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THE EFFECT OF FOOD PORTION SIZE ON THE WEIGHT STATUS OF SAUDI FEMALES OVER 18 YEARS OLD

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Abstract:

Objective: *the current study aims to assess the correlation between the portion sizes of some energy-dense foods with weight status is Saudi Arabia.*

Methods*: A cross-sectional study was conducted among 520 female university students at Tabuk University, Tabuk city, Saudi Arabia between September and December 2018. A four-day dietary record was used to estimate dietary intake over four consecutive days, including the weekend. Foods that contained more than 2.5 kcal per gram were considered energy-dense foods.*

Results*: The results indicate that the portion size of energy-dense foods and beverages such as burgers, French fries, biscuits, chocolate confectionery, soft drinks, and canned juices is positively associated with body mass index (BMI). In addition, the portion sizes of these foods were found to be significantly higher amongst obese and overweight individuals compared to normal-weight participants ($p < 0.05$).*

Conclusion*: the portion size of energy-dense foods should be taken into account when planning for an intervention to improve food choice and public health outcomes.*

Keywords: *portion size; weight status; energy-dense foods; Saudi female*

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INTRODUCTION:

The rate of obesity has increased remarkably across the world, especially in Saudi Arabia. [1] In the past 20 years it has more than doubled.[1,2] A recent survey conducted by the Saudi National Health ministry indicated that there is a high prevalence of overweight and obesity among those aged 15 years and older. The survey showed that the prevalence is significantly higher among women compared to men. [3] Obesity is a threat to health, as it is related to many health issues, including coronary heart disease, type 2 diabetes, hypertension, and mortality. [4] Although, it is commonly understood that weight gain is due to the balance between the food consumed and activity levels.[5] some studies have indicated that food consumption is the main cause of the obesity epidemic. [6] Thus, identifying the nutritional factors related to obesity is an urgent priority.

Several dietary factors can affect the balance of energy intake, which can subsequently influence weight gain. [5] There has been one limited study focusing on a specific dietary factor related to obesity in Saudi Arabia [7], and several studies have focused on the frequency of fast food consumption and sugar-sweetened beverages as predictors of overweight and obesity. [2,7] However, no study in Saudi Arabia has focused on food portion size as predictor of obesity, although it was the main predictor of obesity in a different population. [8]

In the past ten years, there has been a significant increase in the portion size of several foods. [9] Based on data obtained between 1977 and 1998 from the US Nationwide Food Consumption Survey, the content of energy per portion of some foods and drinks has increased significantly. For example, soft drinks increased by 49 kcal, salty snacks by 93 kcal, and French fries by 68 kcal for each portion. [9] A similar trend was observed in food portion size in the UK, [10,11] the Netherlands, [12] Denmark, [13] and the USA. [14-15]

The doubling of portion sizes can lead to an increase in energy consumption by approximately 35%. [16] A recent review revealed that food portion sizes have a significant influence on energy intake. [17] A study conducted by French et al. examined the impact of the consumption of different lunch sizes over six months on weight gain. The study found that a larger lunch size led to a significant increase in energy intake and, subsequently, body weight gain. [18] A recent systematic review showed that there was a significant correlation between lowering the portion size of energy-dense foods and the reduction of body weight. [19] However, another study among Iranian university students found that the portion size of fast foods was related to abdominal obesity but did not influence weight status based on BMI. [20]

High-energy-dense foods are defined as foods that contain more than 225–275 kcal/100 g. This is because they have high fat and/or sugar content, while the fiber and water contents are low. Foods containing between 100–225 kcal/100 g are considered as medium-energy-dense foods. Foods containing 60–150 kcal/100 g are considered low-energy-dense foods based on work by the World Cancer Research Fund.[21] It is likely that a larger portion size of particularly energy-dense foods could lead to a greater energy intake than what is required daily, which could lead to overweight or obesity. [22,23] Therefore, the current study is the first to assess the correlation between weight status (based on BMI) and the portion sizes of energy-dense foods among Saudi Arabian female over 18 years old.

METHODS:

Participants and Recruitment:

A cross-sectional study design was used. It was conducted between September and December 2018 among female students at the University of Tabuk, Saudi Arabia. The sample size was calculated by one of university statisticians. The following formula was used for calculation: $n = z^2\ p\ q/d^2$, Where, n= the minimum sample size, z= standard score corresponding to a given confidence level, p= the proportion in the characteristics being measured, q = 1-p, d = sample error.

A minimum of 400 participants were required as calculated by the statistician. In total, 566 participants were recruited in case of participants withdraw. They were recruited to the study through leaflets distributed at the university. The participants were required to complete a consent form to participate in this study. Any participant who were on a weight-loss regimen or had a medical condition that could influence their weight status were excluded from the study. Pregnant and breastfeeding participants were also excluded from the study. The approval to conduct this study was obtained from the ethics committee of Tabuk university.

General Questionnaire:

This questionnaire was developed by the author. It was piloted on 30 students prior to the study to ensure clarity, estimate the time it took to complete the questionnaire, and to obtain feedback from the participants, which was helpful in making alternations to the questionnaire. The questionnaire consisted of

demographic information (e.g., participants' age, activity level, and ethnicity) and a section discussing the participants' health and if they had any diseases that could influence their weight status.

Dietary Method:
In the current study, a four-day dietary record was used to estimate the dietary intake over four consecutive days, including the weekend. Participants were asked to record everything consumed inside or outside the home. Portion sizes were estimated using household measurements such as spoons, glasses, and plates. The researcher reviewed the estimation of the food portion size with each participant. The energy from the food consumed by the participants was calculated based on known Arabic food compositions. [24]

Food Grouping and Food Portion Size:
Food items were categorized into 52 groups, including 130 sub-groups based on a previous study. [25] The food portion sizes of the most energy-dense food groups were calculated. The portion sizes of the energy-dense foods were calculated based on the method proposed by Wrieden et al. [26] The average food portion sizes consumed by participants over four days were calculated as the total weight of the food consumed divided by the frequency of consumption. For example, if chocolate was consumed nine times over four days and the total weight of chocolate over this period was 100 g, the mean portion size of chocolate (100 g) was divided by 4, giving an average portion size of 25 g. The energy density of food groups was calculated as the total energy of each food group portion divided by the food consumed. [27,28] Foods containing more than 2.5 kcal/g and beverages that contained more than 0.4 kcal/mL were used in the current study as a cut-off point, according to the World Cancer Research Fund. [21]

Anthropometric Measurements:
The anthropometry of all participants was measured at a private location on the university campus. An electronic scale (Seca Ltd., Hamburg, Germany) was used to measure each participant's weight. For accuracy purposes, the scale was calibrated according to the manufacturer's guidelines. Weight was measured to the nearest 100 g. All participants were asked to take off their shoes and heavy clothes and to wear a minimal outer layer of clothing. The height of each of the participants was measured using a portable height measure (Seca 264, Hamburg, Germany). It was measured to the nearest 0.1 cm. BMI was calculated according to the WHO formula: body mass (kg)/height^2 (m^2) to classify the weight of the participants. A stretch-resistant tape was used to measure waist circumference. It was wrapped snugly around the participants while they wore minimal clothing, and it was measured to the nearest 0.1 mm. The participants were advised to stand up straight, relax, and take natural breaths before the measurements.

Statistical Analyses:
Data analyses were carried out using SPSS (version 23). Descriptive statistics were used to describe participants' general characteristics. All data of the current study were described based on the weight status of the participants. A *t*-test for an independent sample was used to determine the difference in portion size of energy-dense foods between obese and normal-weight participants. Pearson correlation was carried out to identify an association between food portion size and weight status.

RESULTS:

Participant Characteristics:
A total of 520 female university students were included in the study. Forty-six participants were excluded from the study (i.e., 10 were misreporting results, 30 withdrew from the study, and 6 were on a weight-loss regimen). All participants were of Saudi Arabian ethnicity. The majority of the participants were moderately active, that is, 90% of those with normal weight compared to 88% of those who were overweight and obese. Around 10% of those with normal weight and 12% of those who were overweight and obese were vigorously active. The following table (Table 1) summarizes participants' characteristics.

Table 1. Characteristics of participants according to their weight status.

General Characteristics	Normal-Weight Participants (n = 309)	SD	Overweight and Obese Participants (n = 211)	SD
Age (years)	21	2.3	21	2.1
Height (cm)	160	6.4	159	6.1
Weight (kg)	53	7.1	80	10.3
BMI (kg/m^2)	21	2.1	32	4.2
Waist circumference (cm)	78	5.1	108	9.4
Total energy (kcal)	1787	323	2349	225

Differences in Portion Size of Energy-Dense Foods and Beverages between Normal-Weight and Obese Participants:

The present study considered 19 food groups as energy-dense (i.e., minimum density of 2.5 kcal/g). Approximately half of these foods (i.e., nine food groups) were commonly consumed by the participants. Table 2 shows the average food portion size (g) of the most energy-dense foods and beverages consumed by participants. The mean portion size of chocolate confectionery, biscuits, French fries, burgers, canned juice, and soft drinks were significantly higher among overweight and obese participants compared to those with a normal weight.

Table 2. The mean portion sizes of foods and beverages for all weight categories.

Food Groups (g)	Normal-Weight (n = 309)			Overweight and Obese (n = 211)		
	n	Mean	SD	n	Mean	SD
Sweet spreads, fillings, and icing	43	21	3.1	99	23	2.2
Savory snacks	54	98	4.2	87	94	6.3
Nuts and seeds	23	30	2.3	66	28	4.2
Chocolate confectionery	68	90	8.3	201	121 *	12.1
Biscuits	87	110	6.5	198	160 *	10.4
Buns, cakes, and pastries	105	73	3.4	165	69	
Cheese	112	37	4.3	123	39	3.1
Breakfast cereals (not high in fiber)	45	45	6.3	100	42	8.1
Meat pies and pastries	54	115	5.0	89	119	3.2
Preserves	33	21	3.0	54	20	5.3
French fries	74	131	18.0	204	200 *	22.3
Burgers and kebabs	118	210	21.3	209	266 *	24.1
White bread, toast, and rolls	150	160	29.0	210	163	27.2
Pizza	77	111	8.0	177	150	17.3
Coated chicken	64	269	12.1	96	272	9.0
Beverages (mL)						
Whole milk	120	131	6.3	150	127	8.1
Flavored milk	133	170	15.4	101	188	20.2
Soft drinks	140	310	14.3	206	412 *	25.1
Canned juice	135	210	11.4	187	322 *	8.4

Data are expressed as mean ± SD. * Portion size was significantly higher in the obese group than the normal weight group ($p < 0.05$).

Association between BMI and Portion Size for the Most Energy-Dense Foods:

A positive correlation was observed between BMI and portion size for some of the energy-dense foods (Table 3). The portion sizes of burgers, French fries, biscuits, and chocolate confectionery were positively correlated with weight status. For instance, for each 10 g of chocolate confectionery, burgers, French fries, and biscuit intake, the value of BMI increased by 0.29, 0.25, 0.,31 and 0.18 kg/m^2, respectively. In terms of beverages, only the portion sizes of high-energy soft drinks and canned juice were positively associated with BMI. For each 100 mL of soft drinks and canned juice, BMI increased by 0.16 and 0.10 kg/m^2, respectively (Table 4).

Table 3. Correlation between portion sizes of the most energy-dense foods and the participant BMIs.

Food Groups (10 g)	Normal-Weight Participants (n = 309)				Overweight and Obese Participants (n = 211)			
	n	Change in BMI *	SD	*p*	n	Change in BMI *	SD	*p*
Sweet spreads, fillings, and icing	43	0.003	0.001	0.78	99	0.021	0.011	0.67
Savory snacks	54	0.041	0.013	0.67	87	0.082	0.016	0.34
Nuts and seeds	23	0.007	0.09	0.18	66	0.101	0.014	0.41
Chocolate confectionery	68	0.093	0.012	0.65	201	0·291	0.199	0.01∞
Biscuits	87	0.073	0.018	0.51	198	0.183	0.101	0.03∞
Buns, cakes, and pastries	105	0.013	0.001	0.98	165	0.092	0.023	0.63
Cheese	112	0.084	0.012	0.65	123	0.054	0.014	0.43
Breakfast cereals (not high in fiber)	45	0.043	0.020	0.43	100	0.115	0.101	0.21
Meat pies and pastries	54	0.064	0.022	0.45	89	0.016	0.012	0.76
Preserves	33	0.005	0.002	0.89	54	0.047	0.022	0.85
French fries	74	0.094	0.038	0.83	204	0.311	0.043	0.01 ∞
Burgers and kebabs	118	0.005	0.003	0.94	209	0.258	0.199	0.02 ∞
White bread, toast, and rolls	150	0.019	0.011	0.91	210	0·066	0.032	0.12
Pizza	77	0.044	0.022	0.85	177	0.012	0.009	0.55
Coated chicken	64	0.093	0.024	0.75	96	0.033	0.014	0.23

* Changes in BMI (kg/m^2) for each 10 g. ∞ $p < 0.05$.

Table 4. Correlation between portion sizes of the most energy-dense beverages and the participant BMI.

Beverages (100 mL)	Normal-Weight Participants (n = 309)				Overweight and Obese Participants (n = 211)			
	n	Change in BMI *	SD	*p*	n	Change in BMI *	SD	*p*
Flavored milk	133	0.018	0.01	0.45	101	0.072	0.34	0.87
Whole milk	120	0.011	0.66	0.89	150	0.061	0.86	0.73
Soft drinks	140	0.093	0.54	0.91	206	0.162	0.11	0.2 ∞
Canned juice	135	0.074	0.04	0.84	187	0.101	0.09	0.04

* Changes in BMI (kg/m^2) for each 10 g. ∞ $p < 0.05$.

DISCUSSION:

The findings of the present study indicate a positive association between BMI and the portion size of some energy-dense foods, such as chocolate, biscuits, French fries, burgers, and soft drinks. In addition, the portion sizes of these energy-dense foods were significantly higher among obese compared to normal-weight participants. To the author's knowledge, this is the first study to evaluate the association between food portion sizes and obesity and overweight in the Saudi population.

These results agreed with another study which found a positive correlation between the portion sizes of pizza, red meat, rice, salted snacks, and soft drinks with obesity incidence among Brazilians aged more than 13 years. [29] Recent data among Brazilians showed a significant relationship between soft drink portion sizes and the incidence of overweight and obesity [30]. Another study in South America demonstrated a significant correlation between BMI values and the portion sizes of fried snacks, commercial juices, pizza, soft drinks, sugar, and salted snacks. [49] A recent systematic review showed that there was a significant correlation between lowering the portion size of energy-dense foods and the reduction of body weight. [20].

Although several studies found that energy consumption was influenced by the size of food portions, only a few have demonstrated the relationship between weight status in adults and portion size. A study conducted in the Netherlands found that large portions were usually consumed by obese women, particularly high-energy-dense foods, while low-energy-dense foods were consumed in smaller portions. [39] Another study conducted among British adults revealed there was little correlation was observed between BMI value and the portion sizes of some food groups. [40]

The increase in body weight was attributed to an increase in energy intake to one that is greater than required. [29] Several controlled studies demonstrated that larger food and beverage portion sizes lead to a significant increase in energy intake. [24,39] These studies have suggested that the consumption of large portion sizes can influence energy balance, which can subsequently lead to an increase body weight. The Dietary Guidelines Advisory Committee revealed that large portion sizes are significantly correlated to body weight. [35] This report emphasizes the importance of portion control to minimize energy intake.

A study by Rolls et al. tested the impact of increasing the portion size of all served foods and beverages on energy consumption for two consecutive days in the US.[34] The study revealed that the energy intake increased by around 16% when the portion size was increased by 50%, while energy intake increased by 26% when portions were increased by 100%. Another study in Northern Ireland demonstrated a significant and continual increase in energy consumption per day when larger portions of food and beverages were served over four days. [36] A longer study lasting for 11 days found that the mean energy intake per day increased by 423 kcal when the portions of all consumed foods and beverages were increased by approximately 50%. [33] This increase in energy consumption was sustained for 11 days, which led to a 4636 kcal increase in the total of energy intake for this period.

In addition, a study examining the impact on weight gain of two different portion sizes of a free box lunch provided to the staff of a medical center for two months in the USA. In the first month, they were required to consume the smaller portion size (767 kcal). In the second month, they consumed the larger portion (1528 kcal). Energy consumed at lunch from the larger portion size was nearly 332 kcal higher than the small portion. The increase in energy in the lunch led to an increase in the total energy consumed per day by approximately 278 kcal. The mean change in the weight during the month for both lunch portion sizes was 0.64 ± 1.16 kg for the large portion and 0.06 ± 1.03 kg for the small portion. [37]

A six-month randomized controlled trial (RCT) aimed to examine the influence of reducing portion size on the weight management of obese patients. The results of this study indicated that people lost a significant amount weight after the intervention, that is, 1.8% of their body weight compared to 0.1% of obese who received the usual care. [45] Another RCT showed that limiting the portion size in obese people facilitated a weight loss of 2.4% after three months of intervention. [46]

Since portion size has a robust and continual impact, it could be used to improve the consumption of healthy and low-caloric food such as fruit and vegetables. A study by Rolls et al. revealed that increasing the portion size of vegetables in a meal by replacing meats and grains with vegetables led to a significant increase in vegetable consumption and a reduction of energy consumed during the meal. [38]

Therefore, people should be educated about the amount that they should consume for different foods and beverages based on the instructions of health organizations.[41,44] Encouraging people to “eat less” of everything is an impossible and ineffective approach to lowering the consumption of energy. A more effective way is to encourage people to consume a lower amount of energy-dense food and greater amount of low-energy-density food. This approach will enable them to consume satisfying amounts of food which could facilitate body weight management. [47]

Multiple RCTs in adults support this strategy. One study was conducted to test the impact of incorporating foods equal in energy but differing in energy density to an energy-restricted diet of overweight and obese adults. The group who incorporated two servings of low-energy-density soup per day showed 50% higher weight loss compared to the other group who incorporated the same amount of energy in the form of a high-energy-density snack food (7.2 vs. 4.8 kg). [48]

There are some strengths in the current study, namely: the anthropometry data were collected by the researcher, which is considered more accurate than self-reported. In addition, the dietary data were revised by the researcher to check the accuracy of the portion size. However, the main limitations were using a cross sectional design as well as collecting data from female at the university of Tabuk, therefore, may not be representative of all women in Saudi Arabia.

CONCLUSIONS:

The present study indicate that the portion size of energy-dense foods and beverages such as burgers, French fries, biscuits, chocolate confectionery, soft drinks, and canned juices is positively associated with body mass index (BMI). In addition, the portion sizes of these foods were found to be significantly higher amongst obese and overweight individuals compared to normal-weight participants. Future interventions should consider modifying the portion size of energy-dense foods to minimize the prevalence of overweight and obese individuals.

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