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# Abnormal Weight Among University Students in the Kingdom of Bahrain (2018): Prevalence, Factors, Predictions, and Recommendations

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**Abstract:** Over the past two decades, the Kingdom of Bahrain has seen an increase in weight in a growing number of people. Experts in the field determined that it is due to a lack of exercise and poor dietary habits. The problem has reached extremely high records of obesity; 37% for females and 30% for males. The statistics were based on a cross-sectional study of 414 volunteers at a local shopping mall. The goal of this primary data analysis was to determine the current prevalence of weight abnormalities. The findings were used to predict the trend of such abnormalities among the sub-population of university students in the Kingdom of Bahrain. The analysis, done in 2018, was based on 1,100 surveys collected from subjects in the central universities in the Kingdom of Bahrain including the University of Bahrain, Ahlia University, University of Bahrain, Arabian Gulf University, Applied Science University, AMM International University, Arab Open University, and Bahrain Polytechnic. The research was conducted over a period of several months. The authors developed surveys in both Arabic and English and randomly selected participants aged between eighteen and twenty-five among full-time students from major universities in the Kingdom of Bahrain. The standards of these weight issues, including obesity, overweight and underweight issues were determined with the use of the International Classification Index, a diagnostic tool used for health management. It is managed and prescribed by the World Health Organization. Based on the Chi-square test, the results strongly depended on the gender, age, and the extent of exercise performed on a weekly basis. As a result, a multinomial logistic regression involving these factors was used to compare the trends and predict the highest and lowest probabilities of each abnormal weight. For example, the male students, aged twenty-two or older who exercise less than one hour a week, were the most likely to be obese and overweight; about 20% and 42% chance, respectively. However, the students most probable to be underweight (about 11%) were those females; aged eighteen or nineteen who exercise less than one hour a week.

**Keywords:** BMI, The Kingdom of Bahrain, Multinomial Logistic Regression Model, Obesity, Overweight, Prevalence, Underweight, University Students

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## 1. Background

Research has found that the problem of obesity has reached increased numbers around the world. It is not an isolated problem; even the people living in the Middle Eastern countries of the Gulf Cooperation Council (GCC); suffer from this epidemic. The Middle East has been

estimated to be the second most obese region in the world; North America is number one. The prevalence of obesity in the Gulf countries among children and adolescents ranges from 5% to 14% in males and 3% to 18% in females. Adult females display a significant increase in obesity with a prevalence of 2%–55% and adult males from 1%–30% [1].

Obesity is a health condition often described as a disorder of

atypical or excessive fat growth in adipose tissue. Calculating the level of obesity in an individual is done by using the body mass index (BMI), a primary method for the population-based measurement of obesity [2]. The condition of being overweight is determined when the BMI of an individual is measured to be higher than 25.0 kg/m<sup>2</sup>. However, the label of obesity is given when one has a BMI higher than 30.0 kg/m<sup>2</sup> or more [2].

The World Health Organization (WHO) states that obesity is a critical disease which can be considered a primary risk factor of global mortality and an urgent public health issue. However, despite these findings, obesity is one of the most mistreated public-health problems [3]. Additional information and education is needed about healthy behavior habits including; regular physical activity, balanced nutrition, no smoking, and a decrease in alcohol consumption [4]. According to the NCD, this will reduce the global mortality from non-communicable diseases. As a result of obesity, 41 million deaths occur yearly all over the world [5].

## 2. The Tendencies of an Increase of Overweight and Obesity in the Kingdom of Bahrain

The World Health Organization describes health as a state of complete physical, mental, and social rank, and not simply the absence of disease or illness [6]. The health status indicators used in the Kingdom of Bahrain, a member of the Gulf Cooperation Council, are as good as those used in more developed countries. Their skills were displayed by their findings regarding the life expectancy to be 74.8 and the infant mortality rate of 7.6 per /1000 live births. Over the years, the Kingdom of Bahrain succeeded to gain control over many of the communicable diseases, and reach 100% coverage of the basic vaccines [7]. However, when compared to fully developed countries, the Kingdom of Bahrain continues to see an increase in chronic non – communicable diseases (NCD). The most common are cancer, cardiovascular disease, and diabetes which are ranked as the leading causes of death in the country [7].

The universal health care system of the Kingdom of Bahrain dates back to 1960 [8]. There was free government-provided health care for all Bahraini residents. Even then, the problem of overweight and obesity was a massive problem that affected the money spent on health care, in health care capitals [9]. The national economy accounted healthcare expenses for 4.5% of the Kingdom of Bahrain's GDP in 2007 [10]. Additionally, the per-capita health expenses of the Kingdom of Bahrain increased in 2015, rising at an average annual rate of 7.20% [11]. Despite all of the modern medical care and prescription drugs offered by the Bahrain Hospitals and Scientific Centers, the problem of obesity continues to a critical issue for the Kingdom of Bahrain.

During the past forty years, the Bahraini people have become progressively more modern, which has resulted in a change from an active lifestyle to an inactive country with unhealthy nutritional behaviors. The principal causes of the rapid growth in the obesity numbers have been studied. Evidence points to the broad environmental and social

changes linked to the change in both the professional structures and daily lifestyle of the family unit and the changes in the former society in the Kingdom of Bahrain. These social factors caused a higher prevalence of chronic obesity, type II diabetes, and cardiovascular disease [12].

One of the significant issues that were examined is the high rate of obesity in young children. Many young people who have an unstable breakfast receive a portion of their energy needs from the in-between meals that they consume [13]. Musaiger *et al.* stated that many of the meals served in school canteens in the Kingdom of Bahrain have a high caloric value with the absence of a daily intake of essential nutrients. As a result, the nutritional quality of their food intake significantly declines from childhood to adolescence. As they age, their consumption of healthy alternatives such as fruit, vegetables, milk, and fruit juices changes to the selection of fatty foods, soft drinks and multi-caloric nutritional foods [14].

Studies have found that obese children living in the Gulf countries grow into obese adolescents. This is particularly true in the Kingdom of Bahrain. This change in a lack of nutritional food and understanding of good eating habits leads to a wide variety of eating disorders. Research has found that many follow a food regimen that is high in saturated fats, sugar, and refined foods and low in fiber [14]. This nutrition behavior is often labeled as the 'Western diet,' which is characterized by an inactive lifestyle [15]. This so-called 'Western diet' may eventually result in such risk factors as chronic non-communicable diseases (NCD) in adulthood. These can cause such chronic illnesses as coronary heart disease, Type 2 diabetes, hypertension, and cancer [8]. This has now become the leading public health problem in most of the countries in the Middle East; particularly the Kingdom of Bahrain [14].

Unhealthy food habits can affect the life of a person forever. Skipping breakfast, having a low intake of fruits and vegetables and a high consumption of carbonated drinks, sweets, and fast food can lead to life-long problems. This can cause dynamic epidemiological transformations which begin for obese children that result in obese adolescents and adults [16]. This trend has been recorded over the past three decades. Also, unhealthy dietary behavior, specific social, psychological, and cultural influences the poor nurturing of parents, the dependence on the mass media and the social network all relate to overweight and obesity [17].

The National Non-Communicable Diseases Risk Factors Survey conducted in the Kingdom of Bahrain revealed that the overall prevalence of obesity was 36.2% in 2007. It was higher in female respondents than in males; 40.0% were obese women, and 32.4% were obese men [18]. In regards to specific age-groups, the highest prevalence of obesity among the male respondents was in the age group 40-49 years; 43.5%. In female respondents, the highest prevalence of obesity was in the age group 50-59 years–51.4% [18].

## 3. Methods

A total of N=1,100 students (597 females, 503 females)

aged eighteen to twenty-five, were randomly selected from the leading universities in the Kingdom of Bahrain; University of Bahrain, Ahlia University, University of Bahrain, Arabian Gulf University, Applied Science University, AMM International University, Arab Open University, Bahrain Polytechnic, and asked to take a survey. Those selected were a representative sample; made up of 54% of females and 46% of males. The questions on the survey asked about socio-demographic characteristics, personal lifestyle, and socio-economic status. The lifestyle questions focused on the subject's level of physical activity as well as their carbohydrate and fat intake. Before administering the survey, the questionnaire was pre-tested by a randomly selected group of students and approved by the Institutional Review Board (IRB). All subjects were asked to sign a written consent to participate in the research process.

Each section of the data was analyzed with the use of the SPSS statistics software program. Before this analysis, the Body Mass Index (BMI) was determined for each student, as the ratio of their weight (in kilograms) to the square of their height (in meters). The results were then converted into the widely-known four BMI categories (obese, overweight, normal weight, and underweight). The conversion was done using the international classification, specifically for adults, as prescribed by the World Health Organization [19].

According to the standard of the WHO, any person with a BMI below 18.5 is considered to be underweight. Those who have a BMI that falls within the range of 18.5-24.99 are considered normal. Those subjects deemed to be overweight or pre-obese have a BMI within the range of 25-29.99. Any person who has a BMI of 30 or more falls into the obese category [20]. Several variables, including, and not limited to, gender, age, fat and sugar intakes, weekly amount of exercise, and the family size and income were examined to determine their significance and the possible effect on the BMI. Cross-tabulations were carried out to calculate the prevalence rates of obesity, overweight, and underweight for each variable

category as well as for the entire sample. The Chi-square test was used to determine the significance of the association between the BMI and these variables. A correlation with a p-value of 0.05 or less was considered to be statistically significant. In addition, confidence intervals were determined to estimate the prevalence of obesity, underweight tendencies and overweight trends for the entire population of university students in the Kingdom of Bahrain. Finally, a multinomial logistic regression was deployed to compare the patterns and predict the highest and lowest probabilities of obesity, overweight, and underweight for this population.

## 4. Results

### 4.1. Descriptive Characteristics of the Sample

As presented in [Table 1], the sample consisted of female students (54%) and male students (46%) who were randomly selected from the foremost universities in the Kingdom of Bahrain. Most of the subjects were about twenty-one years old; 39% of them were 18 or 19, 30% were 20 or 21, and 31% were over 21. The average height was 1.60 m for females and 1.73 m for males. It was found that in both groups the heights were very similar (very small SD). However, this was not the case when weight was considered. [Table 1] shows an average of 60 kg for females and 74 kg for males with an SD of thirteen and fourteen respectively, which represented 21.7% and 18.9% of the respective means. On average, this placed the female students in the normal weight category (BMI  $\approx$  23.5) and male students in the almost overweight category (BMI  $\approx$  24.9). When their families were considered; those who share the same household; most had six people living together, on average, although the size did vary significantly in some cases (SD  $\approx$  2). In the sample, two groups emerged; families with four to six people (60%) and those with seven to nine people living in the same residence (23%).

**Table 1.** Socio-Demographic Characteristics of 1,100 University Students, the Kingdom of Bahrain 2018.

Characteristic	Category	n (%)	Average	SD <sup>(*)</sup>
Gender	Female	597 (54)		
	Male	503 (46)		
Age (years)	18 – 19	428 (39)		
	20 – 21	335 (30)	21	2
	22 – 25	337 (31)		
Height (m)	Female		1.60	0.07
	Male		1.73	0.10
Weight (kg)	Female		60	13
	Male		74	14
BMI (kg/m <sup>2</sup> )	Female		23.7	5.1
	Male		24.9	5
Family Size	3 or Less	125 (11)		
	4 to 6	660 (60)		
	7 to 9	469 (23)	6	2
	10 or More	59 (5)		
Family income (BHD/month)	Less than 500	152 (14)		
	500 - Less than 1,000	289 (26)		
	1,000 - Less than 1,500	316 (29)	1175	545
	1,500 or more	343 (31)		

(\*) SD: Standard Deviation

**4.2. Prevalence of Obesity, Overweight, and Underweight**

[Figure 1] shows that, among the 1,100 participants, the prevalence of obesity, overweight, and underweight were respectively 10.8%, 25.4%, and 8.9%. However, the prevalence highly depended on the gender and the age. As

for the entire population of university students in the Kingdom of Bahrain, a straightforward calculation with a confidence level of 95% would place the prevalence at 10.8±1.8%, 25.4±2.6%, and 8.9±1.7% respectively.

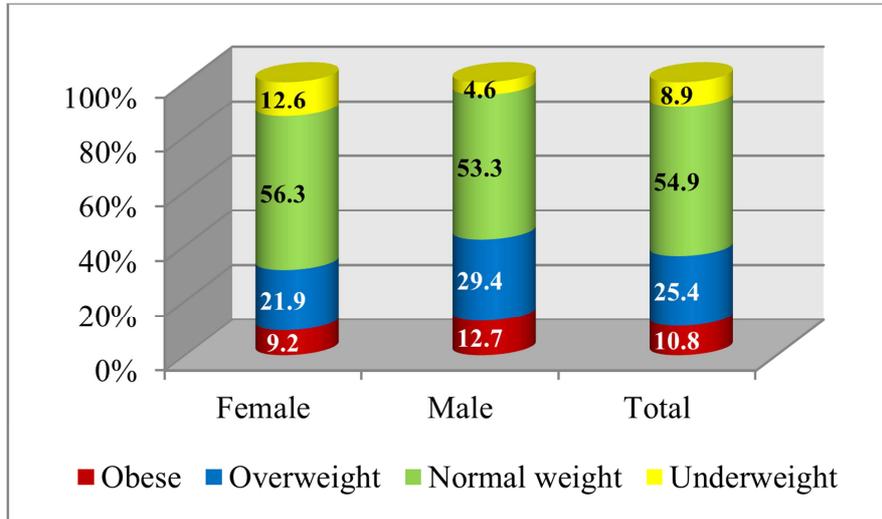


Figure 1. Prevalence of Obesity, Overweight, and Underweight among N=1,100 University Students, the Kingdom of Bahrain 2018.

**4.3. Factors Significantly Associated with the BMI**

In this survey, twelve factors possibly impacting the BMI were examined. Chi-Square test was used to evaluate the statistical significance of their effect. Based on a significance level set at a p-value of 0.05 or less, the test revealed four significant factors sorted in descending order of significance (see [Table 2]).

Table 2. Factors Having Significant Effect on the BMI of N=1,100 University Students, the Kingdom of Bahrain 2018.

Factor <sup>(a)</sup>	Category	BMI Status				Total n (%)	Chi <sup>2</sup> Test p-value <sup>(b)</sup>
		Obese n (%)	Overweight n (%)	Normal W. n (%)	Underweight n (%)		
Gender	Female	55 (9.2)	131 (21.9)	336 (56.3)	75 (12.6)	597 (54.3)	4/(10 <sup>38</sup> )
	Male	64 (12.7)	148 (29.4)	268 (53.3)	23 (4.6)		
Age (years)	19 or less	44 (10.3)	78 (18.2)	246 (57.5)	60 (40)	428 (38.9)	5/(10 <sup>12</sup> )
	20 – 21	25 (7.5)	80 (23.9)	210 (62.7)	20 (6)	335 (30.5)	
	22 or more	50 (14.8)	121 (35.9)	148 (43.9)	18 (4.3)	337 (30.6)	
Amount of Exercise (hours/week)	Less than 1	40 (2.6)	85 (26.7)	153 (48.1)	40 (12.6)	318 (28.9)	0.0155
	1–Less than 3 3 or more	53 (11) 26 (8.6)	114 (23.8) 80 (26.5)	272 (57.6) 179 (59.3)	41 (8.5) 17 (5.6)	480 (43.6) 302 (27.5)	
Sugar Intake (~ cake portions/day)	Less than 2	64 (10.2)	160 (25.5)	357 (56.8)	47 (7.5)	628 (57.1)	0.0385
	2– Less than 4	34 (10.4)	90 (27.5)	174 (53.2)	29 (8.9)	327 (29.7)	
	4 or more	21 (14.5)	29 (20)	73 (50.3)	22 (15.2)	145 (13.2)	
	Total	119 (10.8)	279 (25.4)	604 (54.9)	98 (8.9)	1,100 (100)	

(a) Two more factors nearly had a significant effect on the BMI; the place where students grew up (the Kingdom of Bahrain or outside, p ≈ 0.0772) and their family monthly income (p ≈ 0.0981). (b) Significance level: p = 0.05 or less.

**4.4. Gender and Age**

As shown in [Figure 1], there were relatively more obese and overweight in males (about 13% and 29% vs. 9% and 22% respectively). However, females were much more likely to be underweight than males (about 13% vs. 5%). This was the case even for each of the three age groups (19 or less, 20 to 21, and 22 or more) except when it comes to obesity prevalence among the oldest two groups where the figures

were reversed. Indeed, whereas the female prevalence seemed to vary regularly through age (obesity and overweight increasing from 6% to 16% and from 16% to 34% respectively, and underweight decreasing from 18% to 7%, see [Figure 2]), the male prevalence of overweight was also changing regularly from youngest to oldest (rising from 23% to 37%) but obesity and underweight rates went down from 18% to 7% and from 7% to 3% respectively, then up to 14% and 4% respectively (see [Figure 3]). For the entire

population of university students in the Kingdom of Bahrain, there was 95% chance that, among the six gender-age groups, the youngest males (aged 19 or less) held the highest prevalence of obesity (17.6±6%), the oldest males (aged 22 or more) held the highest prevalence of overweight

(37.2±6.9%), and the youngest females (aged 19 or less) held the highest prevalence of underweight (17.8±4.5%). These differences in BMI, due to the gender and age, were statistically extremely highly significant, with p-values less than 1/10<sup>37</sup> and 1/10<sup>11</sup> respectively.

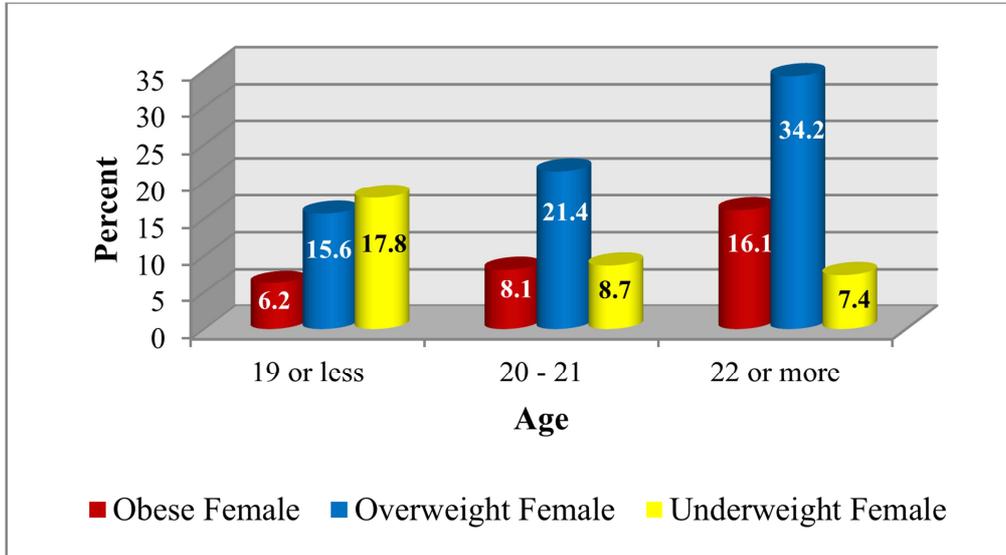


Figure 2. Prevalence of Obesity, Overweight, and Underweight by Age among n=597 Female University Students, the Kingdom of Bahrain 2018.

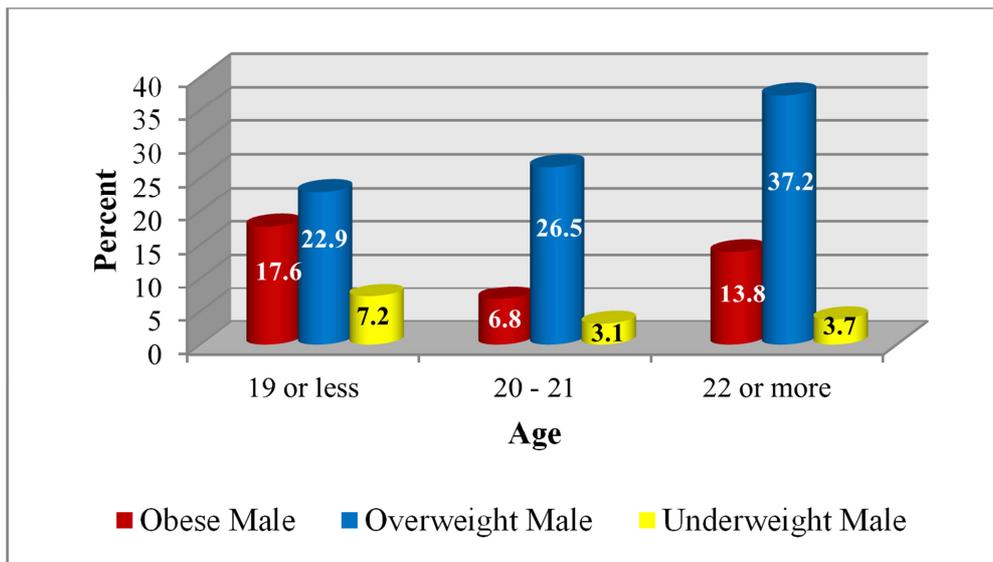


Figure 3. Prevalence of Obesity, Overweight, and Underweight by Age among n=503 Male University Students, the Kingdom of Bahrain 2018.

4.5. Amount of Exercise and Sugar Intake

According to [Table 2], a weekly exercise seemed to be beneficial to obese and underweight students as their proportions decreased through time of exercise (less than 1h/w, 1 to less than 3h/w, and 3h/w or more) from 13% to 9% and from 13% to 6% respectively. But for overweight, the prevalence was almost the same for the opposite two exercise-based groups (about 27%). However, the sugar intake had almost no effect on the BMI categories unless an equivalent of at least four cake portions was taken on a daily basis, case in which the prevalence of obesity and

underweight were at their highest (about 15%) and the prevalence of overweight was at its lowest (20%) among the three sugar-intake-groups. This was also the case where exercising on a weekly basis had the most negative effect on the BMI. Indeed, as shown in [Figure 4], for big consumers of sugar, the longer they exercised the lower their average BMI was. The differences in BMI categories, due to the amount of exercise and sugar intake, were statistically significant, with p-values of about 0.0155 and 0.0385 respectively.

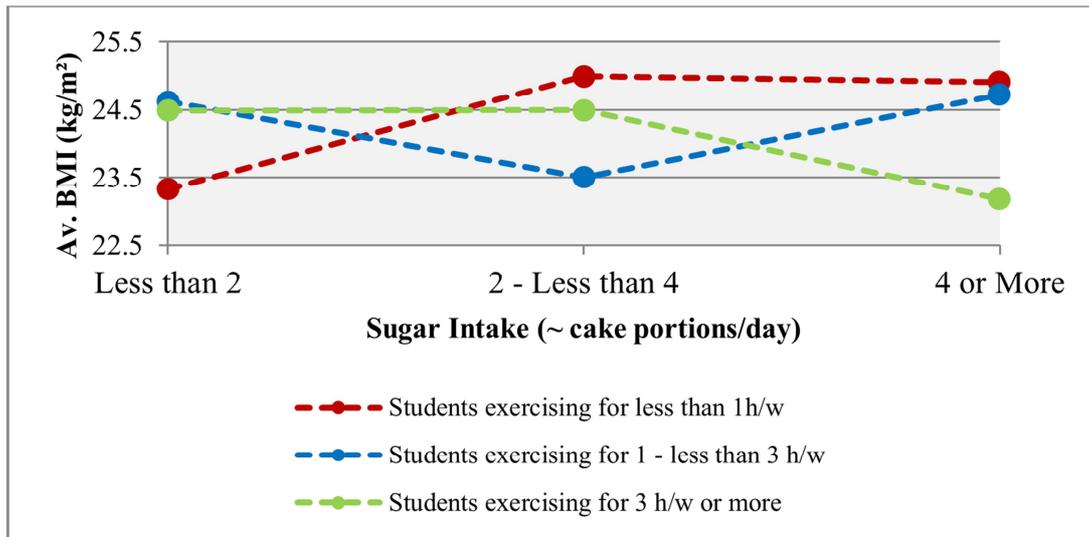


Figure 4. Average BMI by amount of Exercise and Sugar Intake among N=1,100 University Students, the Kingdom of Bahrain 2018.

## 5. Regression Analysis and Predictions

### 5.1. Multinomial Logistic Regression

As it can be noticed in [Table 2], the gender and age were by far the factors which association with the BMI status was the most statistically significant (p-values less than  $1/10^{37}$  and  $1/10^{11}$  respectively). But two other factors (amount of exercise and sugar intake) were also shown to have a significant effect on the BMI ( $p < 0.05$ ). Whereas there was

no relevant linear correlation between the BMI and some or all of these variables, a multinomial logistic regression of the BMI status (with normal weight as reference variable) in terms of the top three influent factors was shown to be statistically highly significant ( $p < 1/10^{14}$ ). The sugar intake was taken out as its contribution to this regression was not significant. The odds ratios for obesity, overweight, and underweight were predicted at 95% of confidence, as part of this regression analysis report, from which the main outputs were derived to get [Table 3].

Table 3. Predicted Odds Ratio (\*) for Abnormal Weight among University Students, the Kingdom of Bahrain (2018).

Predictor	Category	Obese		Overweight		Underweight	
		Coeff. B	Odds Ratio	Coeff. B	Odds Ratio	Coeff. B	Odds Ratio
Gender		-.403	.668	-.299	.741	.880	2.142
Age <sup>(a)</sup>	20 – 21	-.372	.690	.306	1.359	-.813	.444
	22 or more	.357	1.429	.866	2.377	-.901	.406
Exercise <sup>(b)</sup>	Less than 1h/w	.191	1.211	.195	1.215	.365	1.440
	3h/w or more	-.320	.726	.079	1.082	-.229	.795
Constant		-1.914	.147	-1.395	.248	-2.533	.079

(\*) Confidence level: .05. (a) Reference age group: 18 – 19. (b) Reference time interval: 1–Less than 3h/w

### 5.2. Predictions of Abnormal Weight

Based on [Table 3], one may either compare the odds for obesity, overweight, and underweight between two groups of given students category, or estimate conditional probabilities, particularly the highest and the lowest, for each abnormal weight, given their gender, age, and amount of exercise.

### 5.3. Comparison of Trends

Whereas females would be more than twice more likely to be underweight, males would be 1.3 and 1.5 times more likely to be overweight and obese respectively. On the other hand, students aged 22 or more would have 1.4 and 2.4 times more odds for obesity and overweight (respectively) than the youngest ones (aged 18-19), who would be 1.5 times more likely to be obese than the middle-age group (20-21) and more than twice more likely to be underweight than older

students. When it comes to exercise-related trends, students who work out very little (less than 1h/w) are expected to be 1.2 times more likely to be obese or overweight but 1.4 times more likely to be underweight than those who exercise moderately (1 to less than 3h/w), who would have 1.4 and 1.3 times more odds for obesity and underweight (respectively), compared to those who work out for at least 3h/w.

### 5.4. The Highest and Lowest Probabilities

For each abnormal weight, the probability can be predicted using the logistic regression equation which serves as a multiple linear model for the *Log odd* denoted by *L*:

$$L := \ln\left(\frac{p}{1-p}\right) \approx c + \sum_i b_i x_i \tag{1}$$

where *p*, *c*, *b<sub>i</sub>*, *x<sub>i</sub>* denote respectively the probability of a given abnormal weight, the regression coefficients (Column

“Coeff. B” in [Table 3]), and the code values (1 or 0) of the involved predictors. From equation (1), one can estimate the probability  $p$  as follows:

$$p = \frac{1}{1+e^{-L}} \quad (L \approx c + \sum_i b_i x_i) \quad (2)$$

According to equation (2), the probability is increasing with the *Log odd*. So its maximum and minimum values are

$$L_{max} \approx -1.914 + (-.403) * (0) + (.357) * (1) + (.191) * (1) = -1.366$$

and so is the probability of obesity:

$$p_{max}(Obese) \approx \frac{1}{1 + e^{1.366}} \approx .203 = 20.3\%$$

A similar mathematical approach leads to the prediction of the extreme probabilities (related to this logistic regression model) of each abnormal weight. These probabilities along with the corresponding students' categories are presented in [Table 4].

**Table 4.** Extreme Probabilities<sup>(\*)</sup> of each Abnormal Weight among University Students, the Kingdom of Bahrain 2018.

Abnormal Weight	<i>Log odd</i> <sub>max</sub>	<i>p</i> <sub>max</sub> (%)	Likeliest Category <sup>(**)</sup>
	<i>Log odd</i> <sub>min</sub>	<i>p</i> <sub>min</sub> (%)	Least Likely Category
Obese	-1.366	.203 (20.3)	(M, A ≥ 22, E < 1h/w)
	-3.009	.047 (4.7)	(F, A = 20 or 21, E ≥ 3h/w)
Overweight	-.335	.417 (41.7)	(M, A ≥ 22, E < 1h/w)
	-1.309	.213 (21.3)	(F, A = 20 or 21, E ≥ 3h/w)
Underweight	-2.101	.109 (10.9)	(F, A ≤ 19, E < 1h/w)
	-3.662	.025 (2.5)	(M, A ≥ 22, E ≥ 3h/w)

(\*) Based on a logistic 3-predictor regression model. (\*\*) A: Age, E: amount of Exercise, F: Female, M: Male

## 6. Recommendations

The growing number of subjects in the obese population, now called an obesity epidemic, resulted in a significant concern for the government of the Kingdom of Bahrain. The Ministry of Health in collaboration with physicians worked to create a program called: “Comprehensive National Action Plan for Prevention and Management of Overweight and Obesity” in 2005. Their goal was to work together to solve this public health problem [21].

The “Comprehensive National Action Plan for Prevention and Management of Overweight and Obesity” created the project of the nutrition clinic. This was put in place to offer a high standard program for obesity control to all overweight and obese adults, suffering from weight-related problems in the Kingdom of Bahrain. The patients would receive treatment early, to help correct and manage a long-term control of obesity and nutrition behavior guidelines, and its associated diseases [22].

The Principal Objectives of the Program were:

1) To provide early and complete permanent care for the obese patient, reducing weight and end the threat of related diseases and mortality factors

2) To measure the risk factors connected to overweight and obesity (hypertension, dyslipidemia, and diabetes), and to improve the health of the subject with a significant weight loss.

3) To offer weight management programs, consisting of

reached respectively at the highest and lowest values of the amount  $L$ .

For instance, one can show that the likeliest students to be obese, namely the males aged 22 or more exercising for less than 1h/w, would actually have more than one chance in five to be obese. Indeed, the *Log odd* for obesity is maximized with this category of students:

nutritional behavior changes, workout instructions, and lifestyle modifications.

4) To control the usage of the right medicine, if appropriate, and to ensure that the disbursement of medication is carefully done under medical regulation and guidelines.

5) To offer a clear and manageable medical appointment policy for physicians that will be used to control high-risk obese patients.

6) To regularly assess the care of patients in weight management programs and use this observation method on a clear and consistent basis [22].

The specialists of the Ministry's Nutrition and Primary and Secondary Health Care departments created a national task force in 2008. Their goal was to create an index of National Obesity Clinical Guidelines. They would be based on the WHO rules for categorizing BMI, as well as other technical guidance of lifestyle behavior changes. These would include references on how to lose weight and then, how to sustain that weight loss [23].

Since 2008, a rising number of nutrition clinics have helped to encourage people to make the necessary nutrition and behavior changes to decrease the risk of overweight and obesity [23].

Over the years the prevalence of adult overweight and obesity has decreased. In 2014, female obesity was calculated at 37% (BMI ≥ 30) while male obesity was listed as 25% (BMI ≥ 30) [11]. In 2016, the numbers of the obese

population of the Kingdom of Bahrain was 29.8% [24]. The program implemented in the Kingdom of Bahrain can serve as a model of positive lifestyle behavior changes through healthy nutrition, increased workouts, less time using mass media, and working on a reduction of sedentary activities. The actions taken to avoid a weight increase are the same as the steps taken to lose weight. They are daily exercises, healthy nutrition, and a long-term commitment to carefully watch what one eats and drinks. It is a life-long process and one must commit to a life of good health and fitness [25].

## 7. Discussion

### 7.1. Limitations

Although the research achieved its goals, there were some predictable limitations. Firstly, since this was a survey using self-reported data, the participants may not always respond truthfully. This could be because they could not correctly remember some of their personal information such as height and weight, or because they wanted to present themselves in a socially acceptable manner. Secondly, the effect of the family income was not a significant factor in the BMI status. This may be a result of some participants who might not have given truthful and accurate responses to all of the questions regarding family income in order to conceal sensitive information from their peers. Finally, there was also a lack of available data in some cases. All of this was factored into the final results of the research.

### 7.2. Strengths

This study was based on a considerable amount of data collected from a large sample of students from the leading universities in the Kingdom of Bahrain. It concluded that the obesity issue in this sub-population was much less a critical factor when compared to the entire adult population in the Kingdom; 9% vs. 37% for females and 13% vs. 30% for males. In addition, three variables were found to be quite significant when associated with the BMI status: gender, age, and amount of exercise. These factors were used, in a highly substantial logistic regression ( $p \approx 1/10^6$ ), to compare the trends and predict the highest and lowest probabilities of each abnormal weight among the students in the Kingdom of Bahrain.

## 8. Conclusion

The subjects of this survey were  $N=1,100$  students from the central Bahraini universities. The results were mainly dependent on the gender, the age of the students and somewhat on the amount of their weekly exercise and sugar intake. Based on this large sample, it was determined that the prevalence of obesity, underweight and overweight for the entire population of university students were estimated to be  $10.8 \pm 1.8\%$ ,  $25.4 \pm 2.6\%$ , and  $8.9 \pm 1.7\%$ , respectively. With the same confidence level (95%), it was shown that there were relatively more obese and overweight males;  $12.7 \pm 2.9\%$  and

$29.4 \pm 4\%$  vs.  $9.2 \pm 2.3\%$  and  $21.9 \pm 3.3\%$  respectively. There were relatively many more female students who were underweight ( $12.6 \pm 2.7\%$  vs.  $4.6 \pm 1.8\%$ ). More specifically, considering age, it was found that the youngest males, age nineteen or under and the oldest males, age twenty-two or older appeared to be the most obese ( $17.6 \pm 6\%$ ) and overweight ( $37.2 \pm 6.9\%$ ) respectively. Conversely, the youngest females, age nineteen or under were the most underweight ( $17.8 \pm 4.5\%$ ).

Furthermore, a weekly exercise was shown to be beneficial for obese and underweight students. It was determined that the longer they exercised; the lower was their prevalence. However, the sugar intake had almost no effect on the BMI status except for those whose sugar daily consumption was high.

A multinomial logistic regression model which included the top three influent variables was used to compare the trends and predict conditional probabilities of each abnormal weight, with 95% of confidence. For example, females seem to be more than two times more likely to be underweight while males would be 1.3 and 1.5 times more likely to be overweight and obese. Furthermore, students age twenty-two or more would have 1.4 and 2.4 times more odds to become obese and overweight respectively than those aged eighteen or nineteen, who would be more than two times more likely to be underweight than those aged twenty-two or more.

On the other hand, the highest and lowest probabilities of each abnormal weight were determined, with consideration of the gender, age, and amount of exercise of the subject. As a result, the university students most likely to be obese were the males aged twenty-two or older who exercise very little; less than one hour a week. The study indicated that this group would have more than one chance in five to be obese. These same students were also expected to be the most overweight with about a 42% chance. However, when examining the students most likely to be underweight, about an 11% chance, these were the youngest females, age eighteen or nineteen who exercised less than one hour a week.

## Conflict of Interest

The authors have no affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in the manuscript.

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