

Optimization of zero food waste model to improve nutritional status and food literacy of junior high school students in Samarinda

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Abstract. Food waste in school settings remains a significant challenge, contributing to inefficient food utilization and low food literacy among adolescents. This study evaluated a short-term Zero Food Waste model to improve food literacy and nutritional status among junior high school students in Samarinda, Indonesia. A quasi-experimental pre-post study without a control group was conducted among 51 Grade VIII students over three consecutive days. Baseline anthropometric measurements, food literacy assessments, and plate waste observations were performed before an educational intervention using interactive lectures and video media. Post-test assessments and plate waste observations were conducted after the intervention. Food literacy knowledge improved significantly, with mean scores increasing from 25.5% at baseline to 82.4% after the intervention ($p < 0.001$). However, plate waste remained high, averaging 218.42 g from a standard 366.00 g meal, indicating that 59.7% of the served food was discarded. Pre-meal satiety and food preferences were the main contributors to food waste. Nutritional assessment revealed a double burden of malnutrition, with 39.2% of students underweight and 11.8% overweight or obese. The Zero Food Waste model improved food literacy but should be complemented by school-based environmental strategies and portion control to sustainably reduce food waste.

1 Introduction

Adolescence represents a critical growth period with increased nutritional requirements, yet many Indonesian adolescents face the "triple burden of malnutrition," including residual stunting, anemia, and overnutrition [1, 2]. Data show that regional stunting prevalence remains high [3], compounded by rising overnutrition driven by unhealthy diets and school environments where snacks high in sugar, fat, and salt are prevalent [4, 5]. Concurrently, food waste poses a significant challenge among adolescents, driven by unfinished meals and low food literacy [6].

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The FAO reports that one-third of global food is wasted, largely at the consumption level, leading to economic, environmental, and educational losses [7, 8]. The Zero Food Waste approach offers an innovative solution by promoting responsible consumption and minimizing leftovers [9,10]. In schools, this model can be implemented through participatory activities to foster responsible eating habits [11, 12]. However, previous studies have primarily focused on general nutrition knowledge, leaving a gap in integrated approaches that combine food literacy with direct behavioral interventions, such as supervised communal eating, particularly within Indonesian school settings [13, 14, 15]. Therefore, this study aims to evaluate an integrated Zero Food Waste model combining food literacy education and supervised eating practices to improve both food literacy and nutritional outcomes among adolescents

2 Materials and methods

This study utilized a pre–post quasi-experimental design without a control group to evaluate a 3-day short-term Zero Food Waste intervention in Samarinda, Indonesia. The study was officially authorized under administrative permit number 3951/UN17.11/DT/2025, with written informed consent secured from school authorities and parents prior to data collection. Out of 60 eighth-grade students initially enrolled, 51 completed all evaluation phases (n=51).

The intervention protocol was structured chronologically over three consecutive days. On Day 1, baseline data were collected, including anthropometric measurements, initial food literacy knowledge (pre-test), and baseline plate waste assessment during school mealtime. On Day 2, students received a targeted educational session combining interactive lectures and educational video media covering balanced nutrition, portion control, and food waste awareness. On Day 3, students underwent post-test knowledge assessments and post-meal plate waste observations. School-provided meals throughout the study were standardized at 366.00 g per plate (comprising 180 g carbohydrates, 46 g animal protein, 37 g vegetables, 29 g plant-based protein, and 74 g fruits) following Indonesian dietary guidelines.

Data collected included: (1) food literacy knowledge, measured using a standardized questionnaire (Cronbach’s alpha=0.82) administered on day 1 and 3; (2) physical plate waste, measured using the direct weighing method before and promptly after mealtimes; and (3) Body Mass Index-for-Age (BMI-for-Age) z-scores, obtained using anthropometric assessments. Pre- and post-test scores were evaluated using paired t-tests (p<0.05). Descriptive statistics summarized plate waste and anthropometric profiles for the unified cohort.

3 Results and discussion

Table 1 presents the anthropometric, plate waste, and knowledge pre-/post-test results for classes VIII E and VIII F (n=51).

Table 1. Baseline anthropometric measurements and distribution of nutritional status (n=51).

Category	Value / Frequency (n)	Percentage (%)
Age (years, Mean±SD)	13.84±0.42	-
Weight (kg, Mean±SD)	48.63±6.22	-
Height (cm, Mean±SD)	157.37±4.15	-
BMI (kg/m, Mean±SD)	19.75±1.85	-
Nutritional Status (BMI-for-Age)		

Category	Value / Frequency (n)	Percentage (%)
Underweight	20	39.2
Normal	25	49
Overweight	3	5.9
Obese	3	5.9

Note: This table represents the cross-sectional baseline profile of the student cohort before the intervention

These baseline assessments demonstrate a clear coexistence of undernutrition (39.2% underweight) and overnutrition (11.8% overweight/obese) within the studied school environment. This structural imbalance directly reflects the "triple burden of malnutrition" commonly identified across developing urban settings in Indonesia [1]. These systemic nutritional variations are closely tied to individual socio-environmental behaviors, including long-term dietary habits and adolescent snacking preferences outside the campus [4, 5]. Since anthropometric changes require prolonged metabolic adaptations, these initial measurements provide the essential public health justification for integrating Zero Food Waste models into school health frameworks [1].

To evaluate the immediate educational impact of the Zero Food Waste approach, food literacy knowledge was assessed before (Day 1) and after (Day 3) the interactive lecture and video-media session. The mean food literacy knowledge score rose substantially from a baseline of 25.5% to an overall post-test score of 82.4%, yielding a mean net increase of +56.9% (Table 2).

Table 2. Impact of intervention on food literacy knowledge.

Assessment Phase	Mean Score (%)	Standard Deviation (±SD)	Mean Increase (%)	p-value
Pre-Test (Day 1)	25.5	8.4	-	-
Post-Test (Day 3)	82.4	6.1	56.9	<0.001

A paired t-test generated a p-value of <0.001, demonstrating that the observed improvement was directly driven by the targeted educational intervention. This rapid cognitive advancement validates contemporary food literacy frameworks, which emphasize that integrating digital visual media with interactive peer discussions significantly optimizes knowledge retention and resource awareness among students [11, 12].

To assess behavioral change, physical plate waste was measured using the direct weighing method and compared against the standard school-provided served portion of 366.00 g.

Table 3. Physical plate waste analysis based on pre- and post-meal weighing (n=51).

Total Cohort (n)	Standard Served Portion (g/student)	Average Plate Waste (g/student)	Total Plate Waste (g)	Maximum Individual Leftover (g)	Proportion of Food Wasted (%)
51	366	218.42	11139.42	366	59.7

The physical measurements revealed that out of the 366.00 g served portion, the average plate waste per student was 218.42 g, accumulating to a total cohort waste of 11,139.42 g during a single meal session. Proportionally, approximately 59.7% of the total food mass provided was discarded.

These findings demonstrate a significant gap between cognitive literacy and physical behavior, confirming that short-term education alone cannot eliminate physical waste. Qualitative observation logs indicated that this high volume of leftovers was driven by pre-meal satiety due to uncontrolled campus snack purchasing [13], uniform portion sizing that failed to match individual student metabolic demands [14], and an acute aversion to institutional preparations of vegetables and fruits [15]. Therefore, while short-term education effectively develops conceptual food literacy, it must be paired with environment-level interventions to successfully achieve scalable behavior modification [13, 14]

4 Conclusion

The Zero Food Waste approach effectively improved students' theoretical food literacy, although actual plate waste remained high due to portion mismatches and deeply ingrained food preferences. The simultaneous presence of undernutrition and overnutrition highlights a critical double burden of malnutrition within the student body. Therefore, future school nutrition models must pair health literacy with environment-level interventions—including flexible portion controls, snack restrictions, and fruit and vegetable preference education—to achieve scalable, sustainable behavioral changes and support broader school health policies

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