

**Improving Food Safety and Nutrition Knowledge, Attitude, and Practice in Ethiopian Schoolchildren: A School-Based Intervention Study.**

Kassahun Ketema<sup>1</sup>, Aregash Samuel<sup>2</sup> and Mogessie Ashenafi<sup>1\*</sup>

\*Corresponding author email: mogessie.ashenafi@aau.edu.et

Tel. +251911404177

1. Centre for Food Security Studies, College of Development Studies, Addis Ababa University, Addis Ababa, Ethiopia

2. Nutrition, Environmental Health and Non-communicable Disease Research Directorate, Ethiopian Public Health Institute, Addis Ababa, Ethiopia

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## Abstract

Inadequate food safety and nutrition knowledge among school-aged children hampers their developing immune systems, increasing their risk of foodborne illnesses and malnutrition. This longitudinal study examined the impact of a school-based intervention on the food safety and nutrition knowledge, attitudes, and practices (KAP) of 389 randomly selected students in Kuyu District, Northtown, Ethiopia. Data were collected using pre-tested, interviewer-administered questionnaires before and after the intervention. Paired-samples t-tests were performed with SPSS 26.0. Significant improvements were observed across all KAP domains following the intervention ( $p < 0.05$ ). Inadequate knowledge decreased from 73.3% to 17.2%. Negative attitudes declined from 86.1% to 26.7%. Additionally, the percentage of students demonstrating good practices increased from 23.1% to 68.6%. Mean scores for knowledge, attitudes, and practices also showed significant improvements with large effects: knowledge (pre:  $M=5.57$ ,  $SD=1.68$ ; post:  $M=8.32$ ,  $SD=1.72$ ;  $t(388)=-22.71$ ,  $p<0.0001$ , effect size=1.6), attitudes (pre:  $M=4.25$ ,  $SD=1.35$ ; post:  $M=7.82$ ,  $SD=2.00$ ;  $t(388)=-28.98$ ,  $p<0.0001$ , effect size=2.1), and practices (pre:  $M=5.54$ ,  $SD=1.34$ ; post:  $M=8.16$ ,  $SD=1.49$ ;  $t(388)=-31.08$ ,  $p<0.0001$ , effect size=1.8). The school-based intervention significantly improved students' knowledge, attitudes, and practices (KAP) regarding food safety and nutrition. These findings underscore the importance of developing targeted initiatives that promote balanced diets and ongoing food safety education for school-aged children, which should be integrated into national food and nutrition policies.

**Key words:** Schoolchildren, KAP, Intervention, Food Safety, Nutrition,

## Introduction

Food safety and balanced diets are critical for community health (Silva et al., 2023). The World Health Organization (WHO, 2021) emphasizes the importance of access to healthy food for overall well-being and highlights the necessity of protecting food from contaminants such as microbes, mycotoxins, and pesticides throughout the supply chain (Kovač et al., 2021; Ellahi et al., 2024). Foodborne hazards are a significant global public health concern (Alsubaie & Berekaa, 2020), with

schools serving as crucial points of intervention. The WHO advocates for improved food safety education in schools to reduce the global burden of foodborne illnesses (WHO, 2021).

In traditional food preparation in the study area, the staple dish is “injera”, a fermented, soft flatbread typically made from teff flour (*Eragrostis teff*). Injera is served with a hot stew made from legumes, vegetables, or meat, which is cooked just before mealtime. Leftovers, if any, are usually eaten as a snack or during the next meal. Nevertheless, the burden of foodborne diseases in Ethiopia is thought to be high (Mekonnen et al., 2021), and it possibly arises from cross-contamination during food handling.

Schools are vital in promoting lifelong healthy eating habits (WHO & UNESCO, 2021; O'Brien et al., 2021), and children, as knowledge brokers, can extend the impact of school programs to their homes. Despite this potential, malnutrition and unhealthy eating remain significant challenges, especially among school-aged children (Luo et al., 2021). A primary barrier is the lack of awareness among students, teachers, and caregivers (Kana'an et al., 2021; Mekonnen et al., 2024).

Challenges in nutrition and food safety include insufficient understanding, outdated techniques, and substandard procedures (Edin et al., 2024; Rokshana et al., 2022). While proper hygiene can prevent foodborne illnesses (Islam et al., 2023), poor personal hygiene and food handling persist (Disassa & Ashenafi, 2022). Ready-to-eat foods are particularly vulnerable to contamination in the absence of strict safety regulations, posing significant health risks (Islam et al., 2023).

These issues disproportionately affect children, who are more susceptible to malnutrition and foodborne diseases due to immature immune systems and physiological sensitivities (Amoadu et al., 2024). Foodborne diseases result in millions of illnesses and thousands of deaths worldwide each year (Mekuanint, 2020). Notably, food handlers in homes and schools are responsible for up to 20% of outbreaks (Minda et al., 2024). For instance, contaminated food causes 70% of diarrheal illnesses in Ethiopia (Mekuanint, 2020).

Addressing these challenges requires a multifaceted approach, starting with improving schoolchildren's knowledge, attitudes, and practices related to food safety and nutrition (Habib et al., 2023). While extensive research exists in high-income countries (Carrillo-Alvarez et al., 2025), studies on children in low-resource settings are limited (Bello et al., 2024). Current interventions

are often hindered by fragmented curricula and inadequate teacher training (Gebre et al., 2023). A systematic review of existing knowledge, attitudes, and practices could offer valuable insights for future efforts (Minda et al., 2024).

This paper underscores significant gaps and emphasizes the need for evidence-based strategies to enhance nutrition and food safety education in schools, particularly in underserved regions. This supports national efforts to reduce foodborne illnesses and foster healthier futures for children worldwide.

## **Materials and Methods**

### **Study Area and Period**

This longitudinal study was conducted in Kuyu District, North Shewa Zone, Oromia Regional State, Ethiopia, situated 156 kilometers north of Addis Ababa. The district has a population of 187,146, with women making up 50.5% (ESS, 2023; Feleke et al., 2020). There are 41 primary schools (grades 1-8) in the district, serving 25,656 students, of whom 83.5% attend primary school (KDEO, 2022). Data collection took place from May 1 to July 30, 2023.

### **Study Population and Sampling**

The study population included primary school children in grades 5 to 8 and their families. Students in lower grades were excluded because they might have trouble giving accurate responses.

### **Sample Size Determination: Sample Size Determination**

The sample size was calculated using a single population proportion formula with a 95% confidence level and 5% margin of error (Daniel & Cross, 2018):

$$n = \frac{\left(\frac{Z\alpha}{2}\right)^2 \times p(1 - p)}{d^2}$$

where:

$Z\alpha/2$  represents the standard normal deviation for a 95% confidence level (1.96);  $p$  indicates the estimated proportion of KAP (61.3%), and  $d$  denotes the margin of error (0.05).

$$n = \frac{(1.96)^2 \times 0.613 (1-0.613)}{0.05^2} = 365 + 36.5 = 402$$

98  $(0.05)^2$

99 By using the largest sample size of 365 and accounting for a 10% non-response rate, the final  
100 sample size is 402 participants.

#### 101 Sampling Procedure

102 A multistage sampling technique was used. Six primary schools were randomly chosen from  
103 Kuyu District. The calculated sample size was then proportionally distributed among grades 5-8  
104 within these selected schools. Schoolchildren were randomly selected from each grade and sector.  
105 Additionally, the mothers or primary caregivers of the chosen schoolchildren were included in the  
106 study.

#### 107 Intervention

108 From May 1 to July 30, 2023, a three-month program was implemented to improve the knowledge,  
109 attitudes, and practices (KAP) of schoolchildren and their families regarding food safety and  
110 nutrition. This initiative used a "school-home approach" where students served as "agents of  
111 change."

112 A total of 100 male and female school WASH club members, with 10 to 20 students from each  
113 school, participated in a one-week food and nutrition training during the semester break. The  
114 objective of the training was to increase the consumption of nutrient-dense foods by school  
115 children, increase food consumption frequency among school children, improve food safety and  
116 personal hygiene practices of mothers and children, enhance the level of KAP in children and  
117 mothers/guardians, and improve school attendance and academic performance of children. The  
118 training was based on "Five keys to safer food" (WHO, 2026) and on a balanced diet and healthy  
119 eating habits (UNICEF, 2019). Of these, 26 students were carefully chosen by school  
120 administrators to take part in the school-home training and monitoring activities. The selection  
121 focused on older age, strong academic performance, and excellent behavior. These students,  
122 selected from each participating school, were tasked with being change agents in their peers' homes.

Using a prepared manual and other training materials, the 26 selected students held weekly, house-to-house training sessions with mothers and caregivers to promote knowledge transfer and encourage behavior change at the household level. They visited each home once a week to discuss food safety and nutrition issues with the mothers and caregivers. Additionally, all participating schoolchildren were encouraged to share their experiences and information with their own families.

#### Data Collection Tools and Procedure

A structured questionnaire, developed based on reliable and validated tools from previous studies (Deyasso and Ashenafi, 2022; Oliveira et al., 2023), was used to gather data. The questionnaire consisted of 49 items, divided into four sections: knowledge of food safety and healthy nutrition (12 items), attitude toward food safety and healthy nutrition (12 items), practices related to food safety and healthy nutrition (14 items), and sociodemographic characteristics (11 items). It contained both open and closed-ended questions.

Data were gathered through interviewer-administered questionnaires with 402 willing and anonymous participants from the selected schools. Schoolchildren filled out paper questionnaires under their teachers' supervision during class hours. Pre- and post-intervention data were collected from schoolchildren and their families using structured KAP questionnaires and observational checklists.

#### Data Processing and Analysis

Data were entered using EpiData software (version 3.5.3) and analyzed with SPSS (version 26.0). Both descriptive and inferential statistics were used. Regression analysis was used to examine the relationship between various parameters and WASH conditions. Paired-samples t-tests were used to compare individual participants' KAP scores before and after the intervention, with a significance level of  $\alpha = 0.05$ . Bloom's cut-off point for KAP studies was used to classify results as 'good' ( $\geq 80\%$ ), 'moderate' (60-80%), or 'poor' ( $< 60\%$ ), as in Destaw et al. (2021).

#### Ethical Considerations

Ethical approval was received from the Ethical Review Board of the College of Development Studies at Addis Ababa University. Permission to carry out the study was obtained from the

relevant education offices at the zone and district levels. Informed consent was obtained from household heads, school officials, and students over 18 years of age. Before the intervention, meetings were held with parents to describe the study's purpose and to get their consent for their children's participation.

## Results

A total of 389 out of 402 schoolchildren participated in and completed food safety and healthy nutrition programs. Of these, 52.4% were female and 47.8% were male. Most participants (72.2%) were between 10 and 15 years old, while the remaining 27.8% were aged 16 to 20. Regarding residence, 50.6% of the participants lived in rural areas, and 49.4% lived in semi-urban settings. Concerning ethnicity, the Oromo group made up 90.2% of the participants (Table 1).

Table 1: Socio-demographic characteristics of primary schoolchildren in Kuyu district.

| Variables            | Category                  | Number (%) |
|----------------------|---------------------------|------------|
| Sex                  | Male                      | 186 (47.8) |
|                      | Female                    | 203 (52.4) |
| Age                  | 10-15                     | 281 (72.2) |
|                      | 16-20                     | 108 (27.8) |
| Residence            | Rural                     | 197 (50.6) |
|                      | Urban                     | 192 (49.4) |
| Ethnicity            | Oromo                     | 351 (90.2) |
|                      | Amhara                    | 27 (6.9)   |
|                      | Others (Gurage, Walaita)  | 11 (2.8)   |
| Family religion      | Orthodox                  | 280 (72.0) |
|                      | Protestant                | 97 (24.9)  |
|                      | Others (Muslim, Wagefata) | 12 (3.1)   |
| Distance from school | 0-2 km                    | 300 (77.1) |
|                      | >2 kms                    | 89 (22.9)  |
| Physical Disability  | No                        | 374 (96.1) |
|                      | Yes                       | 15 (3.9)   |

The intervention significantly improved student outcomes (Table 2), reducing the number of students with average semester scores below 75% (from 49.6% to 35.0%) and increasing the number of students scoring 75-89% (from 40.9% to 53.5%). Overall disease prevalence decreased

from 11.6% to 6.2%, accompanied by a slight decline in the proportion of diarrhea cases (from 68.9% to 66.7%). School attendance also markedly improved, with 91.5% of students missing 0-2 days per month, a substantial increase from the prior 44.2% who missed over two days.

Table 2: Educational achievement and health-related issues among primary schoolchildren.

| Variables                               | Intervention   |                 | Increase in percentage points |
|---|----------------|-----------------|-------------------------------|
|   | Pre-Number (%) | Post-Number (%) |                               |
| Average semester score                  |                |                 |                               |
| <75                                     | 193 (49.6)     | 136 (35.0)      | -14.6                         |
| 75-89                                   | 159 (40.9)     | 208 (53.5)      | +12.6                         |
| >=90                                    | 37 (9.5)       | 45 (11.5)       | +2.0                          |
| Experienced disease                     | 45 (11.6)      | 24 (6.2)        | -5.4                          |
| Types of disease                        |                |                 |                               |
| Diarrhea                                | 31 (8.0)       | 16 (4.1)        | -3.9                          |
| Others (febrile illness, common cold)   | 14 (3.6)       | 8 (2.1)         | -1.5                          |
| Number of days absent from school/month |                |                 |                               |
| 0-2 days                                | 217 (55.8)     | 356 (91.5)      | +35.7                         |
| >2 days                                 | 172 (44.2)     | 33 (8.5)        | -35.7                         |

#### Improved Knowledge Towards Food Safety and Nutrition

On average, post-intervention knowledge increased by 31 percentage points to 65% (moderate knowledge) across the 12 knowledge items (Table 3). A ‘good’ level of post-intervention knowledge (>80%) was observed in nutritional issues, such as discouraging sugar-rich foods and understanding the consequences of going to school without breakfast. ‘Good’ knowledge was also achieved in food safety topics, including storing food in a cool area, avoiding leftovers, preventing fecal contamination of food, and treating water. ‘Moderate’ post-intervention knowledge level (60-80%) was observed in signs of well-cooked foods and washing raw fruits and vegetables before consumption.

Improved but still insufficient post-intervention knowledge (<60%) was observed in signs of undernutrition, causes of undernutrition, and key moments for handwashing. No improvement was seen in the reasons for separating raw and cooked foods. This is not practiced possibly because, as stew is prepared and consumed immediately, the need to separate cooked from raw foods is not a major concern. Overall, the educational intervention has increased the knowledge of our



respondents, except for their understanding of how to separate raw and cooked foods to prevent kitchen contamination.

Table 3: Knowledge of nutrition- and food safety-related issues among primary school children in Kuyu district.

| Knowledge variables                                       | Intervention outcome |              | Increase in percentage points |
|---|----------------------|--------------|-------------------------------|
|   | Pre-No. (%)          | Post-No. (%) |                               |
| Consequences of a child going to school without breakfast | 161 (41.4)           | 312 (80.2)   | +38.8                         |
| Discourages sugar-rich foods                              | 56 (14.4)            | 313 (80.5)   | +66.1                         |
| Signs of undernutrition                                   | 96 (24.7)            | 176 (45.2)   | +20.5                         |
| Causes of undernutrition                                  | 101 (26.0)           | 128 (32.9)   | +6.9                          |
| Reason for separating raw and cooked foods                | 88 (22.6)            | 81 (20.8)    | -1.8                          |
| Signs of well-cooked foods for safety                     | 107 (27.5)           | 246 (63.2)   | +35.7                         |
| Types of food to place in a cool place                    | 217 (55.0)           | 361 (92.8)   | +37.8                         |
| Reasons to avoid leftover foods                           | 191 (49.1)           | 376 (96.6)   | +47.5                         |
| Washing raw fruits and vegetables before eating           | 130 (33.4)           | 243 (62.5)   | +29.1                         |
| How to prevent fecal contamination of food                | 265 (68.1)           | 378 (97.2)   | +29.1                         |
| Key moment of hand washing                                | 72 (14.5)            | 82 (21.1)    | +6.6                          |
| How to treat water  | 104 (46.0)           | 368 (94.6)   | +48.6                         |
| Average knowledge status                                  | 132 (33.9)           | 254 (65.3)   | +31.4                         |

#### Improved Attitudes Towards Food Safety and Nutrition

The intervention significantly improved students' attitudes towards health and food safety, which were initially "poor" (below 60%) across all 12 assessed items (Table 4). Post-intervention, attitudes showed an average increase of 42 percentage points (ranging from 20% to 55%), elevating the overall classification to a "moderate" level (60-80%). This indicates that the training notably improved schoolchildren's previously poor attitudes regarding nutrition and food safety to an acceptable standard.

Notable improvements included a rise in the seriousness attributed to food poisoning (8 to 72%), an increase in eating breakfast before school (15 to 70%), a growth in the belief that iron-rich foods are healthy (15.7 to 66%), and greater awareness of the importance of handwashing (31 to 61%) and boiling water before drinking (12 to 59%).

201 Table 4: Attitude of nutrition-related issues among primary school children in Kuyu district.

| Attitude variables   | Intervention outcome |                  | Increase in percentage points |
|--|----------------------|------------------|-------------------------------|
|  | Pre-<br>No. (%)      | Post-<br>No. (%) |                               |
| Good to eat before school                                    | 59 (15.2)            | 274 (70.4)       | +55.2                         |
| Good to have three meals with a snack                        | 131 (29.0)           | 236 (60.7)       | +31.7                         |
| Good to have a meal rich in iron (beef, chicken, liver, ...) | 61 (15.7)            | 257 (66.1)       | +50.4                         |
| Liking the taste of meat, eggs...                            | 127 (32.6)           | 206 (53.0)       | +20.4                         |
| Illness is likely from eating spoiled foods                  | 53 (13.6)            | 206 (53.0)       | +39.4                         |
| Food poisoning is serious                                    | 31 (8.0)             | 280 (72.0)       | +64                           |
| Reheating leftover foods before eating is good               | 93 (23.9)            | 277 (71.2)       | +47.3                         |
| Washing fruits with water is good                            | 25 (6.4)             | 213 (54.8)       | +48.4                         |
| Illness from not washing hands is likely                     | 118 (30.8)           | 237 (60.9)       | +30.1                         |
| Diarrhea is a serious health problem                         | 86 (22.1)            | 239 (61.4)       | +39.3                         |
| Handwashing is good before food preparation                  | 75 (19.3)            | 195 (50.1)       | +30.8                         |
| Boiling water before drinking                                | 47 (12.1)            | 230 (59.1)       | +47                           |
| Average Attitude status                                      | 19.5%                | 61.1%            | +42                           |

202 Overall, this demonstrates the intervention's significant impact in transforming information  
 203 into positive behavioral intentions, indicating a substantial shift toward science-based health  
 204 practices across all evaluated areas.

#### 205 Improved Practices Towards Food Safety and Nutrition

206 Students' food safety and hygiene practices were initially very poor, with an average pre-  
 207 intervention score of 17% (ranging from 6.4% to 26.5%). While the intervention led to a 13  
 208 percentage point increase, the improved practices still fell below 60%, indicating that a "moderate"  
 209 level of practice was not achieved (Table 5). This suggests that sustained support and monitoring  
 210 beyond the study's duration are crucial for further improvement.

211 Table 5: Practice of nutrition-related issues among primary school children in Kuyu district,  
 212 North Shewa Zone, Oromia, Ethiopia 2023

| Practice variables                   | Intervention outcome |              | Increase in percentage points |
|--------------------------------------|----------------------|--------------|-------------------------------|
|                                      | Pre-No. (%)          | Post-No. (%) |                               |
| Eat vitamin A and iron-rich food     | 59 (15.2)            | 217 (55.8)   | +40.6                         |
| Eat animal-source food               | 66 (17.0)            | 122 (31.4)   | +14.4                         |
| Eat Vegetables                       | 81 (20.8)            | 138 (35.5)   | +14.7                         |
| Eat fruits                           | 42 (10.8)            | 63 (16.2)    | +5.4                          |
| Cleaning dirty utensils              | 76 (19.5)            | 129 (33.1)   | +13.6                         |
| Store perishable foods               | 103 (26.5)           | 148 (38.1)   | +11.6                         |
| Times of handwashing                 | 97 (24.9)            | 97 (24.9)    | +8.4                          |
| Treat the Water container for safety | 64 (16.5)            | 87 (22.4)    | +5.9                          |
| Treat water for drinking             | 49 (12.6)            | 108 (27.8)   | +15.2                         |
| Ways of treating drinking water      | 25 (6.4)             | 54 (13.9)    | +7.5                          |
| Average Practice                     | 17%                  | 29.9%        | +12.9                         |

Students' food safety and hygiene practices were initially very low, averaging only 17% (with a range of 6.4% to 26.5%) across the ten assessed items before the intervention. While the intervention led to a 13-percentage-point increase, these improvements still fell short of the 60% threshold needed to reach a "moderate" level of practice. This suggests that ongoing support and monitoring beyond the study period are crucial for achieving more substantial and sustained improvements in these practices.

#### Impact of intervention on KAP in food safety and nutrition

A paired-samples t-test was performed to assess the effectiveness of the food safety and health intervention by comparing the mean scores for schoolchildren's KAP before and after the intervention. The analysis showed statistically significant improvements in all three areas.

There was a notable increase in knowledge scores from pre-intervention ( $M = 5.57$ ,  $SD = 1.68$ ) to post-intervention ( $M = 8.32$ ,  $SD = 1.72$ ;  $t(388) = -22.71$ ,  $p < 0.0001$ ). This shows a large effect size of 1.6, indicating a significant improvement in students' understanding.

A notable positive change was observed in attitudes, with mean scores increasing from pre-intervention ( $M = 4.25$ ,  $SD = 1.35$ ) to post-intervention ( $M = 7.82$ ,  $SD = 2.00$ ;  $t(388) = -28.98$ ,  $p$

< 0.0001). This shift resulted in an even larger effect size of 2.1, reflecting a significant positive change in students' attitudes toward food safety and health.

Students' practices also improved significantly, with mean scores increasing from pre-intervention ( $M = 5.54$ ,  $SD = 1.34$ ) to post-intervention ( $M = 8.16$ ,  $SD = 1.49$ ;  $t(388) = -31.08$ ,  $p < 0.0001$ ). This change was accompanied by a large effect size of 1.8, indicating a substantial positive shift in health-related behaviors.

These results clearly show that the intervention had a highly significant and practically meaningful impact on schoolchildren's knowledge, attitudes, and practices (KAP) regarding food safety and health.

## Discussion

The Knowledge, Attitudes, and Practices (KAP) model is a fundamental part of public health research. It provides a systematic approach to understanding health behaviors, enabling researchers to develop effective interventions and evaluate their outcomes (Zarei et al., 2024). The most effective approach to understanding schoolchildren's food safety insights involves assessing their knowledge, attitudes, and practices (Wanniarachchi and Abeysundara, 2023). This framework indicates that improving KAP related to nutrition and food safety can significantly reduce foodborne illnesses, enhance overall health, and lower the risk of malnutrition. Ultimately, KAP greatly influences an individual's dietary choices and routines.

The findings of this study highlight the crucial role of school-based food safety and nutrition education programs in improving the knowledge, attitudes, and practices (KAP) of schoolchildren in our study area. The observed improvements align with regional and international research, supporting the effectiveness of such interventions in similar settings (Bello et al., 2024; O'Brien et al., 2021). School-based nutrition initiatives, including education, better food environments, and comprehensive health-promoting strategies, can positively impact dietary outcomes.

### 4.1 Impact on Knowledge

Our intervention significantly improved schoolchildren's knowledge, as evidenced by a large effect size (Cohen's  $d = 1.6$ ), indicating a substantial increase in nutritional literacy and underscoring the effectiveness of structured school-based programs. This aligns with findings from

similar interventions that have enhanced the understanding of healthy eating and nutrition among schoolchildren (Chaudhary et al., 2020; EL Mokadem & Shokr, 2021; Mogre et al., 2024). A consistent Ethiopian study also found that better diet-related behaviors were directly linked to knowledge gains (Lombamo et al., 2024).

#### 4.2 Impact on Attitudes

The fact that a sufficiently favorable attitude of students ( $p < 0.05$ ) was obtained in the assessed items aligns with other findings showing that nutrition education improves knowledge, attitudes, and practices related to health, nutrition, and hygiene among junior and senior high school students (Rimbawan et al., 2023; Kim et al., 2023). This demonstrates the success of the intervention in fostering positive health-related attitudes, with improved favorable attitudes toward food safety and nutrition (Wanniarachchi et al., 2022).

#### 4.3 Impact on Practices

Although none of the practice items reached satisfactory levels (all below 60%), we observed a statistically significant increase ( $p < 0.05$ ) in the number of schoolchildren demonstrating good food safety and healthy nutritional practices. This result, which is both statistically and practically significant, highlights the effectiveness of structured health education in schools (El Mokadem & Shokr, 2021; Mogre et al., 2024). It is often observed that a person's knowledge and positive attitude do not always translate into action. This gap between what people know and what they do is influenced by various factors, including environmental conditions, cultural practices, and socioeconomic status. These elements can act as significant barriers, hindering the adoption of desired behaviors even when an individual has favorable intentions.

These findings are supported by research from Islam et al. (2023) and Ramu et al. (2023), who also discovered that school-based nutrition and hygiene programs, especially those utilizing hands-on, interactive methods, are highly effective in promoting safe food handling and consumption. These significant improvements emphasize the urgent need to fund similar school-based interventions as part of national health promotion strategies.

#### 4.4 Overall Impact and Comparative Strengths

The paired-samples t-test results consistently show significant improvements across all KAP domains. Knowledge scores increased notably ( $M_{pre} = 5.57$ ,  $M_{post} = 8.32$ ;  $t(388) = -22.71$ ,  $p < 0.0001$ ), with a very large effect size of 1.6. Attitudes also showed a highly significant positive change ( $M_{pre} = 4.25$ ,  $M_{post} = 7.82$ ;  $t(388) = -28.98$ ,  $p < 0.0001$ ), with an even larger effect size of 2.1. Likewise, practices significantly improved ( $M_{pre} = 5.54$ ,  $M_{post} = 8.16$ ;  $t(388) = -31.08$ ,  $p < 0.0001$ ), reflecting a very large effect size of 1.8.

These findings indicate that, while pre-intervention knowledge, attitudes, and practices were initially limited (averaging 34%, 20%, and 17%, respectively), the intervention significantly improved schoolchildren's knowledge and attitudes. These areas saw an average increase of 37 percentage points, reaching a sufficient level (over 60%). This aligns with other studies that also observed substantial improvements in schoolchildren's food safety attitudes relative to their knowledge scores (Buyco et al., 2022; Wanniarachchi et al., 2022). This suggests the intervention effectively translated knowledge into positive behavioral intentions and habits.

#### **Conclusion**

This study shows that a structured educational intervention significantly enhanced schoolchildren's knowledge, attitudes, and practices (KAP) regarding food safety and nutrition. We observed substantial, statistically significant improvements across all KAP areas, with effect sizes demonstrating both practical and educational importance. Essentially, the intervention effectively changed participants' understanding and behaviors toward safer and healthier food choices.

#### **Recommendations**

Given these powerful results, we recommend permanently integrating food safety and nutrition education into school health curricula, ideally starting in primary school with involvement from parents, guardians, and local stakeholders to reinforce learning and promote lasting behavior change at home. We also suggest expanding this effective intervention strategy to more schools and regions, supported by government health and education policies, and conducting longitudinal mixed-method studies to assess the sustainability of these changes and identify areas for future improvement. To better assess the lasting impact of our work, we suggest a follow-up evaluation.

This would help us see if the positive changes in knowledge, attitudes, and practices (KAP) are maintained over time.

### **Limitations of the study**

The questionnaires used in this study might cause students to report what they believe is expected rather than their actual behavior. The study was conducted in only one district in Ethiopia; therefore, the findings may not be applicable to other diverse regions or populations. The study did not evaluate the KAP of students in lower primary grades, meaning the impact of the intervention on younger children, who are also vulnerable, was not assessed. The three-month intervention and monitoring period might not be sufficient to observe lasting behavioral changes, indicating the need for longer-term follow-up.

### **Declarations**

8.1 Acknowledgements. None

8.2 Consent for publication. Not applicable.

8.3 Availability of data and materials. All data generated or analyzed during this study are included in this manuscript.

8.4 Conflicts of interest. The authors declare no conflicts of interest

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8.7 Declaration of generative AI and AI-assisted technologies in the writing process.

During the preparation of this work, we utilized the Gemini language model to enhance the readability and language of the manuscript. After using this service, we reviewed and edited the content as needed and take full responsibility for the content of the published article.

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