nutrición clínica y Dietética Hospitalaria

Artículo Original

Nutr Clín Diet Hosp. 2025; 45(3):366-375
DOI: 10.12873/453mehingko

Synergistic effects of balanced diet education and Ramadan fasting on body weight in obese adolescents

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Recibido: 12/junio/2025. Aceptado: 1/octubre/2025.

ABSTRACT

Background: Obesity is a growing public health issue, driven by poor dietary habits and sedentary behavior during the transition from adolescence to early adulthood. Although Ramadan fasting, as part of the Muslim faith not intended for weight management, may offer health benefits when combined with balanced nutrition. This study aimed to evaluate the effectiveness of combining nutrition education with Ramadan fasting in reducing body weight, improving body composition and dietary habits among obese undergraduate students.

Methods: A randomized pretest–posttest control group study was conducted among 76 obese undergraduate students (BMI ≥25 kg/m²) at Hasanuddin University (February–April 2025). Participants were randomized by the closed-envelope method into an intervention group (balanced nutrition education with Ramadan fasting) or a control group (fasting only). Anthropometry and body composition were measured using standardized procedures with a Tanita BC-730 Bioelectrical Impedance Analyzer. Dietary intake was assessed with a baseline FFQ and repeated 24-hour recalls (eight times during Ramadan). Data were analyzed using Wilcoxon, Mann–Whitney, and independent *t*-tests, with significance set at $p<0.05$.

Results: The intervention group achieved greater weight reduction (2.23 kg, ≈3% vs. 1.52 kg, ≈2.1%; p= 0.045), although the clinical relevance of this change was modest within a short duration. More substantial effects were noted in body composition, including significant reductions in fat mass (–3.21%; $p=0.002$), increases in muscle mass (+3.55%; $p<0.001$), and greater protein intake (+8.53 g; $p=0.007$). An upward trend in fiber intake was also observed ($p=0.059$).

Conclusion: Ramadan fasting combined with balanced nutrition education effectively improved body composition, nutrition knowledge, and healthy eating behaviors.

KEYWORD

Obesity, weight loss, balanced nutrition education, Ramadan fasting.

INTRODUCTION

Obesity, characterized by excessive fat accumulation, has emerged as a global public health concern due to its strong association with chronic conditions such as diabetes, cardiovascular disease, and certain cancers[1]. Among young adults, particularly university students, the prevalence of overweight and obesity has risen significantly, with reports indicating that up to 30% of students fall into these categories[2]. The transition to college life often marks a shift toward unhealthy lifestyle behaviors, including reduced physical activity and poor dietary habits for example, a study by Taslim, et al. (2023) conducted on a modern population in Indonesia indicated that dietary patterns with higher consumption of ultra-processed foods contribute to an increase in body mass index (BMI), waist circumference, and fat mass, which are factors associated with obesity[3,12]. Psychosocial stressors, emotional eating, and a lack of nutritional knowledge further

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exacerbate the risk[4]. In Indonesia, the concept of balanced nutrition is promoted through national guidelines, yet adherence among students remains limited. Interventions targeting this population are essential, as eating habits formed during this stage have long-term health implications. Intermittent fasting, particularly during Ramadan, has shown promise as a culturally appropriate and effective weight management strategy, supported by evidence from various studies. Furthermore, behavioral interventions focused on nutritional education and self-regulation have demonstrated success in promoting weight loss in college populations[5]. This study aims to evaluate the effectiveness of a balanced nutrition education program and Ramadan fasting in reducing body weight among obese undergraduate student.

MATERIALS AND METHODS

Study design and Participants

This randomized pretest–posttest control group study was conducted at Hasanuddin University, Makassar, during the month of Ramadan (30 days) from February to April 2025. A total of 770 undergraduate students were screened for nutritional status; 90 met the inclusion criteria (BMI ≥25 kg/m² and who observed ramadan fasting), and 76 consented to participate. Fourteen participants were lost to follow-up (Figure 1). Participants were randomly assigned to either the intervention or control group using a closed-envelope randomization procedure. Allocation codes were prepared in advance, placed in identical opaque sealed envelopes, thor-

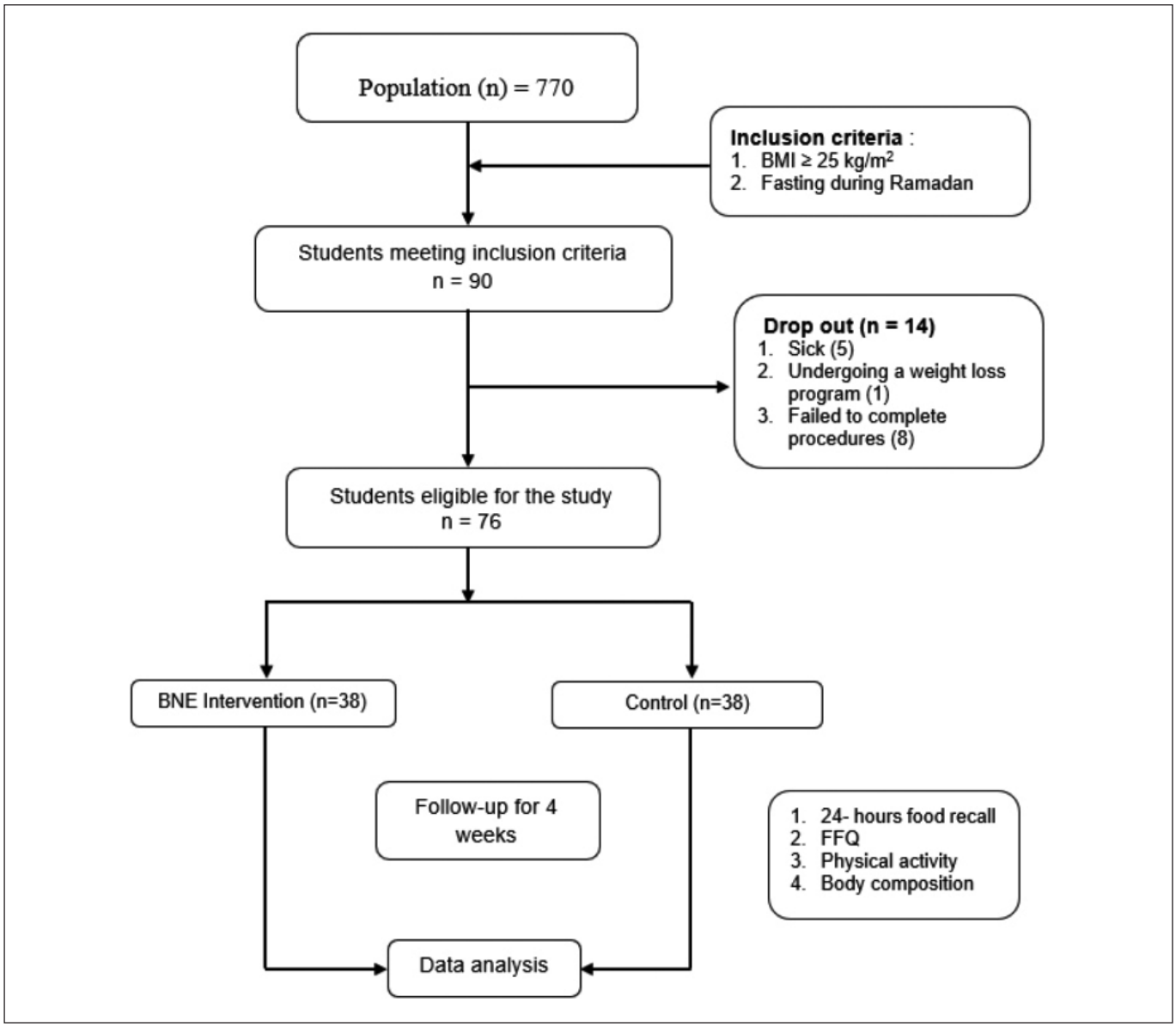

Figure 1. Flowchart of the study

oughly shuffled, and drawn by each participant to determine group assignment. Thirty-eight participants were allocated to the intervention group, which received balanced nutrition education (BNE) in addition to Ramadan fasting, and thirty-eight to the control group (C), which underwent Ramadan fasting only, without educational support. Exclusion criteria included pregnancy, ongoing non-temporary diet programs, the use of diet drugs, and diagnosed psychological or severe sleep disorders. Participants could be withdrawn from the study due to refusal to comply, discontinuation of participation, or severe illness.

Recruitment occurred via WhatsApp, coordinated with class representatives, following ethical approval (No. 30/UN4.6.4.5.31/PP36/2025). Eligibility screening was followed by informed consent procedures. Data collection included demographic characteristics, anthropometric and body composition measurements, FFQ, 24-hours food recall, and physical activity via IPAQ. Anthropometric assessments and dietary recall were conducted before and after the intervention. The BNE group received structured nutrition education through WhatsApp counseling, printed materials, and weekly face-to-face sessions. All participants completed pre- and post-study questionnaires measuring knowledge and attitudes.

Dietary Intake Assessment

Dietary intake data was assessed using repeated 24-hours food recall and a baseline Food Frequency Questionnaire (FFQ). All study participants were instructed to complete the food recall form provided via the WhatsApp (WA) application. The 24-hours food recall was conducted twice a week: once on a weekday coinciding with campus activities (Wednesday or Thursday) and once on a weekend or holiday (Saturday or Sunday), resulting in a total of eight recalls per participant. Reported food intakes were initially recorded in household measures and subsequently converted to gram weights using the food exchange list. Nutritional analysis was performed using NutriSurvey 2005 software.

Anthropometric and Body Composition Measurements

Anthropometric data were obtained by measuring body weight (BW) using a calibrated analog scale, with participants wearing a single layer of standardized clothing to minimize measurement error. Body height (BH) was measured using a wall-mounted stadiometer, and Body Mass Index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m²). Waist circumference and hip circumference were measured using a flexible measuring tape. All instruments were calibrated prior to measurement, and anthropometric assessments were conducted by trained clinical nutrition personnel following standardized procedures.

Body composition (fat mass, muscle mass, visceral fat, bone mass, and total body water) was assessed using Bioelectrical Impedance Analysis (BIA) with the Tanita Body Fat Analyzer (Model 730, Tanita Corporation of America Inc., Arlington Heights, IL, USA). Participants stood barefoot on the device platform, wearing light clothing and free of any personal items such as phones, wallets, keys, bags, or accessories measurement was conducted according to the manufacturer's instructions, with participants standing in an upright position, arms relaxed at their sides, and heels properly aligned on the device's footplate electrodes.

Intervention: Balanced Nutrition Education

The BNE group received balanced nutrition education via counseling through the WhatsApp application. Educational materials included guidance on balanced nutrition during Ramadan, appropriate food selection for suhoor (pre-dawn meal) and iftar (breaking the fast), portion control, physical activity during Ramadan, and sample meal plans tailored to participants' living situations (e.g., living with family, in dormitories, or in rented rooms). Additional educational materials included flipcharts distributed to each participant, containing dietary guidelines from the Indonesia Ministry of Health ***('Isi Piringku')***, this guideline advocates for a balanced dietary pattern by distributing food portions into three key categories: vegetables and fruits (50%), carbohydrates (25%), and proteins (25%). Nutritional requirements for adolescents based on Recommended Dietary Allowances, and food exchange lists. Face-to-face education sessions were conducted once per week during participants' break time, with an average duration of 30 minutes or adjusted according to participant availability.

The effectiveness of the educational intervention was evaluated using weekly food recall reports submitted twice a week by each participant via private WhatsApp messages. If dietary intake reports were inconsistent with the balanced nutrition guidelines, participants were engaged in follow-up discussions to identify and address any challenges they encountered in following the recommendations.

Statistical analysis

Following data collection, the dataset was organized for statistical analysis. Normality testing revealed a non-normal distribution, prompting the use of non-parametric tests, specifically the Wilcoxon test (for paired comparisons) and the Mann-Whitney test (for independent group comparisons), conducted in SPSS version 26 (IBM Corp., Armonk, NY). Additionally, an independent t-test was performed in Microsoft Excel to compare mean (delta) values between variables. The analyses aimed to evaluate differences in anthropometric measures, body composition, and dietary recall before and after intervention across groups. Statistical significance was set at p value ≤0.05.

RESULTS

A total of 76 respondents participated in this study, evenly divided between the intervention group, which received balanced nutrition education alongside Ramadan fasting, and the control group, which engaged in fasting alone. The demographic profiles of both groups were comparable, with no statistically significant differences in sex distribution, age, academic major, parental history of obesity, physical activity level, obesity category, sleep duration, waist-to-hip ratio, or other baseline characteristics, indicating a homogeneous starting point for both groups. (Table 1).

Anthropometric analysis showed that the intervention group had a significant reduction in body weight of –2.23 kg (≈3% of baseline; *p*=0.000), while the control group also

Table 1. Study Characteristics

Variables	Intervention Group		Control Group		p value
	n (%)	Mean±SD	n (%)	Mean±SD	
Gender					
Male	11 (28.9)		8 (21.1)		0.139[a]
Female	27 (71.1)		30 (78.9)		
Age (years)		18.53±0.64		18.45±0.55	0.422[a]
Study major					
Medicine	23 (60.5)		28 (73.7)		0.608[a]
Veterinary medicine	3 (7.9)		1 (2.6)		
Nursing	4 (10.5)		3 (7.9)		
Physiotherapy	8 (21.1)		6 (15.8)		
History of family obesity					
Yes	20 (52.6)		24 (63.2)		0.745[a]
No	18 (47.4)		14 (36.8)		
Supplement consumption					
Yes	1 (2.6)		0 (0)		1.000[a]
No	37 (97.4)		38 (100)		
Weight loss program					
Yes	2 (5.2)		0 (0)		0.240[a]
No	36 (94.7)		38 (100)		
Physical activity					
Low	11 (28.9)		9 (23.7)		0.191[a]
Moderate	19 (50.0)		21 (55.3)		
High	8 (21.1)		8 (21.1)		

[a] Chi-square test; [b] Wilcoxon test; [c] Mann-Whitney test; SD: Standar Deviation; p-value < 0.05 was considered significant.

Table 1 continuation. Study Characteristics

Variables	Intervention Group		Control Group		p value
	n (%)	Mean±SD	n (%)	Mean±SD	
Obesity category					
Obesity I	23 (60.5)		26 (68.4)		0.481[a]
Obesity II	15 (39.5)		12 (31.6)		
Sleep duration (hours)		5.71±0.98		5.63±0.88	0.679[b]
Hip circumference (cm)					
Male		101.68±6.35		103.25±6.58	0.329[c]
Female		106.56±7.76		101.80±6.35	
Waist circumference (cm)					
Male		87.36±6.64		92.13±8.54	0.643[c]
Female		91.39±5.60		88.23±6.30	
Waist-hip-ratio					
Male		0.84±0.10		0.89±0.04	0.861[c]
Female		0.86±0.05		0.88±0.05	

[a] Chi-square test; [b] Wilcoxon test; [c] Mann-Whitney test; SD: Standar Deviation; p-value < 0.05 was considered significant.

demonstrated a smaller reduction of −1.52 kg (≈2.1%; *p*=0.003). The between-group difference was statistically significant (*p*=0.045), though the magnitude of weight loss remained clinically modest within this short-term 30-day period. Regarding BMI, the intervention group showed a significant decline from 29.69 to 28.57 kg/m² (p = 0.000), while the control group exhibited no significant change (p = 0.342). Although the reduction in BMI appeared more pronounced in the intervention group, the between-group difference did not reach statistical significance (p = 0.058). (Table 2).

Table 2. Anthropometric comparison of intervention group and control group pre- and post-test

Variables	Pre-test	Post-test	*p-value*	Δ	*p-value*
	Mean (SD)	Mean (SD)		Mean (SD)	
Weight (kg)					
Intervention group	75.73 ± 11.11	73.83 ± 10.99	**0.000[a]***	-2.23 ± 1.39	**0.045[b]***
Control group	72.68 ± 10.92	71.54 ± 10.57	**0.003[a]***	-1.52 ± 2.06	
BMI (kg/m^2)					
Intervention group	29.69 ± 3.66	28.57 ± 3.68	**0.000[a]***	-0.77 ± 0.61	0.058[b]
Control group	28.57 ± 2.72	28.13 ± 2.76	0.342[a]	0.44 ± 1.04	

[a] Mann-Whitney test; [b] Independent t-test; BMI: body mass index; SD: Standar Deviation; Δ: Difference of post and pre results; * p-value < 0.05 was considered significant.

In terms of body composition, the intervention group demonstrated a significant decrease in fat mass by 3.21% (p = 0.000), while the control group showed only a minimal, non-significant change of 0.11% (p = 0.283). The difference in fat mass reduction between the two groups was significant (p = 0.002). Muscle mass increased significantly in the intervention group by 3.55% (p = 0.000), whereas the control group experienced a non-significant decline of 2.04% (p = 0.307), resulting in a statistically significant difference between groups (p = 0.000). Additionally, visceral fat significantly decreased in the intervention group from 8.32 to 7.50 (p = 0.022), with no change in the control group (p = 0.937), leading to a significant intergroup difference (p = 0.000). (Table 3).

Dietary intake analysis based on 24-hour food recalls indicated that the intervention group significantly reduced energy intake by 431.19 kcal (p = 0.000), fat by 6.73 g (p = 0.024), and carbohydrates by 30.87 g (p = 0.000), while increasing protein intake by 8.53 g (p = 0.007). In contrast, the control group also showed a significant reduction in energy (270.73 kcal; p = 0.000) and carbohydrate intake (11.85 g; p = 0.000), but protein intake increased by only 1.21 g, which was not statistically significant (p = 0.286). The differences in changes between groups were significant for energy (p = 0.002) and protein intake (p = 0.003). No significant differences were observed between groups for fat, fiber, fructose, or sodium intake. However, fiber intake in the intervention group showed a positive trend toward increase (p=0.059), which is clinically relevant in the context of obesity (Table 4).

In assessing knowledge, the intervention group exhibited a notable improvement following the educational intervention. (Table 5).

DISCUSSION

The development of obesity during adolescence is a complex and multifactorial process shaped by genetic, behavioral, and environmental influences. While genetic predispositions influence adipose tissue storage and metabolism, lifestyle factors—particularly poor dietary choices and physical inactivity—play a more immediate role in the escalating prevalence of adolescent obesity. Increased availability of high-calorie, low-nutrient fast food, large portion sizes, and diets rich in sugars and fats significantly contribute to unhealthy weight gain in this population[6,13].

An important determinant of adolescent nutritional behavior is nutritional knowledge, which encompasses understanding food composition, nutrient bioavailability, and the relationship between diet and health. Deficiencies in this knowledge during adolescence can foster maladaptive dietary patterns, increasing the risk of both malnutrition and obesity. Addressing this issue requires targeted, multifaceted interventions adapted to adolescents developmental and psychosocial needs[6,7,9]. A study by Palupi et al.[7], revealed that mindful eating education significantly improved body weight and macronutrient intake among overweigth high school students (aged 15–17 years), though outcomes

Table 3. Comparison of body composition in both group pre- and post-test

Variables	Pre-test	Post-test	*p-value*	Δ	*p-value*
	Mean (SD)	Mean (SD)		Mean (SD)	
Fat mass (%)					
Intervention group	35,97 ± 7,81	32,76 ± 7,58	**0,000**[a]*	-3,21 ± 3,75	**0,002**[b]*
Control group	33,34 ± 7,04	34,44 ± 8,64	0,283[a]	-0,11 ± 5,32	
Muscle mass (%)					
Intervention group	60,52 ± 8,30	64.49 ± 8,94	**0,000**[a]*	3,55 ± 4,44	**0,000**[b]*
Control group	63,64 ± 9,08	61,60 ± 6,90	0,307[a]	-2,04 ± 6,34	
Visceral fat					
Intervention group	8,32 ± 2,16	7,50 ± 1,99	**0,022**[a]*	-0,82 ± 0,76	**0,000**[b]*
Control group	7,65 ± 2,21	7,54 ± 2,34	0,937[a]	-0,11 ± 1,07	

[a] Mann-Whitney test; [b] Independent t-test; SD: Standar Deviation; Δ: Difference of post and pre results; * p-value < 0.05 was considered significant.

Table 4. Comparison of 24-hour food recall in both group pre- and post-test

Variables	Pre-test	Post-test	*P-value*	Δ	*P-value*
	Mean (SD)	Mean (SD)		Mean (SD)	
Energy (Kkal)					
Intervention group	1584,92 ± 495,45	1153,72 ± 240,41	**0,000[a]***	-431,19 ± 220,15	**0,002[b]***
Control group	1569,36 ± 253,33	1298,63 ± 543,43	**0,000[a]***	-270,73 ± 267,43	
Protein (g)					
Intervention group	54,44 ± 18,54	62,98 ± 19,97	**0,007[a]***	8,53 ± 10,85	**0,003[b]***
Control group	46,19 ± 10,35	47,41 ± 19,55	0,286[a]	1,21 ± 12,05	
Carbohydrate (g)					
Intervention group	167,47 ± 51,17	136,6 ± 42,77	**0,000[a]***	-30,87 ± 91,10	0,197[b]
Control group	139,42 ± 75,52	127,57 ± 56,77	**0,000[a]***	-11,85 ± 79,94	
Fat (g)					
Intervention group	49,79 ± 13,65	43,05 ± 23,95	**0,024[a]***	-6,73 ± 24,43	0,201[b]
Control group	43,43 ± 11,26	41,96 ± 22,53	0,164[a]	-1,47 ± 25,89	
Fiber (g)					
Intervention group	6,11 ± 2,92	7,55 ± 2,59	0,059[a]	1,44 ± 3,97	0,160[b]
Control group	5,89 ± 3,19	6,51 ± 2,67	0,055[a]	0,62 ± 3,43	
Fructose (g)					
Intervention group	54,64 ± 25,47	53,77 ± 38,99	0,552[a]	-0.87 ± 47,28	0,453[b]
Control group	51,03 ± 26,06	48,77 ± 31,52	0,509[a]	-2,26 ± 41,51	
Natrium (g)					
Intervention group	3,46 ± 1,20	3,14 ± 2,07	0,380[a]	-0,32 ± 1,47	0,326[b]
Control group	3,52 ± 3,24	3,34 ± 3,01	0,215[a]	-0,18 ± 1,24	

[a] Mann-Whitney test; [b] Independent t-test; SD: Standar Deviation; Δ: Difference of post and pre results; * p-value < 0.05 was considered significant.

Table 5. Comparison of nutrition knowledge in both group pre- and post-test

Knowledge		Intervention group				Control group				*p*- value
		n	%	Mean	SD	n	%	Mean	SD	
Pre test	Good	4	10,6	1,58	0,50	0	0	1,74	0,44	**0,000[b]***
	Fair	23	60,5			28	73,7			
	Less	11	28,9			10	26,3			
Post test	Good	22	57,9	2,87	0,60	13	34,2	2,32	0,52	**0,003[b]***
	Fair	16	42,1			24	63,2			
	Less	0	0			1	2,6			
P value		**0,020[a]***				**0,027[a]***				

[a] Chi-square test; [b] Wilcoxon test; SD: Standar Deviation; * p-value < 0.05 was considered significant.

did not differ significantly from the control group receiving standard care per Ministry of Health guidelines (GENTAS protocol).

The findings of this study demonstrated that both the intervention group (receiving balanced nutrition education) and the control group (no education) exhibited weight reduction among obese students. However, the intervention group achieved a greater mean weight loss (2.23 kg, ≈3% of baseline) accompanied by a decrease in BMI, whereas the control group showed a more modest reduction (1.52 kg, ≈2.1%) without significant BMI changes. Similarly, Bagherniya et al.[14], conducted a 7-month randomized controlled trial involving 172 overweight and obese adolescents, demonstrating that school-based educational interventions significantly reduced BMI and waist circumference, with more pronounced effects in the intervention group.

The present study further indicates that the combined intervention—incorporating the General Guidelines for Balanced Nutrition, the *'Isi Piringku'* dietary model, and Ramadan fasting—positively influenced students' nutritional knowledge. This is consistent with the work of Puspikawati et al.[15], who observed enhanced nutrition-related awareness among high school and university students following youth-led educational programs. Additionally, Herliah et al.[16], found that a two-month web-based She Smart education program significantly improved knowledge and attitudes toward nutrition among 47 obese adolescent girls. The intervention also emphasized mindful eating practices, fostering greater awareness of satiety cues and promoting prudent food choices outside the home. These findings corroborate the experimental study by Zahtamal et al.[17], wherein nutrition counseling and discussions significantly improved adolescents' knowledge, attitudes, and behaviors regarding balanced diets. While this educational approach serves as an effective weight management strategy, its efficacy is comparable to other dietary interventions. Supporting evidence suggests that Ramadan fasting improves body composition, including BMI, body fat percentage, and waist-to-abdominal circumference ratios, likely due to hormonal adaptations involving leptin, ghrelin, and peptide YY—key regulators of appetite and digestion[7].

In the personalized counseling education approach implemented in this study, respondents reported feeling a greater sense of privacy and comfort when discussing issues related to weight management, dietary habits, and physical activity. Notably, our findings demonstrated significant changes in dietary intake, particularly a reduction in macronutrient consumption—specifically energy, carbohydrates, and fat—in the intervention group. This pattern of reduced intake is consistent with previous findings from a study conducted in Qatar, which also observed improvements in body composition among participants fasting during Ramadan[11].

Importantly, our study also found a significant increase in protein intake among participants in the intervention group, as evidenced by 24-hour dietary recall data, which showed a higher consumption of animal-based proteins, particularly eggs and chicken. Despite the observed energy deficit from reduced carbohydrate and fat intake, the weight loss experienced by participants did not appear to compromise lean body mass. This outcome aligns with our balanced nutrition education strategy, which emphasized optimal protein consumption, controlled caloric intake, and structured physical activity to preserve muscle mass[13]. Supporting literature further reinforces this approach. Layman et al.[8], reported that higher protein intake contributes to muscle retention and fat loss during weight reduction. Similarly, study by Paquin et al[18]. indicated that increased muscle mass improves insulin sensitivity and reduces visceral fat accumulation.

This study also demonstrated a reduction in body fat mass accompanied by an increase in muscle mass in the intervention group, suggesting a favorable body composition change as a result of the intervention. In contrast, while the control group also experienced a reduction in body fat mass, this was accompanied by a concurrent loss of muscle mass, indicating a less optimal outcome. These findings are consistent with those reported by Villareal et al.[19], who found that in obese individuals, regular resistance training combined with a low-calorie diet effectively reduced visceral fat without compromising muscle mass. Further supporting evidence is provided by Waters et al.[20], who demonstrated that a combined regimen of resistance and aerobic exercise can reduce visceral fat while maintaining muscle mass.

Dietary fiber emerged as another important finding, given its role in promoting satiety, supporting digestive health, and regulating glycemic response during fasting. Although the increase in fiber intake did not reach statistical significance, the intervention group demonstrated a positive upward trend (p=0.059). This finding is clinically relevant in the context of obesity, as higher dietary fiber intake is associated with improved satiety, reduced energy intake, and beneficial effects on body weight regulation and metabolic health. In contrast to Sulaiman et al.[10], who reported a decline in fiber intake during Ramadan attributed to higher consumption of refined carbohydrates and fast foods at iftar, our findings are consistent with those of Jarrar et al.[21], who observed that greater intake of fiber-rich foods such as vegetables, fruits, and whole grains during suhoor and iftar was associated with significant decreases in BMI and visceral adiposity among obese individuals.

Fructose and sodium intake declined slightly in both groups, though not significantly. This reduction may be attributed to changes in dietary patterns during fasting, such as reduced consumption of processed and sugary foods. Natural food preferences and the physiological demands of fasting, such as the need to maintain hydration and electrolyte bal-

ance, might have driven this shift. Although sodium plays a crucial role during fasting, excessive or insufficient intake can pose health risks, underscoring the importance of balanced consumption[11].

This study's integration of balanced nutrition education with Ramadan fasting offers a practical and cost-effective model for improving adolescent obesity outcomes. However, several limitations should be acknowledged. Only 76 of 770 screened students (≈10%) participated, introducing a risk of selection bias and limiting generalizability. The short intervention period restricted the ability to assess long-term effects. Although repeated 24-hour recalls (eight per participant) supplemented with a baseline FFQ were used, dietary assessment remained less precise than long-term methods. Data collection was also constrained by university closures, preventing end-of-Ramadan measurements, and the sample was not stratified by gender or obesity classification, limiting subgroup analyses. Additionally, Eid celebrations and festive meals may have influenced dietary behaviors after Ramadan. Despite these limitations, high participant retention and adherence to fasting schedules enhanced internal validity.

CONCLUSION

Integrating balanced nutrition education with Ramadan fasting resulted in greater weight loss compared with fasting alone, although the clinical effect was modest over a short duration. More substantial benefits were observed in body composition, including reductions in fat mass and increases in muscle mass, supported by higher protein intake and a positive trend in fiber consumption. These findings highlight the value of incorporating structured nutrition education into Ramadan fasting as a culturally relevant strategy for obesity management. Further studies with larger, more representative samples and longer follow-up are warranted to confirm these results.

REFERENCES

1. Shafiee A, Nakhaee Z, Bahri RA, Amini MJ, Salehi A, Jafarabady K, et al. Global prevalence of obesity and overweight among medical students: a systematic review and meta-analysis. BMC Public Health. 2024;24(1):1673. doi: 10.1186/s12889-024-19184-4.

2. Telleria-Aramburu N, Arroyo-Izaga M. Risk factors of overweight/obesity-related lifestyles in university students: Results from the EHU12/24 study. Br J Nutr. 2022;127(6):914–26. doi: 10.1017/S0007114521001483.

3. Ramírez-Contreras C, Farrán-Codina A, Izquierdo-Pulido M, Zerón-Rugerio MF. A higher dietary restraint is associated with higher BMI: a cross-sectional study in college students. Physiology & Behavior. 2021;240:113536. doi: 10.1016/j.physbeh.2021.113536.

4. Suwalska J, Kolasińska K, Łojko D, Bogdański P. Eating Behaviors, Depressive Symptoms and Lifestyle in University Students in Poland. Nutrients. 2022;14(5):1106. doi: 10.3390/nu14051106.

5. Abdul Majid M, Osama M, Noman M, Nisa U, Haider I. Effect of Ramadan fasting on body weight and body mass index (BMI) in public sector undergraduate medical students of Peshawar. Pak J Med Sci. 2023;39(3):7017. doi:10.12669/pjms.39.3.7017.

6. Saraswati SK, Rahmaningrum FD, Pahsya MNZ, Paramitha N, Wulansari A, Ristantya AR, et al. Risk factors for obesity: a literature review. MKMI. 2021;20(1):70-4. doi:10.14710/mkmi.20.1.70-74.

7. Palupi KC, Fauziah NS, Utami DA, Purwara Dewanti L, Ronitawati P. The Effect of Ramadan Fasting Awareness Intervention on Macronutrient Intake, Fiber, Sugar, and Physical Activity Among Overweight Adolescent Girls. AMNT. 2022;6(1SP):146–56. https://doi.org/10.20473/amnt.v6i1SP.2022.146-156

8. Layman DK, Evans E, Baum JI, Seyler J, Erickson DJ, Boileau RA. Dietary protein and exercise have additive effects on body composition during weight loss in adult women. J Nutr. 2005;135(8):1903–10. doi: 10.1093/jn/135.8.1903.

9. Merz KE, Thurmond DC. Role of Skeletal Muscle in Insulin Resistance and Glucose Uptake. Compr Physiol. 2020;10(3):785–809. https://doi.org/10.1002/j.2040-4603.2020.tb00136.x

10. Saraswati SK, Rahmaningrum FD, Pahsya MNZ, Paramitha N, Wulansari A, Ristantya AR, et al. Risk factors for obesity: a literature review. MKMI. 2021;20(1):70-4. doi:10.14710/mkmi.20.1.70-74.

11. Osman F, Haldar S, Henry CJ. Effects of time-restricted feeding during Ramadan on dietary intake, body composition and metabolic outcomes. Nutrients. 2020;12(8):2478. doi:10.3390/nu12082478.

12. Taslim NA, Handayani ND, Arruan W, Aminuddin A, Bukhari A, Faradillah A, et al. Dietary patterns and ultra-processed foods consumption in modern and traditional populations in South Sulawesi: an analysis of nutritional status and body composition. Nutr Clin Diet Hosp. 2023;43(1). doi:10.12873/431handayani.

13. Arruan W, Bukhari A, Handayani ND, Taslim NA, Faradillah A, Aminuddin. Relationship of physical activity with nutritional status and body composition in traditional and modern populations in South Sulawesi, Indonesia. Nutr Clin Diet Hosp. 2024;44(3). doi:10.12873/443arruan.

14. Bagherniya M, Sharma M, Mostafavi Darani F, Maracy MR, Safarian M, Allipour Birgani R, et al. School-based nutrition education intervention using social cognitive theory for overweight and obese Iranian adolescent girls: a cluster randomized controlled trial. Int Q Community Health Educ. 2017;38(1):37-45. doi:10.1177/0272684X17749566

15. Puspikawati SI, Sebayang SK, Mathofani S. Nutrition education to prevent obesity among university students and school children through Generation Z cadres. MGK. 2024;13(2):563-79. doi:10.20473/mgk.v13i2.2024.563-579.

16. Herliah A, Baso YS, Hidayanty H, Syarif S, Aminuddin A, Bahar B. Effect of web-based She Smart education models on adolescent girls' knowledge, attitudes, and practice about obesity. Int J Health Med Sci. 2022;5(1):50-5. doi:10.21744/ijhms.v5n1.1832.

17. Zahtamal Z, Munir SM. Health education on dietary patterns and physical exercise for managing underweight adolescents. Jurnal PKM. 2019;2(01):64. doi:10.30998/jurnalpkm.v2i01.2939.

18. Paquin J, Lagacé JC, Brochu M, Dionne IJ. Exercising for insulin sensitivity – is there a mechanistic relationship with quantitative changes in skeletal muscle mass? Front Physiol. 2021;12:656909. doi:10.3389/fphys.2021.656909.

19. Villareal DT, Banks M, Sinacore DR, Siener C, Klein S. Effect of weight loss and exercise on frailty in obese older adults. Arch Intern Med. 2006;166(8):860. doi:10.1001/archinte.166.8.860.

20. Waters DL, Aguirre L, Gurney B, Sinacore DR, Fowler K, Gregori G, et al. Effect of aerobic or resistance exercise, or both, on intermuscular and visceral fat and physical and metabolic function in older adults with obesity while dieting. J Gerontol A Biol Sci Med Sci. 2021;77(1):131. doi:10.1093/gerona/glab111.

21. Jarrar AH, Beasley JM, Ohuma EO, Cheikh Ismail L, Qeshta DA, Mohamad MN, et al. Effect of high fiber cereal intake on satiety and gastrointestinal symptoms during Ramadan. Nutrients. 2019;11(4):939. doi:10.3390/nu11040939.