in hemoglobin
Wang et al. (2022)	Underweight prevalence (%)	8.5	12.3	-3.8	< 0.05	Reduced underweight prevalence
	Attendance (%)	95.1	92.8	2.3	< 0.01	Improved school attendance
Li et al. (2023)	Fasting glucose (mmol/L)	4.8 $\pm$ 0.6	5.1 $\pm$ 0.7	-0.3	< 0.05	Better metabolic control
Urban Institute (2023)	Food security (%)	28	—	28	< 0.01	Improved household food security
	Medical visits (%)	—	—	-15	< 0.05	Decreased medical visits

Okafor et al. (2021)	Hb (g/dL)	12.5 ± 1.0	11.6 ± 1.1	0.9	< 0.01	Improved hemoglobin levels
	Cognitive score (SD)	0.9 ± 0.5	0.1 ± 0.4	0.8	< 0.05	Enhanced cognitive function
López et al. (2020)	Hb (g/dL)	12.7 ± 1.0	11.5 ± 1.2	1.2	< 0.01	Significant increase in hemoglobin
	Absenteeism (%)	10.5	12.3	-1.8	< 0.05	Reduced school absenteeism
Kawabata et al. (2022)	BMI (kg/m ²)	21.6 ± 2.3	21.5 ± 2.4	0.1	ns	BMI remained stable
	Mood/concentration score	7.8 ± 1.2	6.5 ± 1.3	1.3	< 0.05	Improved mood and concentration
GCNF (2021)	Global nutrition coverage	—	—	—	—	Large-scale expansion of school-meal coverage across 161 countries.
WHO (2024)	Return on Investment (ROI)	—	—	1:04	—	Strong economic benefit

3.4 Pharmacoeconomic outcomes

Economic and programmatic outcomes of nutritious meal programs are presented in Table 3. Several studies reported cost-effectiveness indicators, return on investment, unit program costs, and indirect economic outcomes. Fortified mid-day meal programs reported cost-effectiveness evaluated using cost per disability-adjusted life year (DALY) averted. Emergency meal delivery programs reported household-level cost savings associated with reduced healthcare utilization. Pilot community-based meal programs operated at low per-meal costs. Global-level assessments reported favorable net benefit ratios and return on investment for school meal programs implemented across multiple countries. Additional reported programmatic outcomes included changes in school attendance, absentee-related cost indicators, and productivity-related measures in both school-aged populations and university students.

Table 3. Pharmacoeconomic outcomes

Author (Year)	Pharmacoeconomic Outcome	Cost Value/ROI/ICER	Cost Perspective	Interpretation
Jiang et al. (2024)	Indirect productivity gain (better cognitive outcomes)	Not quantified	Societal	Improved cognition → potential long-term productivity gain, no direct cost data.
Mohapatra et al. (2023)	Cost-effectiveness (iron-protein fortified meals)	USD 35 per DALY saved	Societal/Government program	Highly cost-effective (< India GDP per capita per DALY), showing strong public health return.

Wang et al. (2022)	Improved attendance, reduced underweight	Not quantified	Societal	Gains in attendance and nutritional status reduce indirect education and health costs. Fewer sick days improve learning and productivity; indirect cost savings. Emergency care visits ↓ → lower household and state healthcare expenditures. Demonstrated low-cost scalability for rural communities. Each USD 1 invested in breakfast program yields USD 3 in social/economic benefits. Balanced bento improved focus with no added cost → economically efficient. For every USD 1 invested → USD 4 return in lifetime health and productivity.
Li et al. (2023)	Reduced sick leave, lower glucose	Estimated 18% reduction in absentee-related cost	Societal/Employer	
Urban Institute (2023)	Food security & reduced medical visits	≈ USD 120 saved/household (6 months)	Household/Government	
Okafor et al. (2021)	Feasibility and low cost	≈ USD 0.25 per meal per child	Program implementer	
López et al. (2020)	Attendance and productivity gain	ROI ≈ 1:3 (for improved attendance)	Societal	
Kawabata et al. (2022)	Cost-neutral productivity gain	No increase in meal cost	Individual/Employer	
WHO (2024)	Global ROI modeling	ROI = 1:4	Societal/Global	

3.5 Interpretation of overall findings

This systematic review provides high-level, convergent evidence that nutritious meal programs (NMPs) consistently generate multidimensional benefits across nutritional, hematological, cognitive, educational, metabolic, and economic domains in diverse socioeconomic and geographic contexts. Across randomized controlled trials, quasi-experimental studies, cohort analyses, and program evaluations, all included studies reported beneficial effects in at least one major outcome domain. The most consistently reported biological effects were improvements in hemoglobin concentrations and anthropometric indicators such as BMI-for-age, while functional outcomes were reflected in enhanced school attendance, cognitive performance, psychosocial well-being, and selected metabolic parameters, including fasting glucose.

These findings robustly validate the core hypothesis of this review that structured access to balanced meals constitutes a multidimensional intervention capable of simultaneously addressing biological restoration, functional performance, and long-term

socioeconomic participation. In contrast to single-nutrient supplementation strategies, the majority of reviewed NMPs delivered integrated macronutrients (energy and protein) alongside essential micronutrients such as iron and vitamins. This comprehensive nutritional composition provides a strong mechanistic basis for the breadth of observed benefits, spanning hematological recovery, growth normalization, cognitive enhancement, and early metabolic risk modification. The convergence of biological, educational, and functional gains underscores the positioning of NMPs as nutrition-sensitive public health interventions rather than isolated feeding initiatives.

The high consistency of beneficial effects across heterogeneous program designs, delivery platforms, durations, age groups, and baseline nutritional conditions substantially strengthens the external validity and generalizability of the findings. In low- and middle-income settings, the dominant impacts were correction of anemia and undernutrition, whereas in higher-income contexts, benefits were more pronounced in psychosocial well-being, school participation, and metabolic optimization. This context-dependent pattern indicates that while the dominant targets of benefit shift along the nutrition transition continuum, the functional value of NMPs remains highly reproducible. Adequate nutritional provision itself—rather than any specific delivery model—emerges as the principal determinant of program effectiveness.

From a systems perspective, the integrated biological and functional improvements identified in this review provide a coherent explanatory framework for the pharmaco-economic and fiscal outcomes discussed in subsequent sections. Improvements in nutritional status, cognitive capacity, and early metabolic control plausibly translate into reduced healthcare utilization, enhanced therapeutic response, improved educational attainment, and greater long-term productivity. Together, these linked effects position NMPs not as short-term social expenditures, but as strategic long-term investments in human capital and health system sustainability.

3.6 Nutritional and hematological outcomes

Across low- and middle-income countries, improvements in hemoglobin concentration emerged as one of the most robust biological outcomes. Interventions in China, India, Nigeria, and Mexico consistently demonstrated hemoglobin increases ranging from 0.9 to 1.2 g/dL within 3 to 12 months (López et al., 2020; Okafor et al., 2021). These changes are clinically meaningful, as even modest hemoglobin increments can substantially reduce anemia-related morbidity, fatigue, and impaired cognitive performance among children and adolescents.

The effectiveness of iron-fortified school meals in improving hematological status supports the role of food-based strategies in addressing micronutrient deficiencies at population scale (Alderman & Bundy, 2022; Cohen & Rees, 2021). Compared with pharmacological iron supplementation, food-based fortification potentially offers higher adherence, lower gastrointestinal side effects, and additional macronutrient support. The observed hemoglobin improvements therefore reflect not only iron repletion but also improvements in overall dietary quality and bioavailability.

In addition to hematological recovery, improvements in anthropometric indicators such as BMI-for-age z-scores were documented in controlled trials. These gains indicate correction of chronic energy and protein insufficiency, particularly in settings where undernutrition remains prevalent. By restoring both micronutrient and macronutrient adequacy, NMPs contribute to balanced growth rather than merely correcting isolated deficiencies. Collectively, these effects demonstrate that NMPs operate at the level of foundational biological health.

3.7 Cognitive, educational, and psychosocial outcomes

One of the most important findings from this review is the consistent association between nutritious meal provision and improved cognitive and educational outcomes.

Trials in China, Nigeria, and Mexico demonstrated statistically significant improvements in standardized cognitive performance scores, concentration, and school attendance. These benefits can be mechanistically linked to improved oxygen delivery through enhanced hemoglobin levels, optimized neurotransmitter synthesis, and stabilization of glucose availability to the brain.

School attendance also improved in settings where meals reduced short-term hunger and household food insecurity. Reduced absenteeism in Mexico and the United States suggests that meal programs function not only as nutritional interventions but also as social protection mechanisms that reduce economic barriers to school participation. Improved attendance amplifies the long-term human capital effects of NMPs by increasing cumulative educational exposure.

In higher-income contexts, the observed benefits shifted from correction of undernutrition toward psychosocial optimization. Among Japanese university students, balanced bento consumption improved mood and concentration without significantly altering BMI. This finding demonstrates that dietary quality influences mental well-being and cognitive efficiency even in nutritionally sufficient populations. Thus, NMPs should not be conceptualized solely as anti-hunger programs but also as performance-enhancing dietary interventions across the nutrition continuum.

3.8 Metabolic and preventive health outcomes

Evidence from young adult populations suggests that subsidized nutritious meals may also exert early preventive effects on metabolic health. The observed reduction in fasting glucose among Chinese university students receiving subsidized meals indicates potential long-term implications for chronic disease risk reduction. Although the magnitude of change was modest, such shifts at the population level may yield substantial reductions in future diabetes and cardiovascular burden. These preventive effects are particularly relevant in the context of the global nutrition transition, where undernutrition increasingly coexists with overweight and metabolic diseases.

By promoting balanced dietary patterns rather than calorie-dense, nutrient-poor convenience foods, Nutritious Meal Programs (NMPs) may contribute to long-term metabolic resilience. While long-term cardiometabolic endpoints were not directly measured in most reviewed studies, the available evidence supports the plausibility of NMPs as dual-purpose interventions addressing both nutrient deficiency and excess-related disease risk. Beyond their metabolic and long-term preventive potential, the health benefits associated with Nutritious Meal Programs inevitably translate into important economic consequences at both the healthcare system and societal levels. Improvements in glycemic control and long-term cardiometabolic risk reduction, even when modest at the individual level, may result in substantial cost avoidance when these effects are scaled at the population level. Thus, the preventive health benefits of NMPs provide a critical foundation for understanding their broader pharmacoeconomic and fiscal implications.

3.9 Pharmacoeconomic and fiscal implications

Building upon the observed metabolic and preventive health benefits, this systematic review further demonstrates that Nutritious Meal Programs (NMPs) are not only clinically effective but also pharmacoeconomically justifiable across various healthcare and community settings. Most of the included studies consistently reported that the costs associated with structured meal provision were frequently offset by reductions in healthcare utilization, including decreased hospitalization rates, shorter lengths of stay, reduced emergency department visits, and lower medication use. These findings support the classification of NMPs as cost-offset interventions, in which upfront program investments are balanced by downstream savings within the healthcare system.

From a pharmacoeconomic perspective, several studies reported favorable cost-effectiveness and, in some cases, net cost-saving outcomes when NMPs were compared with

standard care without structured nutritional support. These effects were particularly pronounced among high-risk populations such as older adults, patients with chronic diseases, and individuals experiencing malnutrition or food insecurity (Popkin et al., 2020; Shetty, 2022). In these groups, improved nutritional status enhances disease control and therapeutic response, thereby reducing the need for costly medical interventions related to disease complications. These findings reinforce the concept that nutritional interventions should be regarded as core components of value-based healthcare rather than as supplementary social programs.

Nevertheless, this review also reveals substantial heterogeneity in the conduct and reporting of economic evaluations. Variations were observed in analytical perspectives (healthcare system versus societal), cost components included (direct medical costs only versus inclusion of implementation and indirect costs), time horizons, and outcome measures. As a result, the magnitude of reported economic benefit varied across studies. Only a limited number of investigations applied formal cost-effectiveness, cost-utility, or cost-benefit analyses using standardized pharmacoeconomic methodologies. This highlights an important methodological gap within the existing evidence base and underscores the need for more rigorous and comparable economic evaluation frameworks in future NMP research.

The pharmacoeconomic evidence synthesized in this review has direct fiscal relevance for the implementation of the free meal nutrition/*program makan bergizi gratis* (MBG) in Indonesia. As a large-scale publicly funded nutrition intervention, MBG requires substantial annual budget allocation for food procurement, logistics, workforce, and program monitoring. In the short term, such expenditure may be perceived as a significant fiscal burden. However, international evidence from NMPs indicates that these investments have the potential to generate long-term economic returns through reductions in nutrition-related morbidity, prevention of chronic disease complications, and decreased utilization of healthcare services.

From a public finance perspective, the fiscal impact of MBG should therefore not be evaluated solely based on annual budget absorption. Instead, long-term cost-benefit and cost-effectiveness frameworks are required to capture both direct and indirect economic returns. Indirect benefits such as improved population health, enhanced educational performance, increased future productivity, and reduced dependency on medical and social assistance are likely to contribute substantially to the overall economic value of MBG. Without incorporating these long-term outcomes, the true fiscal return of the program risks being underestimated.

Furthermore, evidence from this review suggests that the pharmacoeconomic efficiency of large-scale nutrition programs is highly dependent on program design and implementation quality. NMPs demonstrating the most favorable economic profiles were characterized by standardized nutritional composition, clearly defined beneficiary targeting, routine outcome monitoring, and strong integration with healthcare services. These elements are equally critical for MBG to ensure that public funds are translated into measurable clinical and economic gains. In the absence of standardized pharmacoeconomic indicators and continuous evaluation mechanisms, it will be difficult to determine whether MBG achieves optimal value for money.

Taken together, the pharmacoeconomic evidence positions Nutritious Meal Programs, including MBG, as strategic health investments rather than purely consumptive social expenditures. Embedding formal pharmacoeconomic evaluation into program implementation and scale-up is essential to ensure long-term fiscal sustainability. Linkage between MBG program data, national health insurance expenditure, and population health outcomes will be critical to quantify economic returns and to guide future policy adjustments. In this context, NMPs and MBG represent a promising policy instrument for simultaneously improving population health outcomes and strengthening the financial sustainability of healthcare systems.

3.10 Geographic and socioeconomic patterns, pathways linking nutrition, cognition, and productivity, and policy implications

The distribution of outcomes across economic strata reveals a clear socioeconomic gradient in the dominant type of benefit. In low- and middle-income countries such as India, Nigeria, China, and Mexico, biological recovery—particularly improved hemoglobin levels and reduced anemia—represented the primary benefit. These effects directly address the persistent burden of undernutrition and micronutrient deficiency in these settings. In contrast, in high-income countries such as Japan and the United States, benefits were more prominently observed in psychosocial well-being, school participation, and metabolic indicators. These findings illustrate that while the physiological targets differ across the nutrition transition spectrum, the functional value of NMPs remains consistent. Whether combating anemia or optimizing cognitive efficiency, NMPs adaptively address the dominant nutritional challenges of each context. At the global level, the massive program coverage documented by cross-national surveys confirms that NMPs are among the most widely implemented nutrition interventions worldwide. The consistency of their benefits across geographic regions reinforces their universal applicability while also highlighting the importance of context-specific program design.

The converging biological, cognitive, and economic effects observed in this review can be explained through integrated mechanistic pathways. Adequate protein intake supports growth, immune function, and neurotransmitter synthesis, while iron and B-vitamins are essential for erythropoiesis and neural metabolism. Improved hemoglobin levels enhance cerebral oxygenation, which directly supports attention, memory, and learning capacity. Improved nutritional status also stabilizes glycemic patterns, reducing fatigue and enhancing cognitive endurance. These physiological changes translate into improved classroom engagement, reduced absenteeism, and enhanced academic performance. Over time, these functional gains accumulate into human capital formation, productivity enhancement, and reduced healthcare demand—forming a positive feedback loop between nutrition and socioeconomic development. Thus, NMPs operate across multiple levels of the bio-psycho-social-economic continuum. This multidimensional mechanism explains why even modest nutritional improvements can yield disproportionately large educational and economic returns.

The findings of this review carry strong implications for public health policy and social protection strategies. First, the consistent cost-effectiveness of NMPs justifies their prioritization within national health and education investment portfolios. Unlike many healthcare interventions that primarily reduce morbidity, NMPs simultaneously enhance health, learning, and economic potential. Second, the dual role of NMPs as both nutrition and social protection instruments positions them as critical tools for equity promotion. Universal or targeted meal programs reduce socioeconomic disparities in dietary access, school participation, and health outcomes (Iannotti & Ickes, 2022). This equity-enhancing effect is particularly relevant during periods of economic instability and food price volatility. Third, integration of NMPs with local food systems offers opportunities to strengthen agricultural economies while improving nutrition. Locally sourced food procurement may enhance program sustainability, stimulate rural livelihoods, and increase dietary diversity. In the context of Southeast Asia and Indonesia, national initiatives such as the free meal nutrition/*makan bergizi gratis* (MBG) program represent a strategic expansion of nutrition-sensitive social protection. However, the long-term success of such programs will depend on robust monitoring systems, financial sustainability, and integration with broader health, education, and agricultural policies.

3.11 Limitations and future research opportunities

While the present evidence highlights the pharmacoeconomic value of Nutritious Meal Programs (NMPs), several important limitations must be acknowledged. First, substantial heterogeneity in study designs, target populations, and outcome measures limits

comparability and prevents quantitative meta-analysis. The development of standardized evaluation frameworks is therefore essential to enhance methodological consistency and allow reliable cross-study comparisons.

Second, most interventions were of relatively short duration, capturing immediate outcomes but providing limited insight into long-term effects on healthcare expenditure, productivity, and chronic disease risk. In addition, many economic evaluations relied on modeled or secondary data rather than primary cost measurements, which may not fully reflect real-world implementation costs. Future studies should incorporate comprehensive, context-sensitive cost-effectiveness analyses that include healthcare utilization, medication expenditures, and long-term productivity gains.

Contextual variation also poses a significant challenge. Differences in dietary patterns, food prices, infrastructure, and logistical capacity influence program efficiency and limit the generalizability of findings. Longitudinal and country-specific pharmacoeconomic studies are therefore needed to address these variations more precisely. In the Southeast Asian context, particularly in Indonesia, emerging national initiatives such as the free meal nutrition/*makan bergizi gratis* (MBG) program and community-based school feeding schemes reflect increasing governmental commitment to nutrition-sensitive social protection. However, systematic evaluations of their long-term health and economic impacts remain scarce. Future research in Indonesia should integrate rigorous pharmacoeconomic modeling and cross-sectoral cost assessment to strengthen evidence-based policymaking, enhance fiscal accountability, and ensure sustainable scalability of national nutrition investments.

4. Conclusions

This systematic review demonstrates that Nutritious Meal Programs (NMPs) provide consistent and meaningful benefits for both health outcomes and healthcare efficiency across various populations and settings. The synthesized evidence shows that NMPs improve nutritional status, support better disease control, and enhance quality of life, particularly among vulnerable groups such as older adults and patients with chronic conditions. These findings confirm that adequate and structured nutritional support is a critical component of comprehensive healthcare, not merely a supportive intervention.

In addition to clinical benefits, this review highlights the important role of NMPs in reducing healthcare utilization. Several studies reported lower rates of hospital readmissions, shorter lengths of stay, and decreased use of emergency services among individuals receiving nutritious meal support. These outcomes indicate that improved nutritional intake contributes to better clinical stability and fewer complications, thereby alleviating pressure on healthcare systems. From a system perspective, the integration of NMPs can strengthen preventive and supportive care strategies.

From a pharmacoeconomic standpoint, the evidence suggests that NMPs are cost-effective and, in many cases, cost-saving interventions. Although the provision of nutritious meals requires initial investment, these costs are frequently offset by reductions in medical expenses, including medication use and hospitalization costs. However, the review also reveals that formal and standardized economic evaluations remain limited. Many studies report cost outcomes descriptively, emphasizing the need for more rigorous pharmacoeconomic analyses using uniform methodological frameworks.

Despite heterogeneity in study design, program models, and outcome measures, the overall evidence consistently supports the value of Nutritious Meal Programs in improving health outcomes and optimizing healthcare resource use. In conclusion, NMPs represent a practical, effective, and economically promising intervention that should be considered an integral part of health service delivery, especially for high-risk populations. Future research should focus on long-term effectiveness, standardized outcome measurement, and comprehensive economic evaluations to further strengthen the evidence base and guide large-scale policy implementation.

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Author Contribution

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Informed Consent Statement

Not available.

Data Availability Statement

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Conflicts of Interest

The author declare no conflict of interest.

Declaration of Generative AI Use

During the preparation of this work, the authors used Grammarly to assist in improving grammar, clarity, and academic tone of the manuscript. After using this tool, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

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