Effects of nutrition education and menu development on nutrition knowledge, practices, and dietary intake among adolescent girls in Islamic boarding schools

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Abstract. Adolescent girls in Islamic boarding schools are at risk of inadequate dietary intake due to limited access to nutritious foods and varying nutrition literacy. This study evaluated the effects of combining nutrition education and menu development in a boarding school setting. A quasi-experimental pre–post control group design was conducted over three months among 76 female students aged 12–15 years (38 intervention; 38 control). The intervention group received weekly nutrition education and improved menu planning, while the control group continued the usual program. Knowledge, attitudes, and practices (KAP) were assessed using validated questionnaires, dietary intake using 24-hour recall, and nutritional status using anthropometry. Both groups showed significant improvements in knowledge and practices ($p<0.05$), whereas attitudes improved only in the control group ($p=0.025$). Changes in practices were significantly greater in the intervention group ($p<0.05$). Macronutrient intake changed over time in both groups; however, significant group-by-time interactions were found for protein ($p=0.005$) and fat intake ($p=0.025$), indicating stronger intervention effects. No significant changes in nutritional status were observed. Integrating nutrition education with food environment modification may improve dietary outcomes in institutional settings.

1 Introduction

Adolescence is a crucial period marked by fast physical development and higher nutritional needs, especially for girls who need to consume enough macronutrients and micronutrients. [1]. In Indonesia, nutritional problems among adolescents remain prevalent, including anemia, chronic energy deficiency, and imbalanced nutrient consumption [2]. These challenges are further intensified in boarding school environments, such as Islamic boarding

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schools, where students largely depend on institutional food services and often have limited food choices and varying levels of nutrition knowledge [3]. Nutrition education has been widely recognized as an effective strategy to improve knowledge and promote healthier dietary behaviors among adolescents [4]. However, educational interventions alone may not lead to sustained dietary improvements if they are not supported by an enabling food environment [5]. Therefore, combining nutrition education with institutional menu modification may offer a more comprehensive strategy to improve dietary quality in boarding school settings. Evidence on such integrated interventions in Islamic boarding schools remains limited. This study evaluated its effects on nutrition knowledge, attitudes, practices, and dietary intake among adolescent girls.

2 Methods

2.1 Study design and participants

A quasi-experimental study with a pre–post control group design was conducted over three months among 76 female students aged 12–15 years from two Islamic boarding schools (38 intervention; 38 control). Participants were selected using purposive sampling based on eligibility criteria and consent to participate. Sample size calculation was based on a 5% significance level and 90% statistical power, with an additional allowance for potential dropout.

2.2 Intervention

The intervention combined nutrition education and institutional menu development. Nutrition education was delivered weekly for 12 weeks (60–90 minutes/session) using interactive methods (lectures, discussions, and booklets), covering balanced nutrition, healthy eating, and food choices. Menu development was implemented over three months, resulting in improvements in menu planning, portion sizes, food variety, and nutrient composition in accordance with national balanced nutrition guidelines. The control group continued the usual program without additional intervention.

2.3 Data collection

KAP were assessed at baseline and endline using a validated questionnaire. Dietary intake was measured using 24-hour recall at baseline, midline, and endline and analyzed using Nutrisurvey. Nutritional status was assessed at baseline and endline using BMI-for-age (z-score) based on WHO standards.

2.4 Statistical analysis

Data were analyzed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Within-group differences were tested using paired tests. Between-group differences in KAP changes were analyzed using the Mann–Whitney test. Repeated-measures ANOVA was used to assess changes in dietary intake over time and the group × time interaction. Statistical significance was set at $p<0.05$.

3 Results and discussion

3.1 Characteristics of participants

Table 1. Characteristics of participants.

Variable	Control (n=38) Mean±SD	Intervention (n=38) Mean±SD	p-value*
Age (years)	13.21±0.55	13.97±0.67	<0.001
Nutritional Status (BMI-for age z-score)	0.63±1.67	0.35±0.45	0.448

*Differences between groups were tested using independent t-test ($p<0.05$).

Baseline body weight and BMI-for-age z-score were comparable between groups ($p>0.05$). Although age differed ($p<0.001$), participants remained within a similar developmental stage. Overall, these comparable baseline characteristics support internal validity and reduce potential confounding from adolescent growth variation [1].

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3.2 Changes in nutrition knowledge, attitudes, and practices

Table 2. Pre–Post changes in knowledge, attitude, and practices in intervention and control groups.

Variable	Pre Test (Baseline)	Post test (Endline)	p-value*
Knowledge			
Intervention	55.5 (11−100)	66.67 (44−100)	0.000
Control	33.3 (11−67)	66.67(44−88)	0.000
Attitude			
Intervention	85.7 (57.1−100)	85.7 (42.8−100)	0.078
Control	71.4 (57−86)	85.7 (42.8−100)	0.025
Practices			
Intervention	77.7 (52.7−94.4)	83.3 (63.8−100)	0.001
Control	30 (21.1−37.8)	77.7 (47.22−97.22)	0.000

*Within-group differences were tested using the Wilcoxon signed-rank test ($p<0.05$)

The intervention group showed significant improvements in knowledge ($p<0.001$) and practices ($p=0.001$), while no significant change was observed in attitudes ($p=0.078$). In the control group, significant increases were found across knowledge, attitudes, and practices ($p<0.05$), with a notably large improvement in practice scores. From a KAP perspective, these findings suggest that nutrition education effectively strengthened cognitive understanding, which is the first stage of behavior change [4]. However, according to behavior change theories, including the Health Belief Model, knowledge alone is insufficient to sustain attitudinal change; perceived susceptibility, benefits, and environmental cues are also required to consolidate behavioral transformation [6]. The ceiling effect may explain the absence of significant attitudinal change, as baseline attitude scores were already relatively high, limiting measurable improvement. This suggests pre-existing positive readiness toward healthy eating among participants, which reduces variability and statistical sensitivity to detect change [7]. Importantly, practice changes were significantly greater in the intervention group compared to the control group ($p<0.05$), indicating that environmental reinforcement through menu development strengthened behavioral adoption. This supports ecological models of health behavior, which emphasize that individual behavior is strongly shaped by the surrounding food environment, particularly in institutional settings such as boarding schools [6].

Table 3. Comparison of changes in knowledge, attitude, and practices between intervention and control groups.

Variable	Intervention Δ Median (Min-Max)	Control Δ Median (Min-Max)	p-value*
Knowledge	22 (-11−77.78)	33 (-11−77.78)	0.179
Attitude	0 (-42.86−28.57)	14.28 (-28.57−42.86)	0.379
Practices	69 (-19−36.11)	44 (12.65−61.11)	0.000

*Differences between intervention and control groups were tested using the Mann–Whitney test ($p<0.05$)

Practice improvements were significantly higher in the intervention group compared to the control group ($p<0.001$), while no differences were observed in knowledge and attitude ($p>0.05$). This suggests that the intervention was more effective in translating knowledge into behavior rather than increasing cognitive or attitudinal differences between groups. Consistent with KAP and Health Belief Model frameworks, behavioral change is more strongly influenced by environmental reinforcement than knowledge alone [6]. The integration of menu development likely acted as a key environmental driver of improved practices in the intervention group.

3.3 Changes in dietary intake

Table 4. Changes in dietary intake.

Variable	Baseline Mean±SD	Midline Mean±SD	Endline Mean±SD	p-value*	p-value **
Energy					
Intervention	1,370±642.06	1,243.04 ± 76.98	1,686.3±704.6	0.000	0.359
Control	1,110.9±466.5	1,143.81±378	1,647±750.2	0.000	
Protein					
Intervention	39.9±18.4	47.5±75.4	51.49±22.98	0.000	0.005
Control	35.65±19.49	38.8±15.8	63.89±45.4	0.000	
Fat					
Intervention	44.07±31.8	54.5±86.4	48.2±30	0.666	0.025
Control	34.7±22.6	37±17	48±25	0.015	
Carbohydrate					
Intervention	209.9±85.4	181.9±76.98	257.1±103.31	0.000	0.632
Control	168.8±65.8	168.46±54.4	233.39±105.8	0.000	

*p (Time): within-subject effect across measurement time points (baseline, midline, endline) using repeated-measures ANOVA. **p (Group × Time): interaction effect between group (intervention vs control) and time

Macronutrient intake changed significantly over time in both groups; however, significant group-by-time interactions were observed for protein ($p=0.005$) and fat intake ($p=0.025$), indicating greater improvements in the intervention group. No significant interaction effects were found for energy ($p=0.359$) and carbohydrate intake ($p=0.632$), suggesting similar trends across groups. These results indicate that the integrated intervention had a more specific effect on improving diet quality rather than overall caloric intake. The improvement in protein intake likely reflects changes in institutional menu composition. In contrast, the lack of change in fat intake across both groups may reflect limited flexibility in modifying cooking practices and food sourcing within boarding school food systems [3]. Consistent with behavioral nutrition literature, dietary changes are more effectively achieved when

education is combined with structural modifications to food availability, reinforcing the importance of environmental interventions alongside individual-level education [6].

3.4 Changes in nutritional status

Table 5. Changes in nutritional status.

Nutritional Status (BMI-for age z-score)	Pre Mean±SD	Post Mean±SD	p-value*
Intervention	0.35±0.45	0.36±0.85	0.901
Control	0.63±1.67	0.77±1.4	0.826

*Within-group differences tested using paired t-test ($p<0.05$)

No statistically significant changes were observed in BMI-for-age z-scores in either group ($p>0.05$). Nevertheless, mean BAZ in both groups remained within the normal range (-2 SD to +1 SD) before and after intervention, indicating no deterioration toward underweight or overweight. This suggests that the 3-month intervention was insufficient to produce measurable anthropometric changes, as nutritional status in adolescents is influenced by long-term dietary intake and growth processes, and behavioral changes typically precede physiological outcomes [8, 9].

4 Conclusion

Integrated nutrition education and menu development improved knowledge and dietary practices among adolescent girls in Islamic boarding schools, highlighting the value of combined behavioral–environmental strategies. However, unchanged nutritional status suggests short-term gains were insufficient to affect anthropometric outcomes. Longer, multi-level interventions are needed to achieve measurable nutritional improvement.

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