

## Impact of the Relationship between BMI and Food Intake Patterns on Obesity among Undergraduates in Sri Lanka

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### Abstract

**Background:** The rates of overweight and obesity are rising to epidemic proportions among the adults worldwide. **Objective:** This study aims at identifying the prevalence factors of obesity among the University students in Sri Lanka mainly with regard to the relationship between BMI and food intake patterns. **Methodology:** Simple random sampling method was used to select the sample of 500 university students who are currently undergraduates in University of Kelaniya. Data collection was conducted by a self-administered questionnaire. **Result:** Out of the sample, 20.04%, 42.91%, 18.83% and 18.22% students were under weight, normal weight, over weight, and obese respectively. Risk of obese and overweight of university undergraduates in Sri Lanka is increased by fat ( $OR=1.217(y=1)$ ,  $1.247(y=2)$ ) protein ( $OR=1.107(y=1)$ ,  $1.115(y=2)$ ) and carbohydrate ( $OR=1.099(y=1 \& y=2)$ ) intake respectively. Calorie intake is not impact on obese or overweight ( $OR=0.977(y=1)$ ,  $0.976(y=2)$ ). **Conclusion:** Unhealthy food culture of the undergraduate is influenced to indicate the high level of overweight and obesity prevalent among the undergraduates due to lack of awareness of obesity and overweight.

**Keywords:** Overweight, Obesity, BMI, Public health, Logistic regression

### I. Introduction

Prevalence of increasing obesity has been a major concern that affects most of the countries in the world including Sri Lanka lately. This has also caused numerous health consequences in humans such as chronic diseases including diabetes, blood pressure, cardiovascular diseases and cancer [1]. Worldwide at least 2.8 million people die per year due to overweight and obesity related diseases [2]. This problem has had an adverse impact on many countries socially and economically as well. And it has been in a growing trend. Prevalence of overweight, obesity and central obesity among Sri Lankan adults were 25.2%, 9.2% and 26.2% respectively in 2005-2006 and the prevalence of obesity related metabolic problems such as diabetes and hypertension among Sri Lankan adults were 13-14% and 18-19% respectively [3]. Moreover in Sri Lanka the diet-related chronic diseases during 2013 account for 18.3% of all deaths and 16.7% of hospital expenditure.

Obesity is defined as "abnormal or excessive fat accumulation that presents a risk of health" [4]. When it comes to the factors that increase the fat percentage of a person, Rossen & Rossen [5] comment on various factors such as several medical conditions, hormones, food addictions and many more. They emphasize that fundamentally obesity is a consequence of caloric imbalance where the balance is achieved when the energy intake equals the energy expenditure. Furthermore Rossen & Rossen [5] argue that the excess calories provided by the consumption of excess food get stored in the body as fat regardless whether the calories originally came from protein, fat or carbohydrate. Eating patterns play a major role in energy intake and weight management and they consider that Eating Occurrence Frequency (EOF) is positively associated with weight gain because of its positive association with energy intake [6]. Their research findings reveal that Body Mass Index (BMI) increases as eating frequency is increased. And also "dietary therapy" is an importance treatment as a weight management technique that can be used to reduce caloric intake of overweight and obese patients [7]. According to Blundell & Gillett [8], the increasing trend of consuming high energy-dense food creates an imbalance of the energy levels of the body and lead to weight gain and obesity. It was indicated that Sri Lankans consume excess amount of starchy food (Carbohydrate) and significantly a low amount of fruits, vegetables and dairy products [3].

Flegal et al. [9] point out that "BMI is highly correlated with percent body fat" which shows a correlation of 0.72 to 0.79 for men and for women a correlation of 0.72 to 0.84 between the BMI and percent body fat. Further, is recognized BMI as an important anthropometric index of weight and height, used as a screening tool to detect possible weight problems [10]. Hence it is clear that, BMI is an appropriate measure of body fat. It is noteworthy that most previous works have stressed the importance of food intake patterns where obesity is concerned. And considering the statistics with regard to obesity in Sri Lanka, the prevalence of obesity in persons aged 18+ years was 5.1 percent ( $BMI > 30 \text{ Kg/m}^2$ ) in 2008 [11] and 4.6 percent in 2010 [12]. In 2014, 3.5 percent and 10 percent amongst males and females were obsessed respectively in Sri Lanka [12]. In 2012, overweight and obesity rates of women aged 15 to 49 were 22.5 percent and 6.7 percent were respectively [2]. However, a healthy lifestyle in youth increases the chances for a good quality of life as an adult

especially in educated young crowd. More importantly, it provides the elements for good mental and physical fitness during the growth stage. As past literatures have revealed, major reason for prevalence non communicable diseases is overweight and obesity. Among public young educated groups are more important considering future development of particular society. Therefore while the situation non communicable diseases spread all over the world, it is much needed to study about obesity of young educated groups. Therefore the objective of this study is to identify the prevalence factors of obesity among the university students in Sri Lanka mainly with regard to the relationship between BMI and food intake patterns.

## **II. Methods And Materials**

### **2.1 Sample and data collection**

By using simple random sampling methods, 500 students were selected from 10000 of population units which represent the total number of registered students at present. Data was collected using the questionnaire method and each member of the research group was responsible for distributing questionnaires among groups of respondents. This procedure was carried out from September to November 2015. Respondents were instructed to take a few hours to answer the questionnaires in order to make sure that the data submission was reliable.

### **2.2 Variables**

Body Mass Index (BMI) was treated as the dependent variable because WHO[1] recommends BMI as the primary measure of obesity. As predictor variables, Calorie intake per day, fat intake per day, carbohydrate intake per day and protein intake per day were treated. In addition, Effect of day today activities and habits, Awareness and attitude towards obesity, Psychological effect, Effect of overweight family members were contrasted as independent factors against BMI ( See excel data file).

### **2.3 Measurements**

BMI is calculated using weight and height in which the weight is divided by the square of height. By this metric, a BMI of 25-29.9 kg/m<sup>2</sup> is considered overweight and BMI of 30 or more kg/m<sup>2</sup> is considered obese. For this study, cutoff values for BMI were defined in four categories as underweight (<18.5), normal weight (18.5-24.9), overweight (≥25.0-29.9) and obese (≥30.0). Values of the independent variables were defined based on the eating frequency and the nutritional value of the food per portion or. Here the formula was developed as Food intake per day = (Weekly eating frequency × Nutritional value of food) / 7. Statistics provided by USDA [13] was used to calculate the nutritional value of each food. Energy that yields by each type food was measured in calories. Amounts of fat, carbohydrate and proteins in each food were measured in grams.

### **2.4 Methods of Data Analysis**

Statistical Package for Social Sciences software (SPSS) was used to conduct all the statistical analysis. Descriptive data was presented as means and standard deviations. Percentages of the consumption of different food categorized by nutrition, day today activities of the respondents and the obstacles for being healthy were sorted according to the BMI category and gender. To identify the risk of become obese and overweight due to food intake, multinomial logistic model was applied. Furthermore, significant mean differences in BMI within categorical independent variables were measured using t statistics at 5% significant level. For additional analysis, pie charts and custom tables were utilized as well.

#### **2.4.1 Model**

Outcome variable (y) of model indicates BMI which was categorized as 0= Normal weight, 1= Overweight and 2= Obese. In the model normal weight consider as reference category. Then the models are as follows.

$$\log it = (y = 1) = \log \left( \frac{p(y = 1)}{1 - p} \right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4$$

$$\log it = (y = 2) = \log \left( \frac{p(y = 2)}{1 - p} \right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4$$

In the model, Calorie intake per day, fat intake per day, carbohydrate intake per day and protein intake per day were considered as  $x_1, x_2, x_3$  and  $x_4$  respectively.

### III. Results And Discussion

#### 3.1 Demographic characteristics

A total of 500 respondents (190 male and 310 female) were included in this survey. Out of the total, 24.2 percent attended university from home, 27.2 percent lived in the boarding house and 48.6 percent lived in university hostel. Age of the respondents varied from 20 to 27 out of which the majority 37.6 percent of the sample was 23 years old.

#### 3.2 Descriptive statistics

Table 1 shows the descriptive statistics of BMI, the dependent variable and calorie intake per day, fat intake per day, carbohydrate intake per day and protein intake per day which were considered the independent variables. The mean of BMI for males and females were 22.61 and 21.36, calorie intake per day was 1759.94 and 1783.03, fat intake per day was 39.87g and 43.82g, carbohydrate intake per day 243.16g and 247.38g and protein intake per day was 102.23g and 95.46g respectively. Only Calorie intake per day showed a considerable difference between males and females. Further, the results of the study show that 18.8 percent and 18.2 percent of undergraduates aged 20 to 27 are overweight and obese respectively. In terms of the gender, 23.2 percent and 20 percent of males are overweight and obese and 15.8 percent and 16.8 percent of females are overweight and obese respectively.

#### 3.3 Relationship between BMI and food intake

According to the multinomial logistic model given in table 1, when one unit increasing in  $x_2$ ,  $x_3$ , and  $x_4$  for overweight and obese relative to normal weight the multinomial log-odds of preferring overweight or obese to normal weight would be expected to increased. Considering odd ratio (OR) in the model one, it is identified that if subject were to increase fat, protein and carbohydrate intake per day, it is expected undergraduates to be more likely to risk become overweight or obese over normal weight. Although, in general carbohydrate intake is the most effective ingredient for increasing the body weight[3], most effective ingredient for increasing BMI of university undergraduate between 20- 27 age category is fat (OR = 1.217 and 1.247) followed by protein (OR=1.107 and 1.115) and carbohydrate (OR =1.099 and 1.099).It is interesting to identify that when calorie intake per day ( $x_1$ ) increased by one unite the multinomial log-odds of preferring overweight or obese to normal weight would be expected to decreased.it is concluded that if a subject were to increase some ones calorie intake per day, it is expected undergraduates to be more likely to stay in normal weight over obese of overweight (OR=0.977 and 0.976).

**TABLE 01:** Parameter estimates of the multinomial logistic model

Categorized BMI <sup>a</sup>		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
Overweight	Intercept	-1.354	.528	6.577	1	.010			
	Cal_Per_Day (x1)	-.023	.012	3.503	1	.061	.977	.954	1.001
	Fat_Per_Day (x2)	.196	.108	3.317	1	.069	1.217	.985	1.504
	Carb_Per_Day(x3)	.094	.049	3.719	1	.054	1.099	.998	1.209
	Prot_Per_Day(x4)	.102	.053	3.702	1	.054	1.107	.998	1.228
obese	Intercept	-.604	.507	1.420	1	.233			
	Cal_Per_Day (x1)	-.025	.012	4.094	1	.043	.976	.953	.999
	Fat_Per_Day(x2)	.221	.106	4.339	1	.037	1.247	1.013	1.535
	Carb_Per_Day(x3)	.095	.048	3.861	1	.049	1.099	1.000	1.208
	Prot_Per_Day(x4)	.109	.052	4.366	1	.037	1.115	1.007	1.234

a. The reference category is: normal weight.

#### 3.4 Effect of day today activities and habits

Considering the day today activities, on average respondents who do nothing in particular to maintain their body weight had a lower BMI (*Mean* = 20.96, *SE* = 0.23) than the BMI values of the rest (*Mean* = 22.70, *SE* = 0.24). This difference is statistically significant ( $p = 0.000$ ). Based on the categorized BMI, it was found that 51.6 percent of overweight respondents and 30 percent of obese respondents do nothing in particular in order to maintain their body weight (Table 02).

**TABLE 02:** Day today activities based on the categorized BMI

categorized BMI	<i>Have normal food</i>	<i>Do nothing in particular</i>	<i>Eat less oily food</i>	<i>Eat less sugary food</i>	<i>Eat more vegetables</i>	<i>Eat more green leaves</i>	<i>Eat more fruits</i>	<i>Do exercises</i>	<i>Follow a diet</i>	<i>Use fat burning pills</i>
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Normal weight	41.0%	51.9%	17.0%	14.2%	20.8%	8.5%	14.2%	19.8%	16.0%	2.4%
Obese	28.9%	30.0%	40.0%	31.1%	21.1%	15.6%	22.2%	35.6%	31.1%	8.9%
Overweight	28.0%	51.6%	28.0%	15.1%	23.7%	10.8%	12.9%	15.1%	15.1%	7.5%
Underweight	45.5%	62.6%	12.1%	10.1%	12.1%	7.1%	11.1%	14.1%	3.0%	1.0%

Further, it is indicates that daily workouts is an important factor as far as obesity is concerned. On average respondents who work out had a higher BMI (*Mean = 22.72, SE = 0.40*) than the ones who do not (*Mean = 21.60, SE = 0.19*). This difference is also statistically significant ( $p = 0.008$ ). Further, 15.1 percent of overweight and 35.6 percent of the obese respondents were involved in doing exercises. Considering the cooking oil and oily foodconsumption, on average respondents who eat less oily food had a higher BMI (*Mean = 23.74, SE = 0.39,*) than the respondents who do not (*Mean = 21.29, SE = 0.18*) and this difference is significant ( $p = 0.000$ ).as shown in Table 02, 40 percent of the obese category and 28 percent of the overweight category said to be consuming less oily food. When it comes to sugar consumption, there is a statistically significant difference of BMI between less sugary food consumer and rest of them ( $P=0.000$ ). On average, respondents who eat less sugaryfood had a higher BMI (*Mean = 23.29, SE = 0.44*) than the respondents who do not (*Mean = 21.54, SE = 0.18*). In addition 15.1 percent and 31.1 percent of overweight and obese respondents consumed less sugar respectively (Table 02).Daily workouts is an important factor as far as obesity is concerned. On average respondents who work out had a higher BMI (*Mean = 22.72, SE = 0.40*) than the ones who do not (*Mean = 21.60, SE = 0.19*).This difference is also statistically significant ( $p = 0.008$ ). Further, in table 02 indicated that15.1 percent of overweight and 35.6 percent of the obese respondents were involved in doing exercises. Considering the general population in Sri Lanka, they do not engaging with body maintain activities. However people how involve this activities after diagnosing of overweight or obese. This trend is also indicated by the result of lower BMI of the respondents who admitted to be doing nothing about maintaining the body weight and comparatively higher BMI of therest. On the other hand, working out and consuming less sugary and oily food seemed to be more popular among the respondents who already have a higher BMI on average. This allows us to identify that the youth in Sri Lanka who are relatively fat are more involved in the activities that would help them be healthier.

### 3.5 Awareness and attitude towards obesity

The study reveals that 45.6 percent of the obese participants consider themselves as overweight while 13.3 percent consider themselves as obese .On the contrary, almost 54.8 percent of the overweight participants believe that they have the normal weight while 30 percent believe that they are overweight. Only 5.4 of the overweight participants were able to assess themselves correctly. Table 03 shows the reasons that held back the respondents from being healthier and in better shape which identified that 21.5 percent of the overweight participants and 44.4 percent of obese participants stated that they are in good shape as a reason that stopped them from being healthier and in better shape.

**TABLE 03:** Reasons that held back the respondents from being healthy

categorized BMI	<i>My busy schedule</i>	<i>Not physically strong to diet or workout</i>	<i>Lack of support from family and friends</i>	<i>Being fat doesn't affect my look or personality</i>	<i>Can't resist unhealthy food</i>	<i>Money issues</i>	<i>None of the above. I'm in good shape</i>
	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Normal weight	57.5%	9.4%	3.8%	6.6%	17.5%	12.3%	31.1%
Obese	71.1%	17.8%	14.4%	18.9%	28.9%	13.3%	4.4%
Overweight	66.7%	8.6%	5.4%	14.0%	23.7%	11.8%	21.5%
Underweight	37.4%	11.1%	4.0%	2.0%	10.1%	4.0%	44.4%

Different attitudes between these two groups clearly emphasize that the awareness of obesity among the youth in Sri Lanka is inadequate which is why more than half of the overweight participants seem to have

higher esteems about their body fat. However the obese participants are in a better place in terms of awareness compared to overweight participants. Also this finding denotes that the majority of the overweight young crowd in Sri Lanka are not aware of the fact that they are on the verge of being obese and its possible negative consequences. Therefore as identified before, the lack of concern of the overweight participants towards being healthy could be most likely due to this lack of awareness. This draws attention towards the social issue within the present Sri Lankan youth in terms of health. Public health initiatives to improve awareness on overweight and obesity among the youth is important.

**3.5 Psychological effect**

Previous researches distinguish that 70% of obese subjects reported physiologically implausible levels of food intake and that obese or weight-gaining individuals possess a variety of traits that promote eating, and this food intake is much greater than normally assumed to be [8]. Considering the entire sample, respondents who cannot resist unhealthy food have a higher BMI (*Mean = 22.95, SE = 0.43*) than the ones who are in control. (*Mean = 21.57, SE = 0.18*). This difference was significant ( $p = 0.001$ ). As shown in Table 03, 28.9 percent of the obese participants and 23.7 percent of the overweight participants admitted that although they want to be healthy, they cannot resist unhealthy food. Therefore here the psychological effect can be identified as common factor that contributes to the prevalence of obesity. Furthermore, as shown in Table 03, 14 percent of overweight participants and 18.9 percent of obese participants believed that being fat does not affect their look or personality which addresses another side of psychological effects of obesity. This can be further proved by t statistic which identified that in general, respondents who believe that being fat does not affect their look or personality have higher BMI (*Mean = 24.08, SE = 0.50*) than the respondents who do not believe so (*Mean = 21.60, SE = 0.18*) which had a significant difference at the 0.05 alpha level ( $p = 0.000$ ). Once an obese or overweight individual is less motivated to lose weight and be healthier, he or she will tend to accept it eventually. Similarly, the Sri Lankan youth seem to accept being fat which could probably be a reason behind their lack of concern towards their health.

**3.6 Effect of overweight family members**

Research has shown parents with poor eating habits often have children with poor eating habits[14]. In general, respondents whose mothers are overweight have higher BMI (*Mean = 22.43, SE = 0.31*) than the respondents whose mothers are not (*Mean = 21.59, SE = 0.20*) which had a significant difference at the 0.05 alpha level ( $p = 0.025$ ). Similarly, the respondents whose fathers are overweight have even higher BMI (*Mean = 23.23, SE = 0.44*) than the respondents whose fathers are in good shape (*Mean = 21.58, SE = 0.18*). This difference was significant at the 0.05 alpha level ( $p = 0.001$ ). Table 04 specifically shows that respondents whose mother is 33.3 percent and 37.8 percent overweight and obese were reported to be overweight while those whose father is 16.1 percent and 28.9 percent overweight and obese, were reported to be overweight.

**TABLE 04:** Existence of overweight family members based on the categorized BMI

categorized BMI	Is your mother overweight	Is your father overweight	Is your sister overweight	Is your brother overweight	Is your grandmother overweight	Is your grandfather overweight
	Yes	Yes	Yes	Yes	Yes	Yes
Normal weight	26.4%	12.3%	9.9%	7.1%	7.1%	5.7%
Obese	37.8%	28.9%	14.4%	10.0%	8.9%	8.9%
Overweight	33.3%	16.1%	9.7%	17.2%	6.5%	7.5%
Underweight	22.2%	10.1%	3.0%	5.1%	5.1%	7.1%

Therefore this research distinguishes that the respondents with overweight or obese parents do have a direct tendency of being overweight or obese. As the previous researches suggest, this could be mainly due to the poor eating habits of the parents that made the respondents follow poor eating habits as well. In this study special conditions such as genetic obesity are disregarded. Hence, it can be said that the family members and their eating habits has also had an impact on the growing obesity among the youth in Sri Lanka.

**IV. Conclusion**

In conclusion, this study provides evidence that in terms of nutrients, fat intake plays a major role in increasing obesity among the undergraduate in Sri Lanka however carbohydrate and protein intake makes considerably lower effect on growing obesity respectively. In addition, the lack of awareness particularly on the risk factors of obesity, identifying the indications of obesity in advance and taking precautions has also been a primary cause of obesity among Sri Lankan youth. Although we did not study the effect of special medical conditions such as genetic obesity, poor eating habits of the mother and the father of the respondents is identified as another crucial factor that leads to obesity among Sri Lankan youth. Therefore considering the

findings of this study, there is a clear role for public health awareness programs in improving the awareness on obesity.

### **Conflict Of Interest**

There is no conflict of interest regarding the publication of this manuscript

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