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INTRODUCTION

Ultra-processed foods (UPFs) are typically high in energy, sugars, unhealthy fats, and sodium, but low in protein, dietary fiber, and essential micronutrients. Common examples include confectionery, pastries, packaged savory snacks, processed meats, soft drinks, and similar products (1). UPFs have been associated with overweight and obesity, diabetes, cardiovascular diseases, cancer, and many other health conditions. UPFs may

promote adiposity due to their high energy density, rapid glycemic response, low satiety, and altered food structure that affects nutrient absorption and fullness (2). Higher UPF consumption has been linked to a reduced quality of life in women (3) and may promote overweight or obesity in food-insecure and socially vulnerable women, consequently raising the risk of metabolic disorders, and may also be associated with alterations in gut microbiota composition (4-6).

Comparisons and correlations between ultra-processed food consumption and conventional and novel anthropometric indicators in women

Abstract

Aim: This study aimed to investigate the association between ultra-processed food (UPF) consumption and anthropometric indicators in women, including both conventional obesity indicators (body mass index—BMI, waist circumference—WC, waist-to-height ratio—WHtR, and waist-to-hip ratio—WHR) and novel measures (neck circumference—NC, calf circumference—CC, and mid-upper arm circumference—MUAC).

Materials and Methods: This cross-sectional study was conducted from May to July 2025, and data were collected through face-to-face interviews with 256 adult women in Türkiye. Participants completed a semi-quantitative UPF consumption frequency questionnaire in accordance with the NOVA classification. Body weight, height, WC, hip circumference, NC, MUAC, and CC were recorded. BMI, WHtR, and WHR were calculated.

Results: Higher UPF consumption was observed among participants with a BMI ≥ 25 kg/m², particularly for carbonated drinks and for breakfast cereals and cereal and energy bars. Carbonated drink consumption was positively correlated with NC ($p = 0.035$) and CC ($p = 0.001$). Sweet/savory packaged snack consumption was positively correlated with CC ($p = 0.005$) and MUAC ($p = 0.035$), while margarine/spreads were negatively correlated ($p = 0.026$). Energy drink intake was positively correlated with MUAC ($p = 0.008$). Sugared milk- and fruit-based drinks were positively correlated with NC ($p = 0.010$), and sugared cocoa drinks with CC ($p = 0.014$). Poultry and fish nuggets/sticks were inversely correlated with CC ($p = 0.044$). Quartile-based analyses showed that higher consumption of carbonated drinks was associated with significant differences in multiple anthropometric measures (BMI, WC, WHtR, NC, CC, MUAC), whereas packaged snack consumption showed differences only in WC and CC, mainly driven by the lowest vs. higher quartiles (particularly Q1 vs. Q3).

Conclusion: UPF consumption may contribute to increased body fat and underscore the importance of overall dietary patterns in obesity risk.

Keywords: Eating behaviors; health; nutrition; obesity; processed foods

Evidence from a study of adults in Italy indicates that UPF consumption increases with body mass index (BMI), and individuals in the highest tertile of intake exhibit elevated adiposity indices, suggesting a potential role of these foods in promoting excess body fat and related metabolic risks (7). Similarly, a study among Saudi adults found that higher UPF intake was associated with increased BMI, waist circumference (WC), and greater odds of overweight and abdominal obesity, further supporting the link between UPF consumption and adiposity (8). Furthermore, a study of university students in Malaysia identified a significant positive association between UPF consumption and BMI, while research on older adults in Spain found that higher UPF intake was linked to abdominal obesity, providing additional evidence of the relationship between UPF consumption and increased adiposity across different populations (9,10).

Although the association between UPF consumption and adiposity or obesity has been investigated in numerous studies, research conducted specifically in women is limited. Moreover, this relationship has generally been examined using BMI or established anthropometric measures and indices such as WC, waist-to-height ratio (WHtR), or waist-to-hip ratio (WHR). In the present study, we assessed UPF consumption in women in relation to BMI and other conventional obesity-related anthropometric indicators, as well as novel measurements including neck circumference (NC), calf circumference (CC), and mid-upper arm circumference (MUAC). This study aimed to investigate the association between UPF consumption and anthropometric indicators in women, including both conventional obesity indicators and novel measures.

MATERIALS AND METHODS

Study Design and Participants

The study followed the ethical guidelines outlined in the Declaration of Helsinki and was approved by the Ethics Committee of Bayburt University (Date: 16.04.2025, Decision

No: 51). The study was conducted between May and July 2025, and data were collected through face-to-face interviews with university students residing in Bayburt, an inland province in the Eastern Black Sea Region of northeastern Türkiye. Eligibility criteria required that participants be female adults aged 19–64 years and proficient in Turkish. Participants were recruited through convenience and snowball sampling methods, and only those who provided written informed consent were included. Individuals were excluded if they were receiving psychiatric treatment or had a diagnosis of a severe mental disorder (e.g., major depressive disorder, anxiety disorders, or substance use disorders). Participants with special educational needs or cognitive or physical impairments that could interfere with their ability to complete the study instruments were also excluded. Pregnant or breastfeeding individuals were not eligible to participate.

The necessary sample size was determined using an a priori power analysis conducted with G*Power (version 3.1), based on effect estimates reported by Alomari and Almoraie (8), who observed a significantly higher mean BMI among individuals with higher UPF consumption (% of total daily energy intake) compared with those with lower consumption (24.76 ± 5.23 vs. 22.44 ± 4.36 ; $p < 0.001$). The analysis was performed using a one-tailed independent-samples t-test, assuming an effect size of 0.48, a significance level (α) of 0.05, and a statistical power of 95% ($1-\beta = 0.95$), with an allocation ratio of 1:1 between groups. The minimum required sample size was calculated to be 94 participants per group, for a total of 188 participants. The achieved power for this sample size was 0.95.

A total of 267 individuals were initially assessed for eligibility. Among them, 11 participants were excluded for failing to meet the predefined age inclusion criterion. Consequently, 256 eligible participants were included in the study; all provided complete data and were available for the final analysis. The participant selection process is presented in Figure 1.

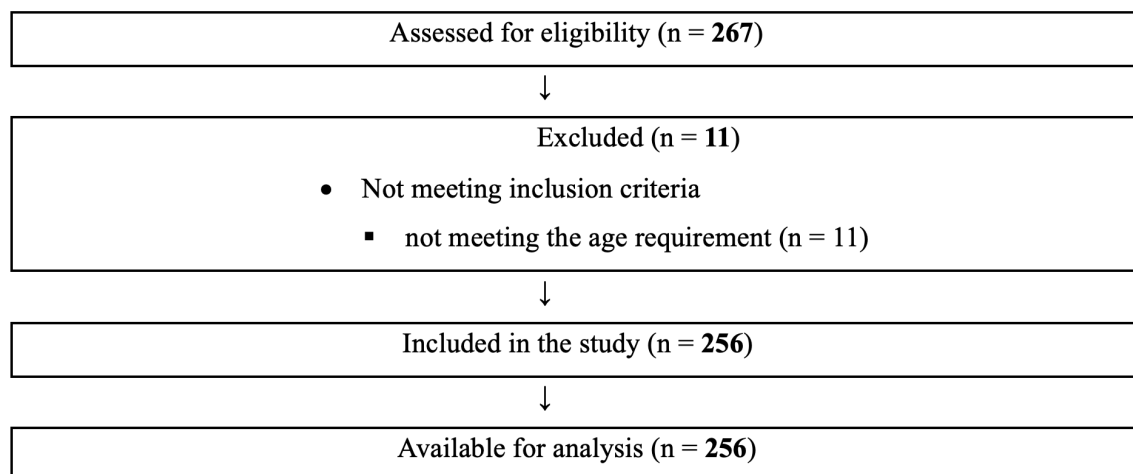


Figure 1. Participant flow diagram.

Measures

Participants' demographic characteristics, including age, marital status, residency, and smoking status, were collected using a structured questionnaire. The frequency of UPF consumption was assessed with a food-frequency questionnaire designed to evaluate UPF intake. Anthropometric data were recorded based on both self-reported information and direct measurements.

UPF consumption was evaluated using a semi-quantitative food frequency questionnaire based on the NOVA classification system (11). The reported food items were grouped into UPF categories using this classification system. Participants indicated how often they consumed each item using the following categories: per meal, daily, 5–6 times a week, 3–4 times a week, 1–2 times a week, every other week, monthly, or not at all. Portion sizes were specified in grams (g), milliliters (mL), or common household measures (e.g., water glass, coffee cup, scoop, teaspoon, tablespoon, or package) and were subsequently converted into standardized g/mL units by the researchers. The amounts of UPFs consumed per eating occasion were recorded, and the average daily intake of UPFs and the corresponding food groups were calculated for each participant.

Self-reported weight and height were used to calculate BMI (kg/m^2), which was then categorized according to World Health Organization criteria as underweight/normal weight ($< 25 \text{ kg}/\text{m}^2$) or overweight/obese ($\geq 25 \text{ kg}/\text{m}^2$) (12).

WC, hip circumference, NC, CC, and MUAC were measured using standardized anthropometric techniques. All circumference measurements were performed using a non-elastic measuring tape following established reference protocols. WC measurements were performed while participants were fasting, standing upright, and maintaining a relaxed posture with arms positioned at their sides. The measurement was obtained at the midpoint between the lowest rib and the iliac crest in accordance with standard anthropometric protocols (13). A WC greater than 80 cm for women is considered indicative of an increased risk of obesity-related metabolic diseases (14). WHtR was calculated by dividing WC by height. A WHtR greater than 0.5 is considered indicative of an increased risk of obesity-related metabolic diseases for both sexes (15). Hip circumference measurements were obtained while standing at the participant's side, and the circumference was recorded at the level of the maximum protuberance of the hips, following standard anthropometric measurement procedures. Abdominal obesity is defined as a WHR above 0.85 in women (14). NC measurements were taken at the midpoint of the neck (16). CC was measured by identifying the widest part of the calf (17). The midpoint between the elbow and shoulder was identified, and the MUAC was measured with the arm positioned at a 90° angle (13).

Data Analysis

Statistical analyses were performed using IBM SPSS Statistics version 21. Prior to the main analyses, data were assessed for

normality and subjected to preliminary diagnostic evaluations, such as outlier detection and examination of distributional assumptions. Although none of the variables met the assumption of normal distribution, descriptive characteristics were additionally presented as mean $\pm$ standard deviation (SD) for reporting consistency, while non-normally distributed variables were summarized as median with interquartile range (IQR). Categorical variables were expressed as numbers (n) and percentages (%).

Differences in UPF consumption between anthropometric risk categories defined by BMI, WC, WHtR, and WHR were evaluated using the Mann–Whitney U test. Relationships between UPF consumption and anthropometric measurements, including NC, CC, and MUAC, were evaluated using Spearman's rank correlation method. Overall carbonated drink consumption and sweet or savory packaged snack consumption were divided into quartiles (Q1, Q2, Q3, Q4), and a nonparametric Kruskal–Wallis test was used to evaluate differences in anthropometric indicators across quartiles. If the Kruskal–Wallis test indicated statistical significance, Dunn's pairwise tests were conducted as post hoc analyses. A p-value of less than 0.05 was considered statistically significant, with a 95% confidence interval.

RESULTS

The study included 256 participants with a mean age of 22.3 ± 2.6 years (range: 19–45). The majority were single (98.4%) and lived in dormitories (71.9%); 32.4% reported smoking. The mean BMI was $22.3 \pm 3.6 \text{ kg}/\text{m}^2$ (median: 21.7, IQR: 20.0–24.2), with 79.7% classified as underweight/normal weight and 20.3% as overweight/obese. Mean WC was $74.0 \pm 9.6 \text{ cm}$, with 24.2% exceeding the risk threshold ($\geq 80 \text{ cm}$). According to WHtR and WHR, 18.8% and 13.3% of participants were classified as at risk, respectively. Mean NC, CC, and MUAC were $31.7 \pm 2.5 \text{ cm}$, $38.3 \pm 9.0 \text{ cm}$, and $27.5 \pm 4.3 \text{ cm}$, respectively (Table 1).

As presented in Table 2, significant differences in UPF consumption were observed across BMI classifications. Participants with a BMI $\geq 25 \text{ kg}/\text{m}^2$ reported higher consumption of carbonated drinks compared with those with a BMI $< 25 \text{ kg}/\text{m}^2$ (median: 53.5 [IQR: 57.2] mL vs. 42.8 [93.4] mL, $p < 0.05$). Similarly, intake of breakfast cereals and cereal and energy bars was greater among participants with a BMI $\geq 25 \text{ kg}/\text{m}^2$ than among those with a BMI $< 25 \text{ kg}/\text{m}^2$ (6.9 [33.5] g vs. 1.0 [15.7] g, $p < 0.05$). No other UPF groups differed significantly across anthropometric categories based on BMI, WC, WHtR, and WHR.

Correlations between UPF consumption and anthropometric indicators are presented in Table 3. Carbonated drink consumption showed a positive correlation with NC ($r = 0.132$, $p = 0.035$) and CC ($r = 0.213$, $p = 0.001$). Intake of sweet or savory packaged snacks was positively correlated with CC ($r = 0.176$, $p = 0.005$) and with MUAC ($r = 0.132$, $p = 0.035$). Consumption of margarine and spreads was negatively correlated with MUAC ($r = -0.139$, $p = 0.026$). Energy drink intake was positively correlated with MUAC ($r = 0.164$, $p = 0.008$). Consumption

of sugared milk drinks, sugared fruit yogurts, and fruit drinks was positively correlated with NC ($r = 0.160$, $p = 0.010$), while consumption of sugared cocoa drinks was positively correlated with CC ($r = 0.153$, $p = 0.014$). Furthermore, consumption of poultry and fish nuggets/sticks was inversely correlated with CC ($r = -0.126$, $p = 0.044$).

Quartile-based analyses were conducted to further examine the associations between UPF consumption and anthropometric indicators. As shown in Table 4, significant differences were observed in several anthropometric measures across quartiles of carbonated drink consumption. BMI ($p = 0.001$), WC ($p =$

0.009), WHtR ($p = 0.004$), NC ($p = 0.030$), CC ($p = 0.009$), and MUAC ($p = 0.012$) differed significantly across quartiles. Post hoc analyses indicated that these differences were primarily driven by comparisons between the lowest quartile (Q1) and the higher quartiles, particularly Q3. Similarly, as shown in Table 5, significant differences were observed in WC ($p = 0.011$) and CC ($p = 0.006$) across quartiles of sweet or savory packaged snack consumption. Post-hoc tests revealed that these differences were primarily between Q1 and Q3. No significant differences were observed for BMI, WHtR, WHR, NC, or MUAC across quartiles of sweet or savory packaged snack consumption.

Table 1. Participant characteristics

Characteristics	Total sample (n = 256)
Age (years), Mean $\pm$ SD (age range)	22.3 $\pm$ 2.6 (19–45 years)
Marital status, n (%)	
Single	252 (98.4)
Married	4 (1.6)
Residency, n (%)	
Dormitory	184 (71.9)
Home	72 (28.1)
Smoking status, n (%)	
Yes	83 (32.4)
No	173 (67.6)
Body Mass Index (kg/m ²), Mean $\pm$ SD / Median (IQR)	22.3 $\pm$ 3.6 / 21.7 (20.0–24.2)
Body Mass Index class, n (%)	
Underweight/Normal weight (< 25 kg/m ²)	204 (79.7)
Overweight/Obese ($\geq$ 25 kg/m ²)	52 (20.3)
Waist circumference (cm), Mean $\pm$ SD / Median (IQR)	74.0 $\pm$ 9.6 / 72.5 (67.0–79.0)
No risk (< 80 cm)	194 (75.8)
Risk ($\geq$ 80 cm)	62 (24.2)
Waist-to-height ratio, Mean $\pm$ SD / Median (IQR)	0.45 $\pm$ 0.06 / 0.44 (0.41–0.48)
No risk (< 0.50)	208 (81.3)
Risk ($\geq$ 0.50)	48 (18.8)
Waist-to-hip ratio, Mean $\pm$ SD / Median (IQR)	0.77 $\pm$ 0.08 / 0.75 (0.73–0.80)
No risk (< 0.85)	222 (86.7)
Risk ($\geq$ 0.85)	34 (13.3)
Neck circumference, Mean $\pm$ SD / Median (IQR)	31.7 $\pm$ 2.5 / 32.0 (30.0–33.0)
Calf circumference, Mean $\pm$ SD / Median (IQR)	38.3 $\pm$ 9.0 / 35.0 (33.0–41.0)
Mid-upper arm circumference, Mean $\pm$ SD / Median (IQR)	27.5 $\pm$ 4.3 / 28.0 (25.0–30.0)
Abbreviations: IQR, interquartile range (25th–75th percentile); n, number; SD, standard deviation; %, percent.	

Table 2. Ultra-processed food consumption by anthropometric indicators (n = 256)

Ultra-processed foods/food groups		Unit	BMI				WC		WHR		WHR	
			< 25 kg/m ² (n = 204)		≥ 25 kg/m ² (n = 52)		< 80 cm (n = 194)	≥ 80 cm (n = 62)	< 0.50 (n = 208)	≥ 0.50 (n = 48)	< 0.85 (n = 222)	≥ 0.85 (n = 34)
			M (IQR)	M (IQR)	M (IQR)	M (IQR)	M (IQR)	M (IQR)	M (IQR)	M (IQR)		
1	Carbonated drinks	(mL)	42.8 (93.4)	53.5 (57.2)	42.8 (93.3)	42.8 (55.8)	42.8 (93.1)	42.8 (47.3)	42.8 (86.6)	42.8 (65.7)		
2	Sweet or savory packaged snacks	(g)	20.2 (50.9)	24.1 (52.4)	19.3 (53.3)	24.8 (41.1)	19.5 (51.9)	26.5 (50.4)	21.5 (51.5)	24.1 (51.5)		
3	Ice cream, chocolate, candies (confectionery)	(g)	35.9 (58.7)	35.5 (63.4)	38.5 (71.0)	31.8 (55.9)	38.5 (67.8)	30.3 (47.5)	38.0 (56.2)	28.0 (80.0)		
4	Mass-produced packaged breads, buns, cookies (biscuits), pastries, cakes and cake mixes	(g)	51.3 (71.8)	28.8 (56.0)	51.3 (70.9)	41.7 (54.5)	50.6 (70.3)	38.1 (51.3)	47.5 (69.6)	49.2 (71.0)		
5	Breakfast cereals, cereal and energy bars	(g)	1.0 (15.7)	6.9 (33.5)	2.0 (19.2)	4.5 (16.8)	2.0 (18.9)	6.3 (22.4)	2.0 (17.3)	2.0 (30.0)		
6	Margarines and spreads	(g)	3.2 (14.8)	3.2 (10.0)	3.2 (15.0)	1.1 (7.5)	3.2 (15.0)	2.1 (9.1)	3.2 (12.0)	2.2 (14.0)		
7	Processed cheese	(g)	7.5 (21.9)	12.8 (26.8)	10.7 (23.5)	6.4 (23.1)	10.0 (23.5)	8.0 (25.1)	9.0 (25.9)	12.8 (23.5)		
8	Energy drinks	(mL)	0.0 (00.0)	00.0 (00.0)	00.0 (00.0)	00.0 (00.0)	00.0 (00.0)	00.0 (00.0)	00.0 (00.0)	00.0 (00.0)		
9	Sugared milk drinks, sugared fruit yoghurts and fruit drinks	(mL)	197.7 (286.7)	238.8 (388.4)	190.6 (326.0)	228.5 (241.0)	200.0 (325.0)	217.0 (241.5)	213.5 (322.5)	174.1 (213.6)		
10	Sugared cocoa drinks	(mL)	00.0 (11.6)	1.0 (48.1)	0.8 (13.4)	00.0 (12.4)	0.8 (13.4)	00.0 (6.3)	0.8 (13.5)	00.0 (5.3)		
11	Meat and chicken extracts and instant sauces	(g)	4.2 (9.3)	4.2 (13.5)	4.2 (13.5)	4.2 (8.3)	4.2 (11.4)	4.2 (8.7)	4.2 (10.1)	4.2 (9.7)		
12	Infant formulas, follow-on milks and other baby products (which may include expensive ingredients)	(mL)	00.0 (00.0)	-	00.0 (00.0)	-	00.0 (00.0)	-	00.0 (00.0)	00.0 (00.0)		
13	Health and slimming products such as powdered or fortified meal and dish substitutes	(g)	00.0 (00.0)	00.0 (00.0)	00.0 (00.0)	00.0 (00.0)	00.0 (00.0)	00.0 (00.0)	00.0 (00.0)	-		
14	Ready-to-heat products including pre-prepared pies and pasta and pizza dishes	(g)	33.6 (75.5)	30.5 (104.9)	34.0 (101.0)	21.4 (61.2)	33.6 (97.0)	30.5 (69.4)	33.6 (100.5)	16.5 (72.3)		
15	Poultry and fish nuggets and sticks	(g)	6.7 (19.7)	5.3 (18.5)	6.7 (19.5)	5.3 (16.6)	6.7 (19.7)	5.3 (19.7)	6.7 (19.2)	6.7 (33.6)		
16	Sausages, burgers, hot dogs and other reconstituted meat products	(g)	26.3 (52.4)	31.9 (72.4)	26.5 (55.0)	31.9 (58.6)	26.6 (58.9)	24.7 (49.0)	26.6 (49.3)	29.1 (107.6)		
17	Powdered and packaged ‘instant’ soups, noodles and desserts	(g)	00.0 (3.3)	00.0 (2.8)	00.0 (4.7)	00.0 (11.5)	00.0 (4.4)	00.0 (1.6)	00.0 (1.9)	00.0 (5.8)		

Mann-Whitney U test was conducted; Values in bold are significant at p < 0.05. Abbreviations: BMI, body mass index; IQR, interquartile range (25th-75th); M, median; n, number; WC, waist circumference; WHR, waist-to-hip ratio; WHtR, waist-to-height ratio.

Table 3. Correlations between ultra-processed food consumption and anthropometric indicators (n = 256)

Ultra-processed foods/food groups	Anthropometric Indicators					
	NC			CC		
	r	p	r	p	r	p
1 Carbonated drinks	0.132	0.035	0.213	0.001	0.108	0.085
2 Sweet or savory packaged snacks	0.093	0.138	0.176	0.005	0.132	0.035
3 Ice cream, chocolate, candies (confectionery)	0.051	0.419	0.025	0.694	-0.033	0.595
4 Mass-produced packaged breads, buns, cookies (biscuits), pastries, cakes and cake mixes	-0.037	0.556	-0.069	0.271	-0.093	0.139
5 Breakfast cereals, cereal and energy bars	0.005	0.940	0.119	0.058	0.067	0.282
6 Margarines and spreads	-0.087	0.164	-0.058	0.359	-0.139	0.026
7 Processed cheese	0.032	0.610	-0.047	0.450	0.005	0.932
8 Energy drinks	0.041	0.509	0.112	0.073	0.164	0.008
9 Sugared milk drinks, sugared fruit yoghurts and fruit drinks	0.160	0.010	0.115	0.066	-0.027	0.668
10 Sugared cocoa drinks	0.049	0.431	0.153	0.014	0.028	0.652
11 Meat and chicken extracts and instant sauces	-0.047	0.455	-0.091	0.145	-0.114	0.067
12 Infant formulas, follow-on milks and other baby products (which may include expensive ingredients)	-0.084	0.180	0.017	0.784	-0.050	0.427
13 Health and slimming products such as powdered or fortified meal and dish substitutes	0.079	0.206	-0.001	0.981	0.117	0.062
14 Ready-to-heat products including pre-prepared pies and pasta and pizza dishes	0.114	0.070	0.077	0.221	0.004	0.945
15 Poultry and fish nuggets and sticks	0.019	0.766	-0.126	0.044	-0.037	0.558
16 Sausages, burgers, hot dogs and other reconstituted meat products	0.066	0.296	0.016	0.803	0.008	0.903
17 Powdered and packaged 'instant' soups, noodles and desserts	-0.108	0.085	-0.113	0.071	-0.067	0.283

Values in bold are significant at $p < 0.05$. Abbreviations: CC, calf circumference; MUAC, mid-upper arm circumference; NC, neck circumference; r, Spearman's correlation coefficient.

Table 4. Comparison of median anthropometric indicators across quartiles of carbonated drink consumption (n = 256)

Anthropometric indicators	Q1 (n = 61)		Q2 (n = 101)		Q3 (n = 44)		Q4 (n = 50)		p	Pairwise comparisons
	M	(IQR)	M	(IQR)	M	(IQR)	M	(IQR)		
BMI (kg/m ²)	20.7	(2.8)	22.0	(4.5)	23.2	(6.1)	21.5	(4.8)	0.001	Q1↔Q2 Q1↔Q3 Q3↔Q4
WC (cm)	71.0	(10.5)	73.0	(14.8)	75.0	(14.4)	72.0	(10.3)	0.009	Q1↔Q3 Q3↔Q4
WHR	0.44	(0.08)	0.44	(0.08)	0.46	(0.08)	0.44	(0.06)	0.004	Q1↔Q3 Q3↔Q4
WHR	0.76	(0.08)	0.75	(0.08)	0.76	(0.11)	0.74	(0.06)	0.070	
NC (cm)	31.0	(2.0)	32.0	(3.0)	33.0	(4.0)	32.0	(3.0)	0.030	Q1↔Q3
CC (cm)	33.0	(8.0)	35.0	(7.0)	37.0	(8.5)	37.0	(11.3)	0.009	Q1↔Q3 Q1↔Q4
MUAC (cm)	27.0	(4.5)	28.0	(6.0)	29.5	(5.7)	27.0	(5.0)	0.012	Q1↔Q3

Comparisons across quartiles were performed using the Kruskal–Wallis test; Post-hoc analyses were conducted using Dunn’s pairwise tests; Values in bold are significant at $p < 0.05$. Abbreviations: BMI, body mass index; CC, calf circumference; IQR, interquartile range (25th–75th); M, median; MUAC, mid-upper arm circumference; n, number; NC, neck circumference; Q, quartile; WC, waist circumference; WHR, waist-to-hip ratio; WHtR, waist-to-height ratio.

Table 5. Comparison of median anthropometric indicators across quartiles of sweet or savory packaged snack consumption (n = 256)

Anthropometric indicators	Q1 (n = 62)		Q2 (n = 66)		Q3 (n = 64)		Q4 (n = 64)		p	Pairwise comparisons
	M	(IQR)	M	(IQR)	M	(IQR)	M	(IQR)		
BMI (kg/m ²)	20.1	(3.8)	21.9	(3.7)	22.3	(4.5)	21.8	(4.2)	0.067	
WC (cm)	70.0	(10.0)	73.0	(12.0)	74.0	(14.0)	72.5	(9.0)	0.011	Q1↔Q3
WHR	0.43	(0.07)	0.44	(0.06)	0.45	(0.09)	0.44	(0.06)	0.106	
WHR	0.75	(0.06)	0.75	(0.07)	0.75	(0.09)	0.75	(0.08)	0.644	
NC (cm)	31.0	(3.0)	32.0	(3.0)	32.0	(3.8)	32.0	(3.0)	0.125	
CC (cm)	33.5	(8.0)	35.0	(7.0)	36.5	(9.8)	36.3	(15.5)	0.006	Q1↔Q3
MUAC (cm)	27.0	(5.0)	27.0	(5.1)	28.0	(5.0)	28.0	(5.3)	0.107	

Comparisons across quartiles were performed using the Kruskal–Wallis test; Post-hoc analyses were conducted using Dunn’s pairwise tests; Values in bold are significant at $p < 0.05$. Abbreviations: BMI, body mass index; CC, calf circumference; IQR, interquartile range (25th–75th); M, median; MUAC, mid-upper arm circumference; n, number; NC, neck circumference; Q, quartile; WC, waist circumference; WHR, waist-to-hip ratio; WHtR, waist-to-height ratio.

DISCUSSION

This study, conducted among young adult women in a single city, examined the associations between UPF consumption and anthropometric indicators, including both conventional and novel measures. Higher consumption of specific UPF subgroups was observed among those with overweight or obesity, particularly carbonated drinks and breakfast cereals and cereal and energy bars. Several UPF categories, especially sugar-sweetened beverages, packaged snacks, and energy drinks, showed weak but statistically significant positive correlations with circumferential measures such as NC, CC, and MUAC. Some UPF categories also showed weak negative correlations, including margarine and spreads with MUAC, and poultry and fish nuggets/sticks with CC. These findings suggest that, among women in this sample, consuming specific UPFs, rather than total intake alone, may be associated with less favorable anthropometric outcomes and body fat distribution patterns.

The higher consumption of carbonated drinks and cereal-based UPF products observed among participants with a BMI ≥ 25 kg/m² (Table 2), together with similar BMI patterns across carbonated drink consumption quartiles (Table 4), is consistent with previous evidence linking specific UPF subgroups to increased adiposity (7). Sugar-sweetened beverages may promote excess energy intake due to their high added-sugar content and limited satiety, thereby contributing to a positive energy balance and weight gain (18,19). Similarly, breakfast cereals and cereal and energy bars, despite often being perceived as practical or healthy choices, frequently contain refined carbohydrates and added sugars, which may contribute to higher caloric intake (20). Higher UPF consumption has consistently been associated with higher BMI in adult populations (21-23). However, a study among adolescent girls reported no significant differences in BMI by frequency of UPF consumption (24). This discrepancy may be partially explained by ongoing growth and pubertal development, higher energy requirements, and shorter duration of dietary exposure in adolescents compared with adults. Furthermore, UPF consumption was not quantified in that study; instead, only the frequency of food intake, based on dietary quality index items, was assessed. These findings suggest that, within the limitations of the current study, not only the total consumption of UPFs but also the types of products consumed may be relevant to understanding obesity risk in similar populations. However, given the cross-sectional design and the limited sample from a single province, these findings cannot be generalized.

Various anthropometric measurements are used to examine the effects of individuals' dietary patterns on body composition. BMI, a commonly used indicator, is a practical measure of total body weight, but it has limitations in reflecting the regional distribution of body fat. In this context, evaluating additional anthropometric parameters such as WC, WHtR, WHR, NC,

CC, and MUAC provides more detailed information about individuals' fat distribution and muscle mass. WC and WHR, in particular, are considered important indicators for assessing abdominal fat, and increases in these measures are associated with adverse health outcomes, including metabolic syndrome, cardiovascular disease, and type 2 diabetes (14,15). While overall BMI, reflecting total body adiposity, was associated with higher UPF consumption, fat distribution indicators (WC, WHtR, WHR) did not differ significantly in UPF intake (Table 2). However, additional quartile-based analyses revealed significant differences in WC and WHtR across carbonated drink consumption levels, mainly between the lowest and higher quartiles (Table 4). Similarly, for sweet or savory packaged snack consumption, significant differences in WC were observed across quartiles, primarily between the lowest and third quartiles (Table 5). This may suggest that certain UPF subgroups may also be associated with cardiometabolic risk linked to fat distribution. Nevertheless, this interpretation should be considered with caution, given the limited generalizability of the sample.

NC is an anthropometric measurement used to assess upper-body fat and has been reported to be associated with various health problems, including obesity, insulin resistance, and obstructive sleep apnea. MUAC is an important indicator of an individual's fat and muscle tissue composition and is used to assess nutritional status. CC is a valuable measure for assessing muscle mass and peripheral fat distribution, and low CC values have been associated with muscle loss and increased risk of malnutrition (25-28).

Several specific correlations were observed between UPF subgroups and anthropometric indicators (Table 3). Carbonated drinks and sugar-containing milk- and fruit-based drinks were positively associated with NC. Quartile-based analyses further showed significant differences in NC across carbonated drink consumption levels, mainly between Q1 and Q3 (Table 4). This may suggest a potential relationship between frequent intake of sugar-sweetened products and upper-body adiposity. Consistent with these findings, previous research has reported a positive correlation between increased sucrose intake and higher NC values, supporting a role for added sugar consumption in regional fat accumulation (29).

In the present study, consumption of carbonated drinks, sugary or salty packaged snacks, and sweetened cocoa beverages was positively correlated with CC (Table 3). Quartile-based analyses further showed significant differences in CC across carbonated drink consumption levels and sweet or savory packaged snack consumption levels, with the main differences driven by comparisons between the lowest and higher quartiles (Table 4 and Table 5). Positive associations between CC and sugar-containing UPFs may indicate that greater peripheral fat accumulation accompanies higher intake of energy-dense

products. Only a limited number of studies have examined the association between CC and dietary intake; most evaluations have been conducted in older adults. While one study reported no association between CC and UPF consumption (30), another study reported that certain individual nutrients were linked to reduced CC (26). The negative correlations observed with certain protein-containing UPFs (poultry and fish nuggets/sticks) in the present study may reflect variations in muscle mass or dietary composition rather than adiposity alone.

Additionally, consumption of packaged sweet or savory snacks and energy drinks showed positive correlations with MUAC (Table 3), which may support the use of MUAC as a measure of body fat. Quartile-based analyses further showed significant differences in MUAC across carbonated drink consumption levels, with the effect primarily observed between Q1 and Q3 (Table 4). These findings align with studies carried out among adults in South India and Bangladesh, which have shown that MUAC measurement is valid for assessing overweight and obesity (27,28). In contrast, consumption of margarine and spreads was negatively correlated with MUAC. These mixed patterns may suggest that different UPF subgroups may relate differently to regional body composition indicators, emphasizing the importance of evaluating specific product categories when interpreting anthropometric variations. However, these findings should be interpreted as exploratory due to the limited and localized sample.

Previous studies have shown that consumption of sweet snack and sugar-sweetened beverages is positively associated with hepatic fat accumulation and obesity indices (31-33). Collectively, previous studies have consistently linked UPF consumption with adiposity and a range of obesity-related and chronic disease outcomes (34-36). The present study also observed similar associations in this sample of adult women. These findings add to the existing evidence by showing consistent patterns across both conventional and novel anthropometric indicators in this specific population. Overall, the results of this study contribute to the existing literature by providing additional evidence from a single study population.

Limitations and Strengths

This study has several noteworthy limitations that should be acknowledged. First, because the study is cross-sectional, it cannot determine cause-and-effect links. Second, reliance on snowball and convenience sampling methods may have introduced selection bias and limited the generalizability of the findings to broader populations. In addition, body weight and height were self-reported, which may introduce potential reporting inaccuracies. The study was conducted in a single province in Türkiye, which may limit the generalizability of the results. Furthermore, UPF intake was evaluated using a food-frequency questionnaire, which may be subject to reporting inaccuracies. Despite these limitations, this study adds to the

existing literature by demonstrating in women the association between UPF consumption and both widely accepted adiposity indices and novel anthropometric measurements. The findings suggest that in women, consumption of specific UPF subgroups may be associated with their anthropometric measurements.

CONCLUSION

The study identified limited associations between UPF intake and various anthropometric indicators among young adult women. Higher consumption of certain UPF subgroups, especially sugar-sweetened beverages, packaged snacks, and cereal-based products, was observed among women with overweight or obesity and was positively related to measurements such as NC, CC, and MUAC. These findings suggest that, in women, body composition and fat distribution may be influenced more by the types of UPFs consumed than by the overall amount consumed. The results also highlight the value of using both traditional and newer anthropometric measurements when evaluating dietary effects on adiposity. However, as the study was conducted in a single city with a relatively small sample, these findings should not be generalized to broader populations. Future longitudinal studies using more precise dietary assessment methods are needed to better understand causal relationships and the long-term impact of various UPF subgroups on obesity risk in women.

Conflict of Interests

The authors declare that there is no conflict of interest in the study.

Financial Disclosure

The authors declare that there is no financial support.

Ethical Approval

This study was conducted in accordance with the Declaration of Helsinki, and ethical approval was granted by the Bayburt University Ethics Committee (Date: 16.04.2025, Decision No: 51).

Informed Consent

All participants provided written informed consent before participation.

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