POLICY ANALYSIS IN SCHOOL MEALS PROGRAM: REGULATION IMPACTS ON IN-SCHOOL FOOD FORTIFICATION

Ni Putu Wulan Purnama Sari[1], Adrino Mazenda[2*], Chenaimoyo Lufutuko Faith Katiyatiya[2], Minh-Hoang Nguyen[3], Quan-Hoang Vuong[3,4]

[1] Faculty of Nursing, Widya Mandala Surabaya Catholic University, East Java, Indonesia

[2] Faculty of Economic and Management Sciences, School of Public Management and Administration, University of Pretoria, Hatfield, South Africa

[3] Centre for Interdisciplinary Social Research, Phenikaa University, Hanoi, Vietnam

[4] Adjunct Professor, University College, Korea University, Seoul, South Korea

[*]Corresponding author: adrino.mazenda@up.ac.za (Adrino Mazenda)

September 3rd, 2024

(Original working draft V1, Un-peer-reviewed)

Abstract

Background: Food fortification refers to the process of adding nutrients to foods during their production. It is a cost-effective strategy with well-documented health, economic, and social benefits. Food fortification practices in school meal programs need guidance and legal support from various national policies.

Aim: This study aims to analyze how various national policies—such as those related to school feeding, nutrition, health, food safety, agriculture, and the private sector—associate with the implementation of in-school food fortification among countries with school meals programs.

Methods: The Bayesian Mindsponge Framework, combining the reasoning strengths of Mindsponge Theory and inference advantages of Bayesian analysis, was employed on a dataset of 126 government representatives who manage large-scale school meal programs in 126 different countries.

Results: Findings showed that food safety policy and agriculture policy were positively and significantly associated with the in-school food fortification practices, while school feeding policy and private sector policy had ambiguous relationships with these practices. Nutrition policy and health policy had a significant negative association with food fortification practices among countries implementing school meal programs.

Conclusions: Findings underscore the strong position of food safety policy and agriculture policy in guiding food fortification practices in school meal programs. There is a need to re-assess the implemented nutrition policy and health policy due to their significant negative associations with these practices. Enhancing and strengthening the school feeding policy and private sector policy may increase their potencies in giving positive impacts on in-school food fortification practices.

Keywords: school meals program; school feeding; policy analysis; food fortification; Bayesian Mindsponge Framework.

“Kingfisher’s 3-day hunger caused him to lose control and

swallow the Taboo Fish in no time.”

—In “Taboo Fish”; *The Kingfisher Story Collection* (Vuong, 2022).

1. Introduction

Global populations have been on the increase, outpacing agricultural production, increasing the demand for food, and altering consumption habits, thereby ameliorating food insecurity (Magqupu et al., 2024; Kemboi et al., 2024). Early nutrition is essential for optimum health and growth, and this may be compromised by dietary deficiencies (Pike et al., 2021). Deficiency of adequate nutrition, improper combination of foods, or inefficient utilization of nutrients may result in malnourishment (Maniragaba et al., 2023). This may cause stunted growth, underweight, or body wasting in children (Maniragaba et al., 2023). According to WHO (2024) about 149 million children under 5 suffer from stunting, 45 million from wasting, and 11 % of school-going are estimated to be too thin for their age. This has propelled global efforts toward reducing the malnutrition burden and long-term effects of nutrient deficiency (Pike et al., 2021). Most countries have developed policies, strategies, and guidelines to govern public health interventions to improve the nutritional status of children (Chrissini & Panagiotakos, 2022; Pike et al., 2021).

Affordable strategies such as food fortification can be used to help avoid micronutrient deficiencies without demanding drastic adjustments to nutritional habits or personal choices (Olson et al., 2021). Food fortification can be defined as the technique of adding micronutrients to food after harvest in order to enhance its nutritional quality and offer a low-risk health benefit to the general public (FAO, IFAD, UNICEF, WFP, 2022). Food fortification is a significant approach used to address micronutrient deficiencies, especially in low- and middle-income countries (Olson et al., 2021; Rowe, 2020). These methods are very beneficial to the economy, society, and health, especially when it comes to lowering infant mortality and nutritional deficiencies (Olson et al., 2021). Public-private sector collaborations are the most effective means of implementing large-scale food fortification while providing nutritious foods (Olson et al., 2021; J. Wang et al., 2022).

Despite being inexpensive, fortification's effectiveness is dependent on a number of variables, including widespread deficiency and centralized processing (Bechoff et al., 2023). A long-term and widely applicable sustainable strategy is provided by biofortification, which increases the nutrient content of staple crops by breeding or genetic engineering (Rai et al., 2024; Shahzad et al., 2021).

Amongst the vulnerable groups, children are more susceptible to malnutrition and nutrient deficiencies (Wang & Stewart, 2013). As a key policy response to enhance children's nutrition and health, school lunch programs have emerged as a critical strategy (Amoadu et al., 2024). School lunch programs improve the health of children and enhance their academic performance globally (Cohen et al., 2021; Wall et al., 2022). The Global Child Nutrition Foundation (2022) reported that about 330 million children received meals from the school feeding program comprising inhabitants from the Middle East and North Africa (8%), Sub-Saharan Africa (16%), South Asia, East Asia and Pacific (26%), and Europe, Central Asia, North America (47%).

Research suggests that these initiatives can have a favorable effect on nutritional awareness, dietary practices, and the consumption of healthful foods (Colley et al., 2019). According to Alves Da Silva et al. (2023) these initiatives can address food insecurity, health disparities, and other broader social determinants of health. However, improving school nutrition and managing micronutrient deficiencies is mostly dependent on national policies. In order to address nutritional inadequacies, government-mandated food fortification and supplementation are crucial tactics (Olson et al., 2021; Rowe, 2020). Nonetheless, implementation remains a challenge. A study conducted in Argentina discovered that school lunches' nutritional value declined with time, especially in socially deprived areas, pointing to the necessity for better policies (Moyano et al., 2020). Zhong et al. (2023) reported as Canada formulates its national school food policy, international experiences drive towards the importance of prioritizing health before profit, guaranteeing accessibility for all to avoid stigma, and encouraging cross-cultural understanding. Effective school lunch programs can improve social skills, lower poverty, and increase educational attainment, among other benefits beyond nourishment (Alves Da Silva et al., 2023).

Policies that guarantee free school meals for all learners can reduce health disparities, enhance academic performance, and encourage social inclusion (Alves Da Silva et al., 2023). Health should take precedence over corporatization, universal access should be provided to avoid stigma, and legislators should encourage cultural inclusivity to optimize health benefits (Zhong et al., 2023). It is, therefore, advisable to provide free school meals to all children, enhance financing for better-quality meals, and uphold nutritional standards instead of lowering them (Ritchie, 2020; Zhong et al., 2023). Policymakers should consider these varied benefits associated with school food programs to foster their effectiveness and success in enhancing children's health and well-being.

Research has shown how biofortified crops can improve micronutrient status and health consequences (Rai et al., 2024). However, it is important to note that there are ongoing challenges pertaining to industry compliance, enforcement, and monitoring of fortification projects (Osendarp et al., 2018; Rowe, 2020). Current studies on food fortification and school meal programs highlight various opportunities and constraints. The success of large-scale food fortification projects in improving population nutrition is contingent upon the state of policy (Theriault et al., 2024).

In Brazil, school menus were deemed sufficient with potential for improvement in terms of decreasing the amount of highly processed foods and raising the number of fresh food options (Alves Da Silva et al., 2023; Azevedo et al., 2023; Rocha et al., 2023). In Indonesia, school meal programs were associated with better health and academic performance of school children; however, drawbacks such as financial constraints and operational difficulties existed (Rimbawan et al., 2023; Sekiyama et al., 2018). According to a study conducted in Canada, staff capacity and finance were major impediments to the implementation of feeding interventions, whereas community engagement was a crucial facilitator (Carducci et al., 2024). McIsaac et al. (2019) also highlighted that stakeholder participation, cost implications, and alignment with fundamental school priorities are some of the challenges that affect the implementation of school nutrition policies (SNPs). Furthermore, policy interpretation, student school nutrition programs, and taxation hamper their progress (Boatemaa et al., 2018). Policy gaps, contradictions, and a lack of cross-sector coordination cause these factors. Governments need to take a more comprehensive strategy, addressing systemic concerns and creating suitable coordinating structures in order to promote food and nutrition security (Boatemaa et al., 2018). To support schools' ability and desire to implement nutrition regulations successfully, dietitians and legislators should collaborate in policy formulations that affect school feeding programs (Mckenna, 2003).

These previous studies underscore the significance of policy review, stakeholder participation, and resource restrictions in school lunch programs. Therefore, this study aims to analyze the association between various national policies related to school feeding, nutrition, health, food safety, agriculture, and the private sector with the implementation of in-school food fortification among countries implementing school meal programs. Enhancing and strengthening these policies could improve food fortification practices in school feeding programs, thereby addressing the problem of hidden hunger among learners through school meal programs.

2. Method

2.1. Theoretical Foundation

The granular interaction thinking of mindsponge theory (MT) was used in the conceptualization of the study, the construction of the parsimonious model, and the explanation of the findings (Vuong & Nguyen, 2024a). At first, the mindsponge mechanism was developed to explain the dynamics of acculturation and global thinking of managers and organizations (Vuong & Napier, 2015). By incorporating evidence from life and neurosciences, the mindsponge mechanism was developed into MT later on

(Vuong, 2023). MT is a mind's information processing theory that considers the subjective cost-benefit judgment in information multi-filtering processes as the key point, determining information absorption and ejection processes (Vuong & Napier, 2015; Vuong, 2023; Mantello et al., 2023). Currently, MT has been updated into a granular interaction thinking theory with the granular interactions thinking mechanism as the key point (Vuong & Nguyen, 2024b). By incorporating the principles of quantum physics (Rovelli, 2018; Keppens, 2018; Rovelli, 2016) and Shannon's information theory (Shannon, 1948), the updated MT proposes an entropy-based notion of value to enhance and strengthen its ability to explain the complexity of human behaviour shaped by various mental products which influence the actual actions (Vuong & Nguyen, 2024b; Davies & Gregersen, 2014).

In MT, the mind is defined as an information collection-cum-processor. While this definition is typically applied to the mental processes of the human mind, it can also extend to a wide range of biological and social systems (Vuong, 2023). MT shows a high credibility to be used in studies of the mind in a collective level, at national level in particular (Duong et al., 2024; Vuong et al., 2022; Vuong et al., 2021). In this study, a nation is conceptualized as an information collection-cum-processor, or a collective mind. MT employs a granular worldview to elucidate the intricate interactions of information units within the mind, which are defined as the possible alternatives perceived by the mind. These information units, whether newly acquired or pre-existing, interact, cohabit, and connect within the mind to establish a mindset, a set of core values (i.e., information units that are deemed important for prolonging the existence of the system) (Vuong & Nguyen, 2024b).

In the current study, implementing in-school food fortification practices in school feeding programs can be deemed an outcome of the nation's information process. For these practices to emerge and persist within the mind (i.e., implemented within the nation's school feeding programs), there are several conditions need to be met. First, the information regarding in-school food fortification practices needs to be available and accessible to the nation. In other words, the nation needs to have access to the knowledge, manpower, and resources that enable the implementation of such practices. Second, the information needs to be justified as beneficial so it can pass through the multi-filtering system of mind (or the nation). The multi-filtering system is mainly based on the mindset to determine whether the information is beneficial, neutral, or costly to the whole system. If the information is deemed beneficial after interacting with the mindset, it will be given a higher probability of being stored and used within the mind (i.e., upheld and implemented within the nation). If it is deemed costly, the information will be discarded. If it is deemed neutral, the information is kept within the mind's buffer zone for later evaluation.

The current study focuses on examining the second condition. In other words, it attempts to examine the types of core values within the mindset that can be associated with the implementation of in-school food fortification practices in school feeding programs. In a nation, laws, policies, and standards play a pivotal role in guiding the national school meal programs to achieve their objectives, so they can be viewed as the mind's core values or constituents of the mindset. School meal programs have three basic objectives, including nutrition, education, and value transfer (Kretschmer, Spinler, and Van Wassenhove, 2014), which often require the involvement of national laws, policies, or standards related to school feeding, nutrition, health, food safety, agricultural issues, and private sectors. For example, in the United States, the Healthy, Hunger-Free Kids Act of 2010 significantly impacted the National School Lunch Program (NSLP), leading to notable improvements in the Healthy Eating Index-2010 scores (Kinderknecht et al., 2020).

Therefore, by examining the associations between the presence of these laws, policies, or standards and the implementation of in-school food fortification practices, the current study is expected to provide insights into the possible contributors or restraints of food fortification practices at the national level.

2.2. Model Construction

2.2.1. Dataset

This study utilized a dataset of 126 government representatives who managed large-scale school meal programs in 126 different countries. The dataset is about the results of a global survey on school meal programs in 2021, which can be accessed publicly at the Global Child Nutrition Foundation (GCNF) Global Survey of School Meal Programs database (GCNF, 2022). GCNF is a non-political and non-profit entity. GCNF global survey was partly funded by the United States Department of Agriculture (USDA). This survey asked about national or large-scale school feeding programs (or school meal or school nutrition programs), including programs that are managed or administered by the national, regional, or local government, as well as large-scale school-based feeding programs that are managed by a non-governmental entity but in coordination with the national government. It also includes programs that do not involve the government but reach a substantial proportion of students in the country.

A standardized questionnaire was used in data collection. This instrument was developed by GCNF. This survey included 11 sections. Four sections contain national-level questions, meaning that the respondents only need to complete these sections once for each country. The remaining seven sections contain program-level questions, meaning that the respondents completed these sections separately for each large-scale school feeding program in each country. Compared to the 2019 GCNF Global Survey of School Meal Programs, this 2021 global survey gathered updated information regarding 1) the scope of school feeding in each country in the most recently completed school year (2020-2021), 2) government financing of, and involvement in, school feeding, 3) nutrition-, education-, and gender-related aspects of school feeding, 4) agricultural and private sector engagement, 5) related health and sanitation topics, and 6) the impact of emergencies. Among all variables, there were only seven variables employed in the current study's statistical analysis to achieve the study objective (see Table 1).

No demographic data was released on the GCNF Global Survey of School Meal Programs database, making the general characteristics of respondents remain confidential. The data of focal point contact information included country's name, survey started date, respondent's name, institution/department/office, job title, email, telephone number, and other contact options; Ministry/Agency and other contact options; was collected for GCNF administrative purposes only and were not be made publicly available in its database.

2.2.2. Variable Selection and Rationale

In the current study, we extracted seven variables from the GCNF dataset to be employed in statistical analysis (see Table 1). To measure six types of national policies, we employed variables of *SchoolFeedingPolicy, NutritionPolicy, HealthPolicy, FoodSafetyPolicy, AgricuturePolicy,* and *PrivateSectorPolicy,* which reflect the presence of any national laws, policies, or standards related to school feeding practices in the country. To measure in-school food fortification practices, we employed the variable *FoodFortification,* which reflects the presence of any fortified food items served in the school meals program. Table 1 below explains the variables' description in detail.

Table 1. Variable Description

Variable's Name	Description	Data Type	Value
SchoolFeedingPolicy	The presence of any national school feeding laws, policies, or standards related to school meals program.	Binary	1 = Yes 0 = No
NutritionPolicy	The presence of any national nutrition laws, policies, or standards related to school meals program.		
HealthPolicy	The presence of any national health laws, policies, or standards related to school meals program.		
FoodSafetyPolicy	The presence of any national food safety laws, policies, or standards related to school meals program.		
AgriculturePolicy	The presence of any national agriculture laws, policies, or standards related to school meals program.		

PrivateSectorPolicy	The presence of any national private sector laws, policies, or standards related to school meals program.
FoodFortification	The presence of any fortified food items served in school feeding program.

2.2.3. Statistical Model

In this study, we positioned the types of national policies as predictors of in-school food fortification practices among countries implementing school meal programs. We formulated the analytical model (see Figure 1) based on the theoretical foundation of MT as presented below:

$$FoodFortification \sim normal(\mu, \sigma) \quad (1)$$

$$\mu_i = \beta_0 + \beta_1 * SchoolFeedingPolicy_i + \beta_2 * NutritionPolicy_i + \beta_3 * HealthPolicy_i + \beta_4 * FoodSafetyPolicy_i + \beta_5 * AgriculturePolicy_i + \beta_6 * PrivateSectorPolicy_i \quad (2)$$

$$\beta \sim normal(M, S) \quad (3)$$

The probability around μ is determined by the form of normal distribution, with the standard deviation σ. The presence of any fortified food items served in the school meal programs of country i is indicated by μ_i. $SchoolFeedingPolicy_i$, $NutritionPolicy_i$, $HealthPolicy_i$, $FoodSafetyPolicy_i$, $AgriculturePolicy_i$, and $PrivateSectorPolicy_i$ are the types of national policies of country i. The model has an intercept β_0 and six coefficients, β_1-β_6. The coefficients of the predictor variables are distributed as a normal distribution around the mean denoted M and with the standard deviation denoted S. The logical network of Model 1 is displayed in Figure 1 below.

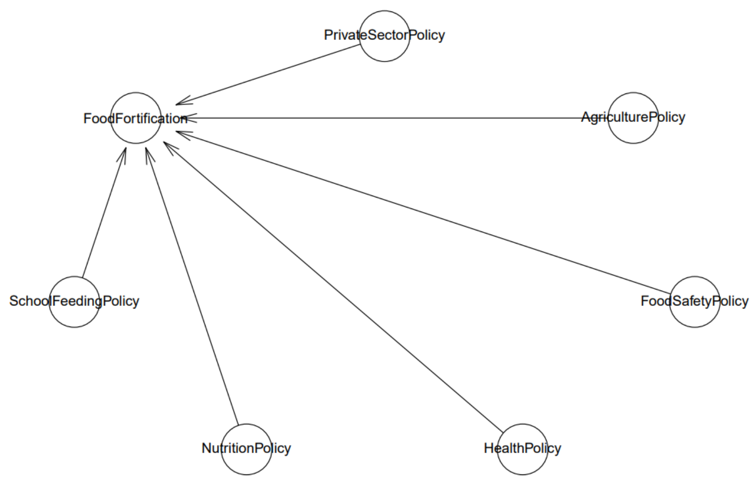

Figure 1. Model 1's logical network

2.2.4. Data Analysis and Validation

Bayesian Mindsponge Framework (BMF) analytics was employed in the current study for several reasons (Nguyen, La, & Le, 2022; Vuong, Nguyen, & La, 2022). First, the analytical method integrates the logical reasoning capabilities of MT with the inferential advantages of Bayesian analysis, exhibiting a high degree of compatibility (Nguyen et al., 2022). Second, Bayesian inference is a statistical approach that treats all the properties (including the known and unknown ones) probabilistically (Csilléry et al., 2010; Gill, 2015), enabling reliable prediction of parsimonious models. Nevertheless, utilizing the Markov chain Monte Carlo (MCMC) technique still allows Bayesian analysis to deal effectively with various intricate models, such as multilevel and nonlinear regression frameworks (Dunson, 2001). Third, Bayesian inference has various advantages over the frequentist approach. One notable advantage is the ability to utilize credible intervals for result interpretation instead of relying solely on the dichotomous decision based on *p*-values (Halsey et al., 2015; Wagenmakers et al., 2018). The Bayesian analysis was performed on R using the **bayesvl** open-access package, which provides good visualization capabilities (La & Vuong, 2019).

In Bayesian analysis, selecting the appropriate prior is required during the model construction process. Due to the exploratory nature of this study, uninformative priors or a flat prior distribution were used to provide as little prior information as possible for model estimation (Diaconis & Ylvisaker, 1985). The Pareto-smoothed importance sampling leave-one-out (PSIS-LOO) diagnostics were employed to check the models' goodness of fit (Vehtari & Gabry, 2019; Vehtari, Gelman, & Gabry, 2017). LOO is computed as follows:

$$LOO = -2LPPD_{loo} = -2\sum_{i=1}^{n}\log\int p(y_i|\theta)p_{post(-i)}(\theta)d\theta$$

$p_{post(-i)}(\theta)$ is the posterior distribution calculated through the data minus data point i. The k-Pareto values are used in the PSIS method to compute the LOO cross-validation in the R **loo** package. Observations with k-Pareto values greater than 0.7 are often considered influential and problematic for accurately estimating LOO cross-validation. When a model's k values are less than 0.5, it is typically regarded as being fit.

If the model fits well with the data, we will proceed with the convergence diagnoses and results interpretation. In the current study, we validated the convergence of Markov chains using statistical values and visual illustrations. Statistically, the effective sample size (*n_eff*) and the Gelman–Rubin shrink factor (*Rhat*) can be used to assess the convergence. The *n_eff* value represents the number of iterative samples that are not auto-correlated during stochastic simulation, while the *Rhat* value is referred to as the potential scale reduction factor (Brooks & Gelman, 1998). If *n_eff* is larger than 1000, it is generally considered that the Markov chains are convergent, and the effective samples are sufficient for reliable inference (McElreath, 2018). As for the *Rhat* value, if the value exceeds 1.1, the model does not converge. The model is considered convergent if *Rhat* =

1. Visually, the Markov chains' convergence was also validated using trace plots, Gelman–Rubin–Brooks plots, and autocorrelation plots.

Data and code snippets of this statistical analysis were deposited at https://zenodo.org/uploads/12742823 for transparency and public evaluation.

3. Results

Before interpreting the results of BMF analytics, it is necessary to evaluate how well Model 1 fits the data. As can be seen in Figure 2, we found no value exceeding the 0.5 threshold; the recommended value is below the 0.7 threshold. This indicates a good fit signal between the model and the data.

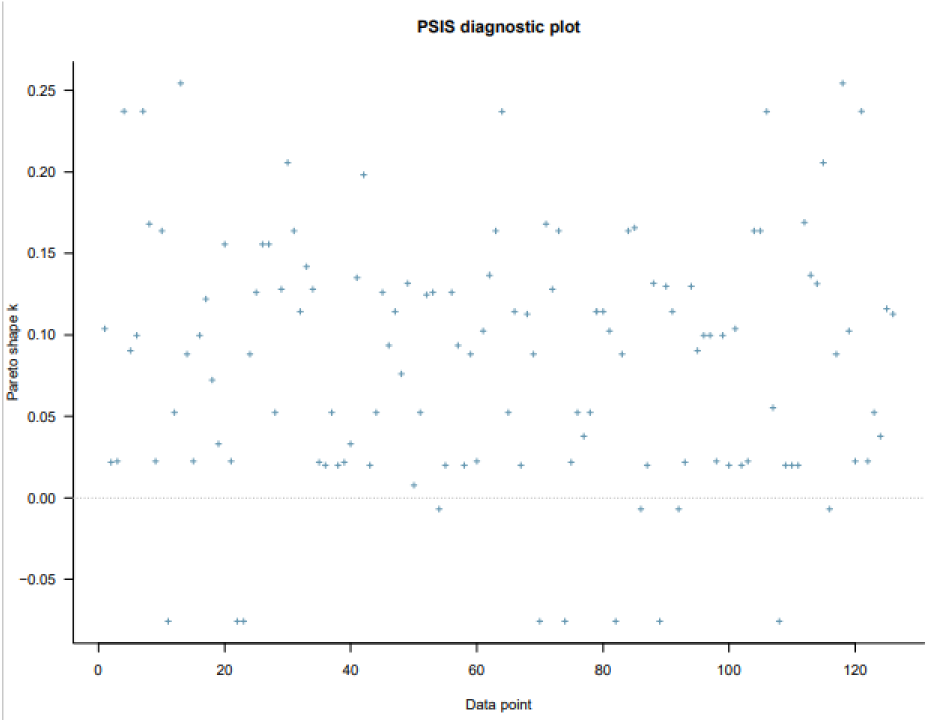

Figure 2. Model 1's PSIS-LOO diagnosis

The posterior distribution statistics of Model 1 are shown in Table 2. All *n_eff* values are greater than 1000, and *Rhat* values are equal to 1, so it can be assumed that Model 1's Markov chains are well-convergent. Table 2 below explains about posterior distribution statistics of Model 1, as illustrated in Figure 1.

Table 2. Estimated results of Model 1

Parameters	Mean	SD	n_eff	Rhat
a_FoodFortification	0.63	0.11	7559	1
b_SchoolFeedingPolicy_FoodFortification	-0.07	0.12	8800	1

b_NutritionPolicy_FoodFortification	-0.24	0.12	9124	1
b_HealthPolicy_FoodFortification	-0.13	0.11	10641	1
b_FoodSafetyPolicy_FoodFortification	0.23	0.11	11238	1
b_AgriculturePolicy_FoodFortification	0.22	0.11	12468	1
b_PrivateSectorPolicy_FoodFortification	-0.06	0.13	12764	1

The convergence of Markov chains is also reflected in the trace plots of Figure 3. In particular, after the 2000th iteration, all chains' values fluctuate around the central equilibrium.

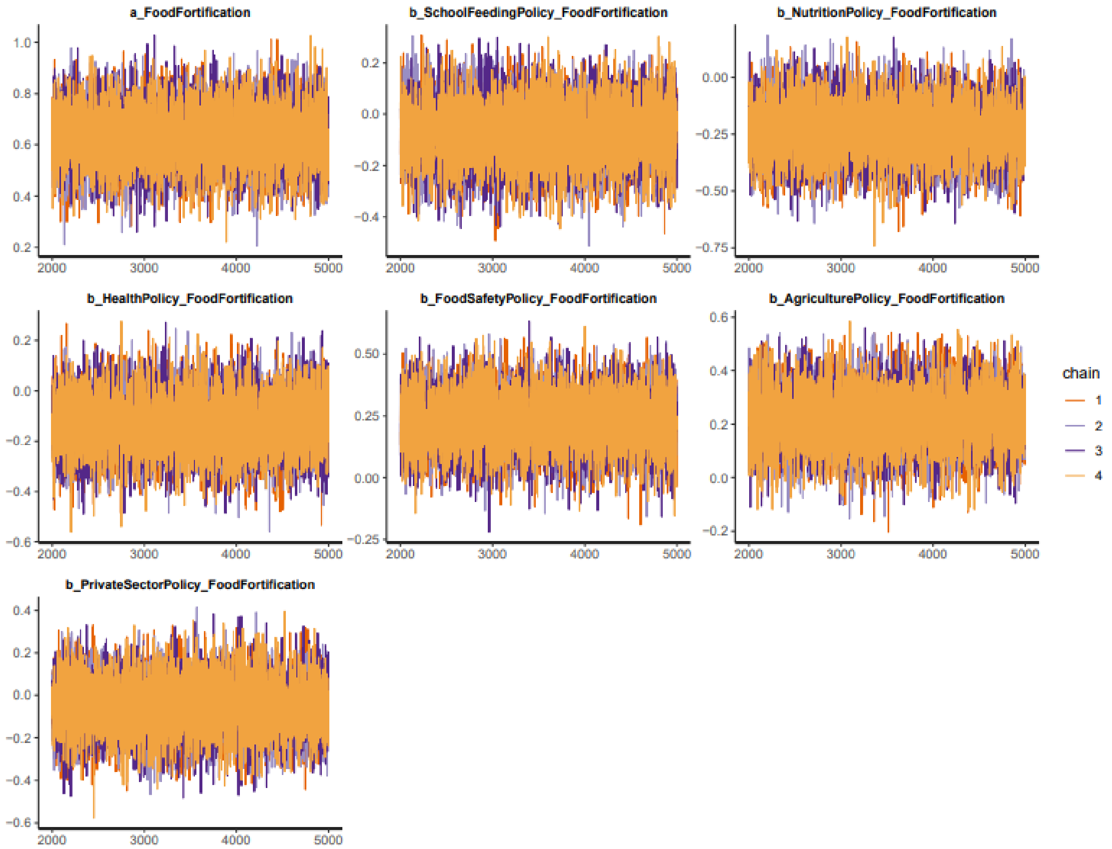

Figure 3. Model 1's trace plots

The Gelman-Rubin-Brooks plots and autocorrelation plots also show that the Markov chains have good convergence. Gelman-Rubin-Brooks plots are used to evaluate the ratio between the variance between Markov chains and the variance within chains. The y-axis demonstrates the shrinkage factor (or Gelman-Rubin factor), while the x-axis illustrates the iteration order of the simulation. In Figure 4, the shrinkage factors of all parameters rapidly decrease to 1 before the 2000th iteration (during warm-up). This manifestation indicates that there are no divergences between Markov chains.

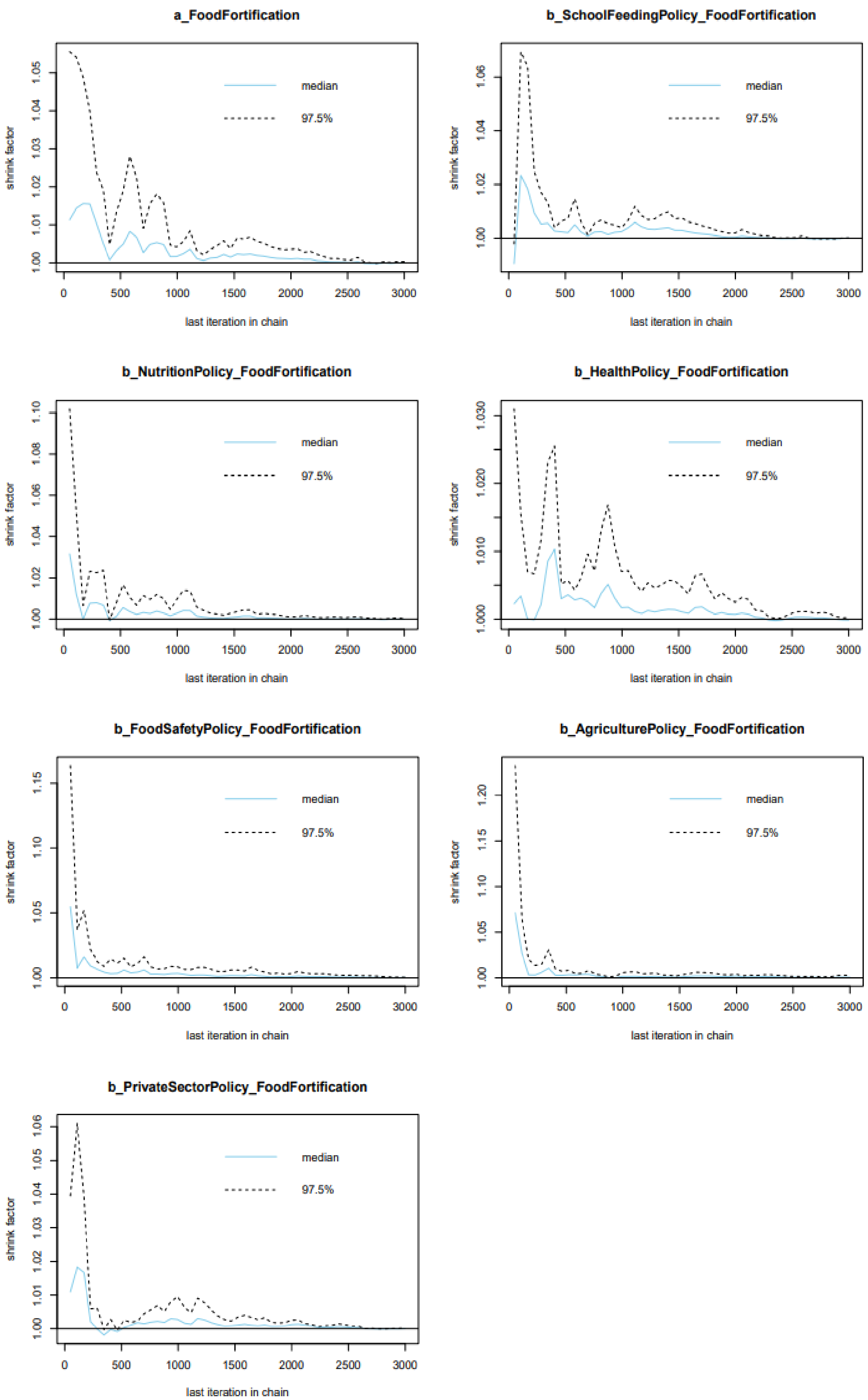

Figure 4. Model 1's Gelman-Rubin-Brooks plots

The Markov property refers to the memory-less property of a stochastic process. In other words, iteration values are not auto-correlated with the past iteration values. Autocorrelation plots are used to evaluate the level of autocorrelation between iteration values. The plots in Figure 5 show the average autocorrelation of each Markov chain along the y-axis and the delay of these chains along the x-axis. Visually, after several delays (before 5), the autocorrelation levels of all Markov chains swiftly drop to 0, indicating that the Markov properties are preserved and the Markov chains converge well.

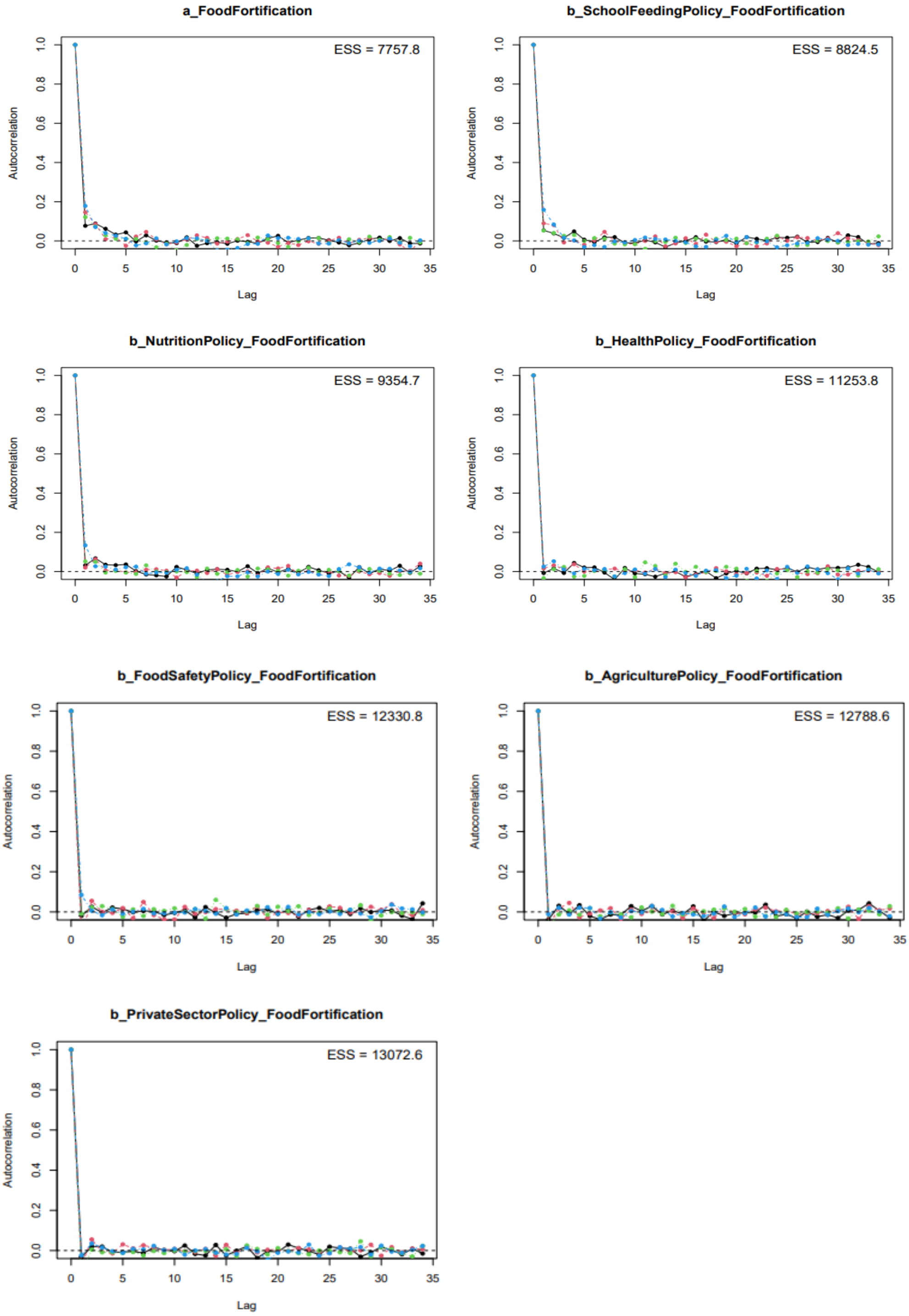

Figure 5. Model 1's autocorrelation plots

Since all the diagnostics confirm the convergence of Markov chains, the simulated results are eligible for interpretation. The estimated results of Model 1 show that among the six types of national policies, food safety policy and agriculture policy had a significant positive association with in-school food fortification practices. In contrast, school feeding policy and private sector policy had ambiguous associations with these practices. Surprisingly, nutrition policy and health policy had a significant negative association with in-school food fortification practices among countries implementing school meal programs (see Figure 6). The posterior distributions of the two coefficients in Figure 6 lie entirely on the negative or positive side of the x-axis, indicating the high reliability of the results.

Figure 6 below illustrates the estimated outcomes based on estimated coefficients by using Mean values for computation because they have the highest probability of occurrence. The distribution of *b_FoodSafetyPolicy_FoodFortification* and *b_AgriculturePolicy_FoodFortification* are fully located on the positive side of the x-axis, while the distribution of *b_NutritionPolicy_FoodFortification* and *b_HealthPolicy_FoodFortification* are situated on the negative side. These distributions signify the reliable positive association between *FoodSafetyPolicy* and *AgriculturePolicy* with *FoodFortification* and the negative association between *NutritionPolicy* and *HealthPolicy* with *FoodFortification*.

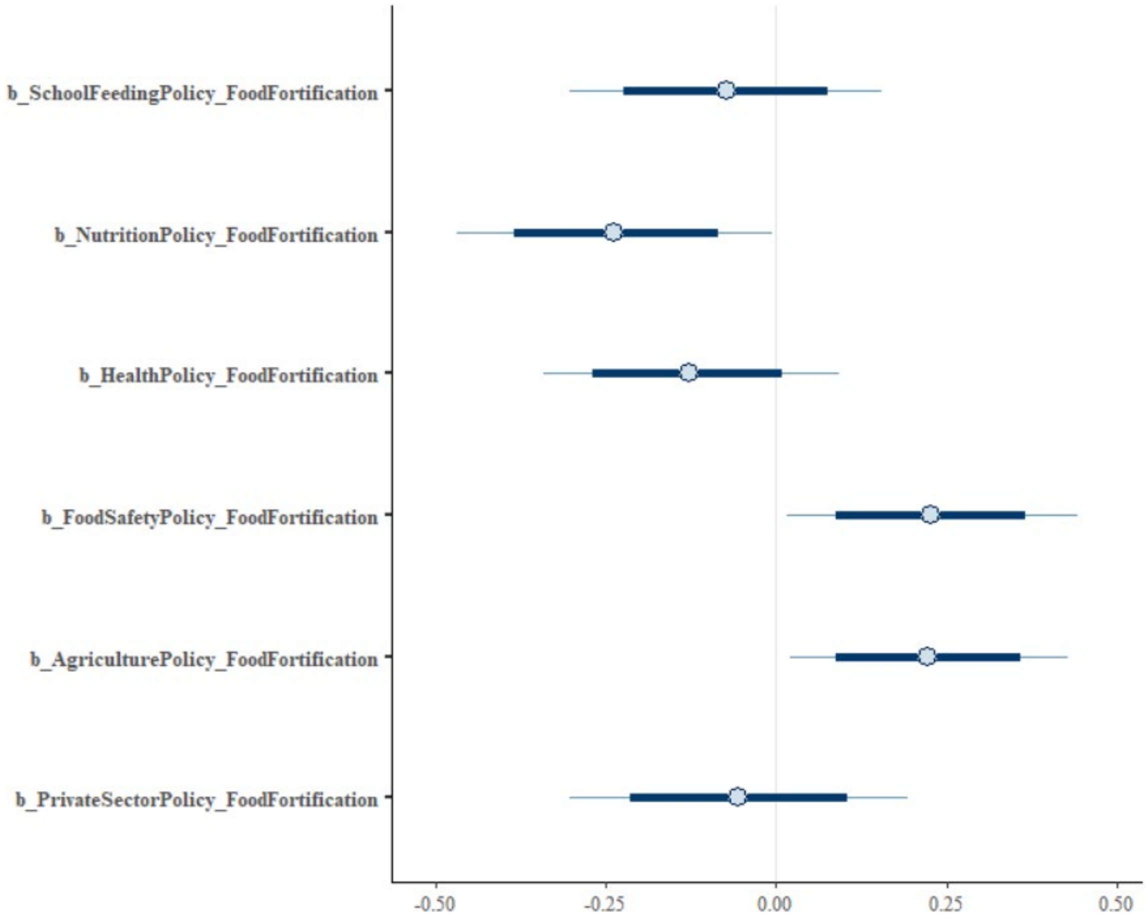

Figure 6. Estimated coefficients

4. DISCUSSION

The study employed the Bayesian Mindsponge Framework to analyze the association between national policies on school feeding, nutrition, health, food safety, agriculture, and the private sector with the implementation of food fortification in school meal programs.

The presence of food safety and agriculture laws, policies, or standards related to school meal programs is positively associated with the implementation of in-school food fortification practices. This result is in line with Pawlak & Kolodziejczak (2020) and Wang et al. (2022), who reported that agriculture policies provide a platform for safeguarding vulnerable individuals such as school participants, expanding the availability and accessibility of a variety of nutritious foods while strengthening human and institutional capacity. This concurs with von Braun et al. (2023), who postulated that monitoring these policies and their implementation on a timely basis is critical. This could further include continuous assessment of feeding programs and nutrition profiles in attaining food security in schools. Asirvatham et al. (2022) and Cele & Mudhara (2022) also noted that the implementation of strategies that prioritize the production of food high in micronutrients and farmer market accessibility is essential. This will promote successful food safety results, which call for coordinated efforts from many stakeholders, such as distributors, farmers, and regulators, whose actions are influenced by incentives, knowledge, and capacities (Brouwer et al., 2020; Unnevehr, 2022).

Findings suggest that food safety and agriculture policies effectively guide and support the implementation of in-school food fortification as part of the national school meal programs. MT views these national policies as core values deeply embedded in the collective mind of a nation, serving as essential benchmarks for the acceptance or rejection of new information or values related to food fortification (Vuong, 2023). For example, in the United States, the first food fortification policy was established in 1980 by the Food and Drug Administration (FDA), a federal agency within the Department of Health and Human Services. This policy, which outlined six basic principles of food fortification, continues to serve as a foundational guideline for food fortification practices in the U.S. today. In addition to FDA policies and regulations, some manufacturers also exercise discretion in supporting food fortification practices (Dwyer et al., 2015).

MT views food fortification practices in school meal programs as a product of the nation's information processing system. For these practices to emerge and be sustained within the national framework, the information regarding in-school food fortification must first be available and accessible to the nation. The information regarding food fortification practices includes knowledge and attitude of the human resources, the internal and external driving forces to catalyze food fortification practices, the available budget, access to fortified foods, etc. These elements enable a conformity assessment, or benchmarking, following regulated national policies, which are regarded as the nation's core values.

When food fortification practices align with these core values after a rigorous benchmarking process—where national policies act as a multi-filtering system—these practices can be effectively implemented and maintained in school meal programs. This alignment results in a strong, positive correlation between national policies and in-school food fortification. Given the significant role of food fortification in reducing the risk of nutrient deficiency diseases such as beriberi, goiter, pellagra, and rickets over the past century (Dwyer et al., 2015), legal protection and adherence to national policies or standards are essential. This study underscores that food safety and agriculture policies help guide and support food fortification practices in school meal programs.

In contrast, nutrition and health laws, policies, or standards were found to have a negative association with the implementation of in-school food fortification practices. These findings were unexpected and contradict Pietinen et al. (2010), who attributed the success of fortification programs to effective nutrition policies. Similarly, Wojcicki and Heyman (2006) suggested that nutrition policies positively influence food choices and participation in school feeding programs. Wineman et al. (2022) also emphasized that school feeding programs typically complement other initiatives, such as health programs, which would suggest that their respective policies should positively influence food fortification.

The negative associations observed in the study could be attributed to potential food wastage in school meal programs, where efforts to meet nutritional demands might result in plate waste due to lower consumption of fortified foods by students (Burgaz et al., 2023; Sunding & Zilberman., 2001). Likewise, studies by Chaudhary et al. (2020) and Alonge et al. (2024) indicated that increased food production and the provision of readily available healthy foods positively impacted nutrition, although they also noted concerns about obesity and non-communicable diseases among children. However, other research has shown that food fortification can reduce nutrient deficiencies and improve the nutritional status of children (Pike et al., 2021; Rowe, 2020). This improvement may be linked to the availability of healthy nutritional foods provided through school nutrition programs (Bundy, 2005; Grigsby-Duffy et al., 2022). Furthermore, Chaudhary et al. (2020) argued that school food programs and related interventions have the potential to improve dietary behaviors, attitudes, and anthropometric outcomes in young children, while also promoting healthy eating habits. As a result, schools have the capacity to implement long-lasting changes that create a healthier learning environment for children, enhancing both their short- and long-term health (Chaudhary et al., 2020).

MT views the negative association between nutrition and health policies and in-school food fortification practices as an unconformity between the new information on food fortification and the nutrition and health policies in the mindset of the nation. This condition may exist potentially due to the incapabilities of meeting the following condition: The information regarding the in-school food fortification practices is justified as costly for the nation based on the nutrition and health policies, so it cannot pass through the multi-filtering system of the mind.

FDA proposed some possible conditions for making food fortification practices favorable to the nation (Dwyer et al., 2015), as mentioned below:

1. The nutrient intake without fortification is below the desirable content for a significant portion of the population.
2. The food being fortified is consumed in quantities that would make a significant contribution to the population's intake of the nutrient.
3. The additional nutrient intake resulting from fortification is unlikely to create an imbalance of essential nutrients.
4. The nutrient added is stable under proper conditions of storage and use.
5. The nutrient is physiologically available from the food to which it is being added.
6. There is reasonable assurance that it will not result in potentially toxic intakes.

Assessing these six conditions reveals the possibility that the information on in-school food fortification, when benchmarked against nutrition and health policies, may not fully meet one or more of these criteria. This implies that such practices may not be considered favorable or sufficient from the perspective of nutrition and health policies.

In addition, the findings also suggest that school feeding and private sector policies had unclear associations with in-school food fortification practices, likely due to incoherent policies on food fortification. These results align with Roothaert et al. (2021), who reported that unclear policies hindered the full adoption of school meal programs. Wang and Fawzi (2020) also noted that school meal programs do not employ a one-size-fits-all approach, which may influence the effectiveness of food fortification efforts. In contrast, van Stuijvenberg (2005) highlighted that food fortification had positive effects on growth, morbidity, micronutrient status, and cognitive function in school children. However, Tsang et al. (2016) pointed out that the involvement of the private sector in providing school meals might compromise policy goals, emphasizing the need for conflict of interest protections. Challenges associated with private sector policies in implementing food fortification could be due to language barriers, limited resources, and the complex technologies involved (Reeve et al., 2018). Despite these challenges, Olson et al. (2021) argued that the private sector plays a crucial role in food fortification. Consequently, their policies could significantly contribute to managing, building capacity for, implementing, monitoring, and advocating for food fortification practices in school meal programs (Olson et al., 2021).

MT views this unclear association as a result of the nation's information processing. When information on in-school food fortification practices interacts with the national mindset—particularly school feeding and private sector policies—it is perceived as neutral. Consequently, this information is kept in a buffer zone, awaiting further evaluation. This situation may arise from insufficient information on food fortification practices in school meal programs, including details about opportunities and challenges in relation to these two policies.

5. Study Limitations

This study is not without limitations. The nature of the cross-sectional study has made the changing value of the variables studied unmeasurable over time. This study may portray a certain situation at one time to show a pattern of events but may not show the dynamic changes of the situation in the field. The questionnaire used is a self-reported questionnaire by design. It might be less objective for measuring variables. A qualitative study employing in-depth interviews among policymakers and stakeholders or parties involved in school feeding program execution is needed to fully understand the impacts of various national policies on in-school food fortification practices.

6. Conclusions

Several national policies related to school meal programs significantly impact in-school food fortification practices. Food safety policy and agriculture policy have a positive and significant association with the in-school food fortification practices. Both policies effectively guide and support the implementation of in-school food fortification as part of the national school meal programs in implementing countries. The nutrition policy and health policy have a significant negative association with food fortification practices. A reassessment of both policies is necessary to identify problematic clauses and make positive adjustments that can support in-school food fortification practices. School feeding policy and private sector policy have an ambiguous relationships with food fortification practices. Enhancing and strengthening these policies could potentially increase their positive impacts on in-school food fortification practices.

REFERENCES

Alonge, O., Homsi, M., Rizvi, M. S., Malykh, R., Geffert, K., Kasymova, N., Tilenbaeva, N., Isakova, L., Kushubakova, M., Mavlyanova, D., Mamyrbaeva, T., Duishenkulova, M., Pinedo, A., Andreeva, O., & Wickramasinghe, K. (2024). Design and Implementation of Brief Interventions to Address Non-communicable Diseases in Uzbekistan. *Global Health: Science and Practice*, *12*(4), 1–16. https://doi.org/10.9745/ghsp-d-23-00443

Alves Da Silva, E., Pedrozo, E. A., & Nunes Da Silva, T. (2023). The PNAE (National School Feeding Program) activity system and its mediations. *Frontiers in Environmental Science*, *10*, 981932. https://doi.org/10.3389/fenvs.2022.981932

Amoadu, M., Abraham, S. A., Adams, A. K., Akoto-Buabeng, W., Obeng, P., & Hagan, J. E. (2024). Risk Factors of Malnutrition among In-School Children and Adolescents in Developing Countries: A Scoping Review. *Children*, *11*(4), 1–19. https://doi.org/10.3390/children11040476

Asirvatham, R., Demi, S. M., & Ezezika, O. (2022). Are sub-Saharan African national food and agriculture policies nutrition-sensitive? A case study of Ethiopia, Ghana, Malawi, Nigeria, and South Africa. *Agriculture and Food Security*, *11*, 60. https://doi.org/10.1186/s40066-022-00398-x

Azevedo, A. B. C. De, Bandoni, D. H., Amorim, A. L. B. De, & Canella, D. S. (2023). Evaluation of food purchasing in the Brazilian School Feeding Programme: Feasibility of the requirements and recommendations. *Public Health Nutrition*, *26*(12), 3331–3342. https://doi.org/10.1017/S136898002300229X

Bechoff, A., de Bruyn, J., Alpha, A., Wieringa, F., & Greffeuille, V. (2023). Exploring the complementarity of fortification and dietary diversification to combat micronutrient deficiencies: A scoping review. *Current Developments in Nutrition*, *7*(100033). https://doi.org/10.1016/j.cdnut.2023.100033

Boatemaa, S., Drimie, S., & Pereira, L. (2018). Addressing food and nutrition security in South Africa: A review of policy responses since 2002. *African Journal of Agricultural and Resource Economics*, *13*(3), 264–279.

Brooks, S. P., & Gelman, A. (1998). General methods for monitoring convergence of iterative simulations. *Journal of computational and graphical statistics*, *7*(4), 434-455.

Brouwer, I. D., McDermott, J., & Ruben, R. (2020). Food systems everywhere: Improving relevance in practice. *Global Food Security*, *26*, 100398. https://doi.org/10.1016/j.gfs.2020.100398

Bundy, D. (2005). School health and nutrition programs. *Food and Nutrution Bulletin*, *26*(2), S186–S192. https://doi.org/10.5455/pmb.20110215104609

Burgaz, C., Gorasso, V., Achten, W. M. J., Batis, C., Castronuovo, L., Diouf, A., Asiki, G., Swinburn, B. A., Unar-Munguía, M., Devleesschauwer, B., Sacks, G., & Vandevijvere, S. (2023). The effectiveness of food system policies to improve nutrition, nutrition-related inequalities and environmental sustainability: a scoping review. In *Food Security* (Vol. 15). Springer Netherlands. https://doi.org/10.1007/s12571-023-01385-1

Cele, T., & Mudhara, M. (2022). Impact of market participation on household food security among smallholder irrigators in KwaZulu-Natal, South Africa. *Agriculture*, *12*, 261. https://doi.org/10.3390/agriculture12020261

Chaudhary, A., Sudzina, F., & Mikkelsen, B. E. (2020). Promoting healthy eating among young people—a review of the evidence of the impact of school-based interventions. *Nutrients*, *12*, 2894. https://doi.org/10.3390/nu12092894

Chrissini, M. M., & Panagiotakos, D. B. (2022). Public health interventions tackling childhood obesity at European level: A literature review. *Preventive Medicine Reports*, *30*, 102068. https://doi.org/10.1016/j.pmedr.2022.102068

Cohen, J. F. W., Hecht, A. A., McLoughlin, G. M., Turner, L., & Schwartz, M. B. (2021). Universal school meals and associations with student participation, attendance, academic performance, diet quality, food security, and body mass index: A systematic review. *Nutrients*, *13*, 911. https://doi.org/10.3390/nu13030911

Colley, P., Myer, B., Seabrook, J., & Gilliland, J. (2019). The impact of Canadian school food programs on children's nutrition and health: A systematic review. *Canadian Journal of Dietetic Practice and Research*, *80*(2), 79–86. https://doi.org/10.3148/cjdpr-2018-037

Csilléry, K., Blum, M. G. B., Gaggiotti, O. E., & François, O. (2010). Approximate Bayesian Computation (ABC) in practice. *Trends in Ecology & Evolution*, 25(7), 410–418. https://doi.org/10.1016/j.tree.2010.04.001

Davies, P., and Gregersen, N. H. (2014). "Information and the nature of reality: From physics to metaphysics," Cambridge University Press, Cambridge. Diaconis, P., & Ylvisaker, D. (1985). Quantifying prior opinion. In J. M. Bernardo, M. H. DeGroot, D. V. Lindley, & A. F. M. Smith (Eds.), *Bayesian Statistics* (Vol. 2, pp. 133-156). North Holland Press.

Diaconis, P., & Ylvisaker, D. (1985). Quantifying prior opinion. In J. M. Bernardo, M. H. DeGroot, D. V. Lindley, & A. F. M. Smith (Eds.), *Bayesian Statistics* (Vol. 2, pp. 133-156). North Holland Press.

Dunson D. B. (2001). Commentary: Practical advantages of Bayesian analysis of epidemiologic data. *American Journal of Epidemiology*, 153(12), 1222–1226. https://doi.org/10.1093/aje/153.12.1222

Duong, M.-P. T., Sari, N. P. W. P., Mazenda, A., Nguyen, M.-H., & Vuong, Q.-H. (2024). Improving the market for household livestock production to alleviate food insecurity in the Philippines. Animal Production Science, 64(7). https://doi.org/10.1071/an23349

Dwyer, J. T., Wiemer, K. L., Dary, O., Keen, C. L., King, J. C., Miller, K. B., Philbert, M. A., Tarasuk, V., Taylor, C. L., Gaine, P. C., Jarvis, A. B., and Bailey, R. L. (2015). Fortification and Health: Challenges and Opportunities. *Advances in Nutrition*, 6(1), 124-131.

FAO, IFAD, UNICEF, WFP, W. (2022). The State of Food Security and Nutrition in the World 2022. In *The State of Food Security and Nutrition in the World 2022*. FAO. https://doi.org/10.4060/cc0639en

Food and Drug Administration (FDA), the United States. (1980). *Nutritional Quality of Foods; Addition of Nutrients.* Fed. Regist.

Gill, J. (2015). *Bayesian Methods: A Social and Behavioral Sciences Approach* (3rd Ed.). Florida: CRC Press.

Global Child Nutrition Foundation. (2022). School meal programs around the world. Results from the 2021 Global Survey of School Meal Programs. In *Global Child Nutrition Foundation*.

Global Child Nutrition Foundation (GCNF). (2022). *Global Survey of School Meal Programs database*. GCNF: Seattle. https://gcnf.org/global-reports/

Grigsby-Duffy, L., Brooks, R., Boelsen-Robinson, T., Blake, M. R., Backholer, K., Palermo, C., & Peeters, A. (2022). The impact of primary school nutrition policy on the school food environment: A systematic review. *Health Promotion International*, *37*, 1–18. https://doi.org/10.1093/heapro/daac084

Halsey, L. G., Curran-Everett, D., Vowler, S. L., & Drummond, G. B. (2015). The fickle P value generates irreproducible results. *Nature Methods*, 12, 179-185. https://doi.org/10.1038/nmeth.3288

Kemboi, M.K., Mazenda, A., & Katiyatiya, C.L.F. (2024). Coping strategies and food insecurity experiences: the case of female-headed Agricultural households in

Liberia. *British Food Journal*, 126(7), 2825-2840. https://doi.org/10.1108/BFJ-10-2023-0884

Keppens, A. (2018). What Constitutes Emergent Quantum Reality? A Complex System Exploration from Entropic Gravity and the Universal Constants. Entropy, 20(5), 335. https://doi.org/10.3390/e20050335

Kinderknecht, K., Harris, C., & Jones-Smith, J. (2020). Association of the Healthy, Hunger-Free Kids Act with Dietary Quality Among Children in the US National School Lunch Program. JAMA, 324(4), 359. https://doi.org/10.1001/jama.2020.9517

Kretschmer, A., Spinler, S., and Van Wassenhove, L. N. (2014). A school feeding supply chain framework: critical factors for sustainable program design. *Production and Operations Management*, 23(6),990–1001. https://doi.org/10.1111/poms.12109

La, V.-P., & Vuong, Q.-H. (2019). *Bayesvl: Visually learning the Graphical Structure of Bayesian Networks and Performing MCMC with 'Stan.'* Available at: https://doi.org/10.31219/osf.io/wyc6n

Magqupu, S., Chikwanha, O. C., Katiyatiya, C. L. F., Strydom, P. E., & Mapiye, C. (2024). Consumers ' purchasing behaviour and quality preferences for pork sold in the informal street markets of the Cape Metropole , South Africa. *Agrekon*, *0*(0), 1–20. https://doi.org/10.1080/03031853.2024.2363788

Maniragaba, V. N., Atuhaire, L. K., & Rutayisire, P. C. (2023). Undernutrition among the children below five years of age in Uganda: a spatial analysis approach. *BMC Public Health*, *23*, 390. https://doi.org/10.1186/s12889-023-15214-9

Mantello, P., Ho, M.-T., Nguyen, M.-H., & Vuong, Q.-H. (2023). Machines that feel: Behavioral determinants of attitude towards affect recognition technology—upgrading technology acceptance theory with the mindsponge model. *Humanities and Social Sciences Communications*, 10(1). https://doi.org/10.1057/s41599-023-01837-1

McElreath, R. (2018). *Statistical Rethinking: A Bayesian Course with Examples in R and Stan*. Chapman and Hall/CRC Press.

McIsaac, J. L. D., Spencer, R., Chiasson, K., Kontak, J., & Kirk, S. F. L. (2019). Factors influencing the implementation of nutrition policies in schools: A scoping review. *Health Education and Behavior*, *46*(2), 224–250. https://doi.org/10.1177/1090198118796891

McKenna, M. L. (2003). Issues in implementing school nutrition policies. *Canadian Journal of Dietetic Practice and Research*, *64*(4), 208–213. https://doi.org/10.3148/64.4.2003.208

Moyano, D., Rodriguez, E. R., & Perovic, N. R. (2020). An analysis of policy interventions regarding school lunch programs and their role in the healthy nutrition of children in Córdoba, Argentina. *Salud Colectiva*, *16*, e2636. https://doi.org/10.18294/SC.2020.2636

Nguyen, M. H., La, V. P., & Le, T. T. (2022). Introduction to Bayesian Mindsponge Framework analytics: An innovative method for social and psychological research. *MethodsX,* 9, 101808, doi: https://doi.org/10.1016/j.mex.2022.101808

Olson, R., Gavin-Smith, B., Ferraboschi, C., & Kraemer, K. (2021). Food fortification: The advantages, disadvantages and lessons from sight and life programs. *Nutrients*, *13*,

1118. https://doi.org/10.3390/nu13041118
Osendarp, S. J. M., Martinez, H., Garrett, G. S., Neufeld, L. M., De-Regil, L. M., Vossenaar, M., & Darnton-Hill, I. (2018). Large-scale food fortification and biofortification in low- and middle-income countries: A review of programs, trends, challenges, and evidence gaps. *Food and Nutrition Bulletin*, *39*(2), 315–331. https://doi.org/10.1177/0379572118774229
Pawlak, K., & Kolodziejczak, M. (2020). The role of agriculture in ensuring food security in eveloping countries: Considerations in the context of the problem of sustainable food production. *International Journal of Humanities and Applied Social Science*, *12*, 5488. https://doi.org/10.33642/ijhass.v5n1p1
Pietinen, P., Männistö, S., Valsta, L. M., & Sarlio-Lähteenkorva, S. (2010). Nutrition policy in Finland. *Public Health Nutrition*, *13*(6 A), 901–906. https://doi.org/10.1017/S1368980010001072
Pike, V., Bradley, B., Rappaport, A. I., Zlotkin, S., & Perumal, N. (2021). A scoping review of research on policies to address child undernutrition in the Millennium Development Goals era. *Public Health Nutrition*, *24*(13), 4346–4357. https://doi.org/10.1017/S1368980021001890
Rai, D., Chaudhary, C., Khatak, A., & Banyal, S. (2024). A sustainable approach to combat micronutrient deficiencies and ensure global food security through biofortification. *European Journal of Nutrition & Food Safety*, *16*(4), 15–30. https://doi.org/10.9734/ejnfs/2024/v16i41404
Reeve, E., Thow, A. M., Bell, C., Engelhardt, K., Gamolo-Naliponguit, E. C., Go, J. J., & Sacks, G. (2018). Implementation lessons for school food policies and marketing restrictions in the Philippines: A qualitative policy analysis. *Globalization and Health*, *14*(8), 1–14. https://doi.org/10.1186/s12992-017-0320-y
Rimbawan, R., Nurdiani, R., Rachman, P., Kawamata, Y., & Nozawa, Y. (2023). School lunch programs and nutritional education improve knowledge, attitudes, and practices and reduce the prevalence of anemia: A pre-post intervention study in an Indonesian Islamic Boarding School. *Nutrients*, *15*, 1055.
Ritchie, L. D. (2020). School meals matter: Federal policy can improve children's nutrition and health (Jia etÂ al. 2020). *Public Health Nutrition*, *23*(16), 3025–3027. https://doi.org/10.1017/S1368980020002591
Rocha, L. L., Cordeiro, N. G., Jardim, M. Z., Kurihayashi, A. Y., Gentil, P. C., Russo, G. C., & Mendes, L. L. (2023). Do Brazilian regulatory measures promote sustainable and healthy eating in the school food environment? *BMC Public Health*, *23*, 2166. https://doi.org/10.1186/s12889-023-17111-7
Roothaert, R., Mpogole, H., Hunter, D., Ochieng, J., & Kejo, D. (2021). Policies, multi-stakeholder approaches and home-grown school feeding programs for improving quality, equity and sustainability of school meals in Northern Tanzania. *Frontiers in Sustainable Food Systems*, *5*, 621608. https://doi.org/10.3389/fsufs.2021.621608
Rovelli, C. (2018). Reality is Not What It Seems: The Journey to Quantum Gravity. Penguin. https://www.amazon.com/dp/0735213933

Rovelli, C. (2016). Seven Brief Lessons on Physics. Riverhead Books. https://www.amazon.com/dp/B00Z8VTMYG/

Rowe, L. A. (2020). Addressing the fortification quality gap: A proposed way forward. *Nutrients*, *12*, 3899. https://doi.org/10.3390/nu12123899

Sekiyama, M., Kawakami, T., Nurdiani, R., Roosita, K., Rimbawan, R., Murayama, N., Ishida, H., & Nozue, M. (2018). School Feeding Programs in Indonesia. *The Japanese Journal of Nutrition and Dietetics*, *76*(Supplement 1), S86–S97. https://doi.org/10.5264/eiyogakuzashi.76.s86

Shahzad, R., Jamil, S., Ahmad, S., Nisar, A., Khan, S., Amina, Z., Kanwal, S., Aslam, H. M. U., Gill, R. A., & Zhou, W. (2021). Biofortification of Cereals and Pulses Using New Breeding Techniques: Current and Future Perspectives. *Frontiers in Nutrition*, *8*(October), 1–23. https://doi.org/10.3389/fnut.2021.721728

Shannon, C. E. (1948). A Mathematical Theory of Communication. Bell System Technical Journal, 27(3), 379–423. https://doi.org/10.1002/j.1538-7305.1948.tb01338.x

Sunding, D., & Zilberman, D. B. T.-H. of A. E. (2001). Chapter 4 The agricultural innovation process: Research and technology adoption in a changing agricultural sector. In *Agricultural Production* (Vol. 1, pp. 207–261). Elsevier. https://doi.org/https://doi.org/10.1016/S1574-0072(01)10007-1

Theriault, V., Kirimi, L., Wineman, A., Kinyumu, E., & Tschirley, D. (2024). Assessment of the policy enabling environment for large-scale food fortification: A novel framework with an application to Kenya. *PLOS Global Public Health*, *4*(5), e0003211. https://doi.org/10.1371/journal.pgph.0003211

Tsang, B. L., Moreno, R., Dabestani, N., Pachón, H., Spohrer, R., & Milani, P. (2016). Public and private sector dynamics in scaling up rice fortification: The Colombian experience and its lessons. *Food and Nutrition Bulletin*, *37*(3), 317–328. https://doi.org/10.1177/0379572116646897

Unnevehr, L. J. (2022). Addressing food safety challenges in rapidly developing food systems. *Agricultural Economics*, *53*(4), 529–539. https://doi.org/10.1111/agec.12724

van Stuijvenberg, M. E. (2005). Using the school of feeding system as a vehicle for micronutrient fortification: Experience from South Africa. *Food and Nutrition Bulletin*, *26*(2 SUPPL. 2), S213-219. https://doi.org/10.1177/15648265050262s212

Vehtari, A., & Gabry, J. (2019). *Bayesian Stacking and Pseudo-BMA weights using the loo package*. In (Version loo 2.2.0). https://mc-stan.org/loo/articles/loo2-weights.html

Vehtari, A., Gelman, A., & Gabry, J. (2017). Practical Bayesian model evaluation using leave-one-out cross-validation and WAIC. *Statistics and Computing*, 27(5), 1413-1432. https://doi.org/10.1007/s11222-016-9696-4

von Braun, J., Afsana, K., Fresco, L. O., & Hassan, M. H. A. (2023). Science and Innovations for Food Systems Transformation. In *Science and Innovations for Food Systems Transformation*. https://doi.org/10.1007/978-3-031-15703-5

Vuong, Q.-H., and Nguyen, M.-H. (2024a). *Better Economics for the Earth: A Lesson from Quantum and Information Theories*. Hanoi, Vietnam: AISDL. https://www.amazon.com/dp/B0D98L5K44/

Vuong, Q.-H., and Nguyen, M.-H. (2024b). Further on informational quanta, interactions, and entropy under the granular view of value formation. https://philpapers.org/rec/VUOARN

Vuong, Q. H. (2023). *Mindsponge Theory.* Berlin: Walter de Gruyter. https://books.google.com/books?id=OSiGEAAAQBAJ

Vuong, Q.H. (2022). *The Kingfisher Story Collection*. https://www.amazon.com/dp/B0BG2NNHY6

Vuong, Q. H., Nguyen, M. H., & La, V. P. (2022). *The Mindsponge and BMF Analytics for Innovative Thinking in Social Sciences and Humanities*. Berlin: Walter de Gruyter. https://books.google.com/books?id=EGeEEAAAQBAJ

Vuong, Q.-H., Le, T.-T., La, V.-P., Nguyen, H. T. T., Ho, M.-T., Van Khuc, Q., & Nguyen, M.-H. (2022). Covid-19 vaccines production and societal immunization under the serendipity-mindsponge-3D knowledge management theory and conceptual framework. Humanities and Social Sciences Communications, 9(1). https://doi.org/10.1057/s41599-022-01034-6

Vuong, Q.-H., Nguyen, H. T. T., Pham, T.-H., Ho, M.-T., & Nguyen, M.-H. (2021). Assessing the ideological homogeneity in entrepreneurial finance research by highly cited publications. Humanities and Social Sciences Communications, 8(1). https://doi.org/10.1057/s41599-021-00788-9

Vuong, Q.-H., and Napier, N. K. (2015). Acculturation and global mindsponge: An emerging market perspective. *International Journal of Intercultural Relations*, 49, 354-367.

Wagenmakers, E.-J., Marsman, M., Jamil, T., Ly, A., Verhagen, J., Love, J., Selker, R., Gronau, Q. F., Šmíra, M., Epskamp, S., Matzke, D., Rouder, J. N., & Morey, R. D. (2017). Bayesian inference for psychology. Part I: Theoretical advantages and practical ramifications. *Psychonomic Bulletin & Review*, 25(1), 35–57. https://doi.org/10.3758/s13423-017-1343-3

Wall, C., Tolar-Peterson, T., Reeder, N., Roberts, M., Reynolds, A., & Mendez, G. R. (2022). The impact of school meal programs on educational outcomes in African school children: A systematic review. *International Journal of Environmental Research and Public Health*, *19*, 3666. https://doi.org/10.3390/ijerph19063666

Wang, D., & Stewart, D. (2013). The implementation and effectiveness of school-based nutrition promotion programmes using a health-promoting schools approach: A systematic review. *Public Health Nutrition*, *16*(6), 1082–1100. https://doi.org/10.1017/S1368980012003497

Wang, D., & Fawzi, W. W. (2020). Impacts of school feeding on educational and health outcomes of school-age children and adolescents in low- and middle-income countries: A systematic review and meta-analysis. *Journal of Global Health*, *9*, 55. https://doi.org/10.7189/jogh.11.04051

Wang, J., Ding, X., Gao, H., & Fan, S. (2022). Reshaping food policy and governance to incentivize and empower disadvantaged groups for improving nutrition.

Nutrients, *14*, 648. https://doi.org/10.3390/nu14030648

Wineman, A., Ekwueme, M. C., Bigayimpunzi, L., Martin-Daihirou, A., Eth, E. L., Etuge, P., Warner, Y., Kessler, H., & Mitchell, A. (2022). School meal programs in Africa: Regional results from the 2019 global survey of school meal programs. *Frontiers in Public Health*, *10*, 871866. https://doi.org/10.3389/fpubh.2022.871866

Wojcicki, J. M., & Heyman, M. B. (2006). Healthier choices and increased participation in a middle school lunch program: Effects of nutrition policy changes in San Francisco. *American Journal of Public Health*, *96*(9), 1542–1547. https://doi.org/10.2105/AJPH.2005.070946

World Health Organization (WHO). (2024). Malnutrition. https://www.who.int/news-room/fact-sheets/detail/malnutrition. (Accessed 15 August 2024).

Zhong, A., Yin, L., O'sullivan, B., & Ruetz, A. T. (2023). Historical lessons for Canada's emerging national school food policy: an opportunity to improve child health. *Health Promotion and Chronic Disease Prevention in Canada*, *43*(9), 421–425. https://doi.org/10.24095/hpcdp.43.9.04