Impact of the relationship between Body Mass Index (BMI) and food intake patterns on obesity among undergraduates in Sri Lanka

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Abstract

The rates of overweight and obesity are rising to epidemic proportions among the adults worldwide leading to a substantial increase in health risks associated with weight. Similarly, overweight and obesity rates in Sri Lanka has also been on a growing trend within the recent past. Addressing the current situation, this study aims to identify the factors of obesity among the undergraduates in Sri Lanka, particularly with regard to the relationship between BMI and food intake patterns. A sample of 500 undergraduates from University of Kelaniya who currently live with their parents, in hostels and boarding houses were selected using simple random sampling. Survey was carried out in representing the students Data collection was conducted by a self-administered questionnaire. Measures of heights and weights were used to calculate BMI (weight/height^2) where BMI $\geq$25.0-29.9 and $\geq$30.0 was defined as overweight and obese respectively. Eating frequency and nutritional values of food was used to calculate calorie, fat, carbohydrate and fat intake per day. Out of the sample, 20.04 percent had BMI<18.5(underweight), 42.91 percent were BMI between 18.5-24.9 (normal weight), 18.83 percent were between 25.0- 29.9 (overweight) and 18.22 percent were BMI 30.0 or above (obese). Findings of this study identified that 18.8 percent and 18.2 percent of the study sample are overweight and obese respectively. Multiple regression and the independent t test revealed that the higher level of protein intake and lack of awareness among the participants as the factors that are directly associated with the obesity.

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Increasing level of overweight and obesity among the youth indicates the important role of health professionals in improving awareness, encouraging positive lifestyle and promoting preventative measures of unhealthy food culture among undergraduates in Sri Lanka.

Key words: *Overweight, Obesity, BMI, Public health, Regression analysis*

Introduction

Prevalence of increasing obesity has been a major concern that affects most of the countries in the world including Sri Lanka. This has also caused numerous health consequences within humans such as chronic diseases including diabetes, blood pressure, cardiovascular diseases and cancer (WHO, 2015). Worldwide at least 2.8 million people die each day due to overweight and obesity In 2008, 24 percent of adults aged 20 + were obese (BMI>30 kg / m2) in the world whereas in 1980, only 13 percent were reported as obese which has shown a rising trend in obesity worldwide. The worldwide prevalence of obesity has nearly doubled between 1980 and 2008. (Jayatissa, Hossain, Gunawardana, Ranbanda, Gunathilaka & Silva., 2012). This in turn has created an adverse impact on many countries socially and economically as well. Due to these growing problems resulted by obesity, it is worthwhile to pay attention on identifying obesity in the first place and what factors cause it.

The World Health Organization (WHO) (2015) defines obesity as "abnormal or excessive fat accumulation that present a risk of health". According to NHLBI Obesity Education Initiative (2000), obese patients first need an assessment which includes determination of the degree of obesity and the overall health status. For this purpose, WHO (2015) recommends Body Mass Index (BMI) as the primary measure of obesity and defines BMI as "a crude population measure of obesity", "a person's weight (in kilograms) divided by the square of his or her height (in meters)". By this metric, a BMI of 25-29.9 kg/m^2 is considered overweight and BMI of 30 or more kg/m^2 is considered obese (Rossen & Rossen, 2012). Considering more facts that prove BMI is the most appropriate measure of obesity, Flegal et al. (2009) points 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. NHLBI Obesity Education Initiative (2000) mentions in their report that "BMI is recommended as a practical approach for assessing body fat in the clinical setting" and moreover states that "it provides a more accurate measure of total body fat". Similarly Kaur, Kau, Deepak & Gohlan (2007) recognize BMI as "an important anthropometric index of weight and height, used as screening tool to detect possible weight problems". Hence it is clear that, BMI is an appropriate measure of body fat.

When it comes to the factors that increase the fat percentage of a person's, Rossen & Rossen (2012) 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 (2012) 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. As identified by Heather et al. (2009) 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. Their research findings reveal that BMI increases as eating frequency is increased. In addition NHLBI Obesity Education Initiative (2000) also highlights the importance of "dietary therapy" as a weight management technique that can be used to reduce caloric intake of overweight and obese patients. So it is noteworthy that most previous works have stressed the importance of food intake patterns where obesity is concerned. Therefore for this research, special conditions like hormones, medical conditions are disregarded and food intake patterns will only be considered as a factor of obesity. So here it is assumed that the obesity of an ordinary person entirely depends on the particular person's calorie intake which is gained by food. This draws a link between food intake and body fat. Thus this confirms that a person's food intake or the dietary patterns acts as a primary factor or a variable that causes higher BMI over 30 kg/m^2 which ultimately leads to obesity.

Food intake patterns vary based on many factors. Blundell & Gillett (2001) describe about the biological and environmental forces that control food intake and how they were changed by the evolution of the world. They bring out the

theory that "the evolutionary process has favored biological traits associated with preferences for high energy density (sweet and/or fatty) energy-yielding foods". Therefore according to Blundell & Gillett (2001), one of the major changes resulted by the evolution was "the preference for high energy-dense food over low energy-dense food". This allows us to reach the conclusion that the increasing consumption of high energy-dense food creates an imbalance of the energy levels of the body and lead to weight gain and obesity. So in this research, finding the types of food and nutrient compositions that cause obesity in Sri Lanka will be a main focus area as well.

Obesity and food intake patterns in Sri Lanka

Since this research is based on the data collected from Sri Lanka, it is important that the relationship between obesity and the food pattern within Sri Lankan context is addressed. Considering the statistics with regard to obesity in Sri Lanka, previous work by Jayawardena et al. (2013) identifies that the 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. At the same time, the prevalence of obesity in persons aged 18+ years in 2008 was 5.1 percent (BMI>30Kg/m2) (CIA World Fact book, 2015) and in 2008, 3.5 percent and 10 percent amongst males and females, respectively (WHO, 2014). In 2012, overweight and obesity rates of women aged 15 to 49 were 22.5 percent and 6.7 percent were respectively (Jayatissa, Hossain, Gunawardana, Ranbanda, Gunathilaka & Silva., 2012).

Moreover the diet-related chronic diseases in Sri Lanka during 2013 accounted for 18.3% of all deaths and 16.7% of hospital expenditure. This emphasizes how badly Sri Lanka is affected by obesity and its health consequences at the moment. Regarding the food intake patterns in Sri Lanka, Jayawardena et al., (2013) indicate that Sri Lankans consume excess amount of starchy food (Carbohydrate) but significantly a low amount of fruits, vegetables and dairy products which is further explained by an example that some people consume rice with potato curry showing that people consume only starchy food for the whole day. Therefore the food intake that is predominantly based on carbohydrate has resulted the calorie imbalance causing high prevalence of

diabetes, insulin resistance, increased cholesterol and many more chronic diseases. Having identified food intake patterns in Sri Lanka as a major determinant of obesity, the study aims to provide insights on the relationship between obesity and food intake patterns in Sri Lanka based on the hypotheses that 'The relationship between obesity and food intake patterns of Sri Lankans is affected by the BMI'.

Methodology

This research studied the impact of BMI on the relationship between obesity, food intake patterns and was mainly designed for the Sri Lankan context particularly focusing on the identification of different adverse food intake patterns followed by university students and how it affect their BMI. Also the food habits of the individuals with higher BMIs and under the risk of obesity or already obese were taken into consideration. The process of identifying adverse food intake patterns also included the identification of types of nutrition that mostly contribute to increase body fat of the youth in Sri Lanka. For the study sample, 20 to 27 old healthy Sri Lankan government university students were recruited from University of Kelaniya. The study was based on university in order to highlight the importance of youth for country's future and therefore a healthy lifestyle in youth increases the chances for a good quality of life as an adult providing the elements for good mental and physical fitness during the growth stage. (WHO, 2015) Therefore studying the lifestyle of university students allowed us to see through the causes of obesity among the youth and find preventive measures. Simple random sampling was used to recruit the subjects from the population of 10 000. Out of the population, 500 of subjects were randomly selected. The sampling method was determined based on the previous researches carried out on similar areas by Laura, Alberto, Alejandra & Díaza (2009) and Karageorgi et al. (2013).

Data was collected using the questionnaire method and the data collection 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. Questionnaire for this study comprised 16 questions which included questions about personal dietary assessment and awareness and prevalence of obesity. Questionnaire was

aimed on collecting both qualitative and quantitative data out of which some of the qualitative data were converted into quantitative data for further investigation.

Body Mass Index (BMI) was treated as the dependent variable whereas calorie intake, fat intake, carbohydrate intake and protein intake were treated as independent variables. Body mass index (BMI) was calculated using weight and height in which the weight was divided by the square of height. Cutoff values for BMI were defined based on the previous work by Jayatissa, Hossain, Gunawardana, Ranbanda, Gunathilaka & Silva (2012). Four categories of BMI were identified 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 where the statistics provided by USDA (2015) was used to calculate the nutritional value of each food. Therefore the formula was developed as Food intake per day = (Weekly eating frequency × Nutritional value of food) / 7. 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.

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 and all the other qualitative data were sorted according to the BMI category and gender. Regression analysis which included with Pearson correlation, Overall model fit, ANOVA and parameter estimates were used to determine the factors associated with overweight or obesity among the study sample. Overall differences in BMI were measured using t statistics. At a P value < 0.05 and 0.01 was accepted as significant. For additional analysis, pie charts and custom tables were utilized as well.

Result

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 houses and 48.6 percent lived in the 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. 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 as the independent variables. Mean of BMI for male and female were 22.61 and 21.36, calorie intake per day was 1759.94 and 1783.03, fat intake per day was 39.87 and 43.82, carbohydrate intake per day 243.16 and 247.38 and protein intake per day was 102.23 and 95.46 respectively. Only Calorie intake per day showed a considerable difference between male and female.

Table 1: Descriptive Statistics

	BMI	Calories per day	Fat per day	Carbs per day	Protein per day
	Mean	Mean	Mean	Mean	Mean
Male	22.61	1759.94	39.87	243.16	102.23
Female	21.36	1783.03	43.82	247.38	95.46

Source: Author, 2016

Model for this study was developed as BMI = f (X_1, X_2, X_3 ,X_4) which showed that BMI is a function of X_1, X_2, X_3 and X_4, independent variables and that a change or variation in any of those variables would cause a change in BMI. The relationship between BMI and food intake patterns of the respondents was calculated using a multiple regression. As shown in Table 2, Pearson correlation was used to identify the relationship between these variables. The relationships between BMI and independent variables showed positive relationships. The relationship between BMI and calorie intake per day turned out to be a weak positive relationship which was shown by the correlation coefficient of 0.133 whereas BMI showed a comparatively stronger positive correlation to protein intake per day which was 0.195. P values of the correlation coefficients were statistically significant at the 0.01 and 0.05 alpha level.

Table 2: Correlation coefficients

		BMI	Calories per day	Fat per day	Carbs per day	Protein per day
BMI	Pearson Correlation	1	.133**	.091*	.099*	.195**
	Sig. (2-tailed)		.003	.041	.027	.000
	N	500	500	500	500	500
Calories per day	Pearson Correlation	.133**	1	.915**	.921**	.901**
	Sig. (2-tailed)	.003		.000	.000	.000
	N	500	500	500	500	500
Fat per day	Pearson Correlation	.091*	.915**	1	.739**	.807**
	Sig. (2-tailed)	.041	.000		.000	.000
	N	500	500	500	500	500
Carbs per day	Pearson Correlation	.099*	.921**	.739**	1	.716**
	Sig. (2-tailed)	.027	.000	.000		.000
	N	500	500	500	500	500
Protein per day	Pearson Correlation	.195**	.901**	.807**	.716**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	500	500	500	500	500

Source: Author, 2016

Table 3 presents the overall model fit. Multiple correlation between the dependent variable and the independent variables shown by the R value was 0.255 which implied that the dependent variable had a weak positive relationship with the independent variables. R square coefficient 0.065 indicated that only 6.5 percent of variance in BMI can be explained by the four independent variables.

Table 3: Overall Model Fit

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.255[a]	.065	.057	3.73139

Source: Author, 2016

According to the ANOVA shown in Table 5, only 477.532 of total variance was described by the regression or the independent variables while 6892.025 of total variance was not described. P value, 0.000 was lower than 0.05 and therefore was accepted as significant. Based on the parameter estimates as shown in Table 6, the regression equation was derived as $Y = 21.114 - 0.046X_1 + 0.368X_2 + 0.180X_3 + 0.227X_4$. P values of all the variables were identified as statistically significant at the 0.05 alpha level (p= 0.000).

Table 5: ANOVA Table

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	477.532	4	119.383	8.574	.000[b]
Residual	6892.025	495	13.923		
Total	7369.557	499			

Source: Author, 2016

General Discussion

Contribution of Nutrients

Findings of this study identified that 18.8 percent and 18.2 percent of the respondents 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. Examining the contribution of nutrients to obesity, previous researches suggest that predominantly carbohydrate diets raise the insulin resistance and leads to obesity (Jayawardena et al., 2013) whereas this study rejects the fact that carbohydrate intake contributes to obesity the most. Instead this implies that as a nutrient, protein makes the highest contribution towards obesity of the youth in Sri Lanka. On the other hand, previous researches indicate that Sri Lankans consume excess amount of starchy foods but per below amount of fruits vegetables and dairy products (Jayawardena et al., 2013). Similarly, this study identifies that consumption of starchy food or carbohydrates of the respondents are higher than the consumption of protein, vegetables, dairy and fruits. It should be noted that despite the fact that respondents consume

carbohydrate the most, protein intake is the mostly correlated nutrient to increasing BMI. Although this could possibly be due to the higher calorie amount in proteins than carbohydrates.

Awareness and Attitude

With regard to awareness and attitude towards obesity, Table 6 outlines the differences between the self-assessment of the respondents. 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 and 13.3 percent of the obese participants were able to assess themselves correctly.

Table 6: Self-assessment of the respondents based on the categorized BMI

	Do you consider yourself			
	Underweight	Normal weight	Overweight	Obese
Normal weight	22.6%	68.9%	8.5%	0.0%
Obese	8.9%	32.2%	45.6%	13.3%
Overweight	9.7%	54.8%	30.1%	5.4%
Underweight	39.4%	58.6%	2.0%	0.0%

Source: Author, 2016

Different attitudes between these two groups clearly emphasize that the awareness of obesity among the youth in Sri Lanka is inadequate which is further denoted by more than half of the overweight participants having underestimations about their body fat. 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. However, notably, the obese participants are in a better place in terms of awareness compared to overweight participants. This draws attention towards the social issue within the present Sri Lankan youth in terms

of health highlighting the importance of public health initiatives in improving the awareness on overweight and obesity among the youth.

Effect of Overweight Family Members

Past researches have shown parents with poor eating habits often have children with poor eating habits (Campbell et al., 2007). In the same way, Table 7 shows that mother of 33.3 percent and 37.8 percent of overweight and obese respondents were reported to be overweight while father of 16.1 percent and 28.9 percent of overweight and obese respondents were reported to be overweight respectively.

Table 11: Existence of overweight family members based on the 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%

Source: Author, 2016

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 that this could be mainly due to the poor eating habits of the parents that made the respondents follow poor eating habits too. 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 created an impact on the growing obesity among the youth in Sri Lanka.

Conclusion

In conclusion, this study provides evidence that 18.8 percent and 18.2 percent of Sri Lankan youth aged 20 to 27 are overweight and obese respectively and gender wise, 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. In terms of nutrients, protein intake plays a major role in increasing obesity among the youth in Sri Lanka but carbohydrate and fat intake make considerably lower effect on growing obesity respectively. In addition, the lack of awareness particularly of the risk factors of obesity, identifying the indications of obesity in advance and taking precautionary measures has also been a primary cause factor of obesity among Sri Lankan youth. Although we did not study the effect of special medical conditions such as genetic obesity among respondents, poor eating habits of mother and father of the respondents is found to be 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 where by the rates of overweight and obesity among young generation of the country can be hopefully kept in control.

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