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***Corresponding Author**
Nidaa Harun

E-mail
nidaadr@uo.edu.pk

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A significant association between acid-alkaline imbalance and obesity of adolescent college girls

Asma Yawar[1], Shahid Mahmood Rana[1], Nidaa Harun[2,*], Sabra Afzal[3], Nimra Arooj[2], Kaneez Fatima[2]

[1]Department of Home-Economics, University of Sargodha, Sargodha 40100, Pakistan
[2]Department of Botany, Faculty of Life Sciences, University of Okara, Okara 56130, Pakistan
[3]Department of Economics, Lahore College for Women University, Lahore 54000, Pakistan

Abstract

Obesity has become a major health concern in the past few decades. It is quite threatening that it is now a common problem among our adults, especially girls. The possible reason for this alarming increase is might acid-alkaline imbalance by the disproportional diet of our young girls. Therefore, current research was planned to identify an association between acid-alkaline imbalance and obesity of adolescent college girls. The nutritional and acid-alkaline status of 428 college girls aged between seventeen-nineteen years from Government Girls Higher Secondary school, Nishatabad, Faisalabad, were evaluated in this prospective study. Blood, saliva, and urine samples were used as study instruments, along with a food frequency questionnaire and anthropometric measures. Based on Body Mass Index (BMI), 227, 178, and 23 volunteers were found to be normal weight, underweight and obese, respectively. The anthropometrics, indicative biomarkers, and dietary intakes of all volunteers were assessed. It is found that weight (63.19±1.57 kg), BMI (29.17±0.64 kg/m^2), body fat (34.45±0.58 %), body water (47.73±0.42%), and muscle mass (34.65±0.22%) of obese girls fluctuates significantly from normal ones and international standards. Drastic and significant variations in acid-alkaline status were found in obese girls as depicted by pH values of blood (7.35±0.01), saliva (5.46±0.13), and urine (5.77±0.11). Very pitiable, inadequate, and imbalanced dietary intakes were explored in obese students as indicated by servings of junk foods (4.82±0.53), fats, oils, & sweets group (4.56±1.09), vegetable group (0.86±0.09), and fruit group (1.72±0.18). A positive association was found in some dietary intakes and indicative biomarkers. Malnutrition resulted in meager anthropometrics, imbalance of acid-alkaline status, and obesity in adolescent college girls.

Introduction

In the last few decades, obesity has become the most substantial health concern and, its magnitude is increasing in an adolescent at an alarming rate [1]. Obesity has a genetic basis; however, a rapid increase in its frequency suggests some other triggering factors like sedative lifestyle [2], suboptimal diets, and environmental changes [3]. The trend of healthy diet declines during adolescence [4]. For instance, increase the consumption of sugar-sweetened drinks. Intake of poor quality diet at the teenage can carry forward into adulthood [5]. That may lead to morbidness of multiple health illnesses like coronary heart disease (CHD), gall bladder disease, diabetes type II, hemorrhagic stroke, sleep apnea, osteoporosis, and a few other certain cancer types [6]. Furthermore, persisting adolescent obesity can cause long-term consequences in psychosocial disorders in individuals [7]. Reports also indicate that obesity can affect the length of life. Data from the United States propose that adults (aged 20–30 years) having BMI (body mass index) ≥ 45 kgm are under more threat of life expectancy reduction [8]. It has been observed that obesity and pH are related to each other. Excessive calories are stored in the cell as unburned fatty acids, called fats. On cellular metabolism of these fatty acids in different kinds of acids like acetic acid, lactic acid, and LDL cholesterol, which in return cause the rise in pH of body fluids. The acidic body conditions lead to oxygen deficiency which ultimately reduces the cellular metabolism, thus resulting in obesity [9]. An abridged metabolic rate makes it even more challenging for the body to dispose of unburned food and stored as additional fat. Alternatively, a rise in pH causes depletion of stored minerals in the muscles, bones, and other organs. Therefore, in the long run, it causes osteoporosis, aging, and multiple other degenerative diseases [10] recommended that a lower cellular pH has been noticed in obese subjects. It has also been shown that a low cellular pH can cause protein loss in the urine and that muscle loss in metabolic acidosis is due to endogenous protein catabolism [11]. Moreover, obese people had lower cytosolic free magnesium and higher free calcium than normal people, implying that an ionic hypothesis plays a role in disease development and explains obesity, hypertension, and insulin resistance [12]. Multiple research indicate a possible relationship between obesity and acid-alkaline imbalance. However, despite the attempts of several researchers, the link between obesity and pH imbalance remained unclear. Hence the current study was designed to scrutinize the correlation between obesity and pH imbalances by investigating the college girls. Such research outcomes may play role in the establishment of national standards for dietary requirements. Additionally, may serve as baseline data for future nutrition programs to improve the health of people [13].

Materials and Methods

Study design

For this research, a cross-sectional study design was adopted [14]. For the study, Government Girls Higher Secondary school, Nishatabad, Faisalabad was selected after formal permission from authority [15]. Data were collected between January 2012 and December 2012 through multiple visits to the study site. A two-stage sampling technique such as purposive and convenience sampling techniques; (non-probability sampling methods) was employed [16]. Girls between the age group of 17–19 were selected on their BMI basis as the study population. This particular age group has been chosen because this is a crucial stage of adolescence, especially for girls. These girls are regarded as future mothers, and their current health status directly or indirectly affects the health of their own and their child. The initial sample size was 428 girls, and on their BMI basis, 227 volunteer girls were categorized under the label of average weight, 178 as underweight, and 23 found as obese. This categorization was done according to the lower BMI cut-off values for classification of weight in Asian adults by the International Association for the Study of Obesity and the International Obesity Task Force (Underweight < 18.5, Normal range is 18.5–22.9, obese ≥ 25) [17]. This was first stage sampling. As per guidelines of [30], 5–20% of the first-stage sample is needful for the second-stage sample size. At second stage sampling, 20% normal weight (88 individuals) and underweight (88 individuals) while 5% obese (22 individuals) girls were selected randomly from the total sample for further studies [17].

Anthropometric Measurements

The height (cm) of bare footed volunteers was measured through Stadiometer. Body composition including body fat (%), weight (Kg), muscle mass (%),body water (%) of college girls were investigated through the special scale Bio-Electrical Impedance based scale (BG–64, Burer, Germany) [18]. Each reading was taken in triplicate; however, their mean used for results interpretation. This data was utilized to calculate BMI (kg m^{-2}) and ideal body weight (kg) (Kraut). Finally, the data was compared to industry standards for assessing the nutritional health of adolescent subjects [19].

Indicative biomarkers

The pH of volunteers' blood was resolved through Automatic Electrolytes Analyzer (K-Lite-5; Meizhou Cornley Company Hi-Tech Co. Ltd., China) as procedure adopted by [33], pH of urine and saliva samples of adolescent volunteers was measured through Automatic Urine Chemistry Analyzer (Uritest-50, URIT Medical Electronics Co. Ltd., China) and pH meter (inoLab®pH720, WTW, Germany), respectively.

Food intakes assessment

The food frequency questionnaire was used to assess the dietary consumption of subjects. Each volunteer's intake of serving numbers was calculated to determine the mean serving number of each food group, which was then compared to the FAO's Food Guide Pyramid's reference number of servings [20].

Statistical Analysis

The data were analyzed by using the SPSS-23. Descriptive analysis was used for interpretation of the data. Furthermore, the data obtained was subjected to Duncan Multiple Range Test (DMR) [21] was used if there was a significant difference between groups, and one way analysis of variance (ANOVA) techniques have been used if there was a significant difference between groups [22]. The significance level was set at p 0.01. Pearson correlation was applied to explore the association between dietary intakes and indicative biomarkers of volunteers. Obtained results were interpreted analytically and logical conclusions were drawn [20].

Results and Discussions

The relationship between volunteer age and weight categories was presented in (**Table1**). Approximately 17% of underweight volunteers were 17 years old, whereas the maximum number of normal weight volunteers (44.3%) were 18 years old, and the number of both underweight and obese volunteers (45.5%) were 19 years old (45.5%) [23]. The highest number of obese and underweight volunteers was 19 years old, while the maximum number of normal weight participants was 18 years old (**Table 1**). From a whole sample, 88 girls with normal weight, 88 girls who were underweight, and 22 obese girls were selected for further analysis. Volunteers' age and weight categories were found to have no significant relation. The age and weight categories of volunteers were found to have a non-significant association. The age ranges for normal weight were 18.5–30.11, underweight 18.4–30.10, and obese 18.9–50.18 were determined to be non-significantly different (**Table 2**). These results demonstrated that age has very little impact on the categories of weight [24]. There was also a non-significant association identified between volunteer body weight and height categories. The body weight and weight categories of volunteers, on the other hand, were found to have a significantly associated. According to the table, underweight participants had the lowest weight range values, whereas obese volunteers had the highest weight range values. Similarly, volunteer's body mass index (BMI) and weight categories have a high correlation. BMI values for obese people were (29.1–70.64), while those for underweight volunteers were (17.1–70.11). The results show that obese volunteers had the highest BMI values, while underweight volunteers when compared to conventional norms, Asian Adolescent volunteers have BMI lower values

Table 1: Demography of study population

Age (years)	Weight Categories			Total
	Normal Weight	Underweight	Obese	
17	14	15	3	32
	15.9%	17%	13.6%	16.2%
18	39	33	9	81
	44.3%	37.5%	40.9%	40.9%
19	35	40	10	85
	39.8%	45.5%	45.5%	42.9%
	88	88	22	198
Total (17-19)	44.44%	44.44%	11.11%	100.0%

Table 2: Anthropometrics, pH and dietary intakes of adolescent college girls

Indicators	Normal Weight Girls		Underweight girls		Obese Girls	
	Mean	SE	Mean	SE	Mean	SE
Age (year)	18.53[n-s]	0.11	18.43	0.10	18.95 [n-s]	0.18
Weight (Kg)	48.70[b]	0.53	41.76[c]	0.48	63.19 [a]	1.57
Height (cm)	157.26[n-s]	0.62	155.59	0.67	157.09[n-s]	1.14
Body Mass Index (Kg/m²)	21.04[b]	0.18	17.17[c]	0.11	29.17[a]	0.64
Body Fat (%)	22.58[b]	0.08	60.29[a]	0.24	34.45[a]	0.58
Body Water (%)	54.48[b]	0.23	17.48[c]	0.21	47.73[c]	0.42
Body protein (%) (Muscle Mass)	38.74[b]	0.23	41.19[a]	0.13	34.65[a]	0.22
pH of Blood	7.41[a]	0.01	7.35[b]	0.02	7.35[b]	0.01
pH of Saliva	6.78[b]	0.04	6.94[a]	0.08	5.46[c]	0.13
pH of Urine	6.52[c]	0.06	5.95[b]	0.06	5.77[a]	0.11
Bread, Cereal, Rice, & Pasta Group (Servings)	6.32[b]	0.25	5.31[c]	0.27	7.82[a]	0.49
Fruit Group (Servings)	2.45[a]	0.13	1.64[c]	0.10	1.72[b]	0.18
Vegetable Group (Servings)	1.10[a]	0.10	0.71[c]	0.04	0.86[b]	0.09
Meat, Poultry, Fish, Dry Beans, Eggs, & Nuts Group (Servings)	1.55[b]	0.15	0.88[c]	0.08	2.81[b]	0.47
Milk, Yoghurt, & Cheese Group (Servings)	2.12[b]	0.21	1.46[c]	0.12	3.71[a]	0.63
Fats, Oils, & Sweets Group (Servings)	2.91[b]	0.15			4.56[a]	1.09
Junk/Fast Food Group (Servings)	4.56[b]	1.09	1.50[c]	0.15	4.82[a]	0.53

(18.50–22.90) [37]. Overweight and obesity were found to be prevalent in the general population of Pakistan determined to be 25.0 percent [25]. The rate was highest among participants aged 15–24 years, with women accounting for 13.8 percent of the total. 27.51 percent of reproductive-age women in Africa and South Asia were underweight [26].

Body Composition

The percentage of body fat and the weight categories of volunteers were shown to have a highly significant relationship (Table 2). Body fat % values for obese volunteers were 34.4–50.58, followed by normal weight volunteers with 22.5–80.08, and underweight volunteers with 17.4–80.21 [27]. Table 2 shows when compared to the other groups, underweight volunteers had the lowest body fat percent values, while obese volunteers had the highest. According to the BG-64 Beurer Germany manual, the usual weight range for adolescent participants in the age group (17–19) is 17–22. A highly positive relation was also found in the body water (%) and weight categories of volunteers [28]. The mean body water % in obese individuals was 47.73, followed by 54.480 in normal weight volunteers, and 60.29 in underweight volunteers. The ratio of body water was highest among underweight volunteers, according to the results. As can be seen from the data, underweight volunteers had the highest percentage of body water, while obese individuals had the lowest percentage of body water. But, according to the BG-64 manual, these all fall within the normal range of body water such as 45–60%. According to Beurer Germany [24], obesity lowers the water content of adipose tissue. Obese women have less Total Body water (TBW) per unit of body weight (BW) than women of normal weight. Obese persons have more total body water, although their TBW: BW ratio is lower than normal weight subjects. The TBW: BW ratio seems to be a measure that changes with obesity. The relationship between body protein % and volunteer weight categories was shown to be highly significant. Table 2 shows that obese people had body protein % values of 34.65, normal weight volunteers had 38.75 and underweight volunteers had 41.19 Underweight volunteers had the lowest body protein percent values compared to obese volunteers who had the lowest values compared to other groups, as seen in the table. According to the BG-64 Beurer Germany manual, for the age group (17–19), the normal range of body protein percent is 35–41. Urine pH is negatively proportional to Body Mass Index (BMI) and related directly to muscle mass, according to a previous study [29]. Discovered that the presence of extra fat or adiposity in humans resulted in decreased muscle mass and strength, as well as decreased bone mass [30].

Indicative Biomarkers

The pH of blood and the weight of volunteers had a substantial link, which was also extremely significant in the case of saliva and urine. The blood pH of average-weight subjects was normal (7.41±0.01) while obese ones' value (7.35±0.01) was tilting towards acidic end but lie within optimal range i.e. 7.35–7.45 [31] observed that blood pH from prolonged or chronic acidogenic meals was close to the lower end of the physiological range (7.36–7.38) than the higher end (7.42–7.44). Persistent acidogenic meals, in fact, have the potential to cause small reductions in blood pH and plasma bicarbonate [32]. The pH of obese girls' saliva (5.4–60.13) was found to be acidic, while the pH of healthy weight adolescents' saliva (6.7–80.04) was within the optimal range (6.0–7.4) [33] (Table 1). Acid loading may induce temporary acid-base disequilibrium, if the pH of saliva is too low (6.5), the body may create too many acids or get overloaded due to insufficient urine elimination. Obese girls (5.7–70.11) had lower urine pH values than normal participants (6.5–20.06), as shown in Table 1, which agreed on an ideal range of 5.8–7.0. Similar findings were reported, who found that persons who ate more acidic meals based on animal protein had more kidney acid excretion and, as a result, had more acidic urine pH than those who ate diets based on plant sources. According to [34], urine pH is inversely and directly related to BMI and muscle mass, respectively [35].

Assessment of dietary intakes

The consumption (servings) of food groups and the subjects' weight were found to have a highly significant relationship [36]. Obese and normal-weight girls consumed (7.8–20.49), (1.7–20.18), (0.86–0.09), (2.8–10.47), (3.7–10.63), (4.5–61.09) and (4.8–20.53) servings of bread, cereal, rice, pasta group, fruit group, vegetable group, meat, poultry, fish, dry beans, eggs, nuts group, milk, yoghurt, cheese group, milk, yoghurt, cheese group, fats, oils, sweets group and junk/fast food group, respectively as tabulated in **Table 1** [37].

Conclusions

Current results showed that Obese adolescents clearly consumed more oils, sweets, and junk/fast food, fats, and fewer servings of fruits and vegetables than recommended in, which could be a contributing factor to acid-alkaline imbalance and obesity in young girls. Obese girls had greater body weight (63.19±1.57 kg), BMI (29.17±0.64 kg/m^2) and body fat (34.45±0.58 %). Whereas less body water (47.73±0.42%), and muscle mass (34.65±0.22%) in comparison to normal weight girls. These indicative markers fluctuate significantly from normal ones and international standards. Additionally, pH values of body fluids of obsess girls is significantly more acidic relatively to normal ones i.e., blood (7.35±0.01), saliva (5.46±0.13), and urine (5.77±0.11). Very pitiable, inadequate, and imbalanced dietary intakes were explored in obese students as indicated by servings of junk foods (4.82±0.53), fats, oils, & sweets group (4.56±1.09), vegetable group (0.86±0.09), and fruit group (1.72±0.18). Normal-weight volunteers, on the other hand, consumed nearly the usual number of servings of all food groups, in the comparison to the suggested number of servings per day in. As a result, it was possible to determine the association between acid alkaline status and dietary intake and nutritional status since obese girls consumed less alkaline and more acid-producing meals than normal-weight participants.

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Ethical Consent

Ethical consent of ethical review committee of University of Sargodha, Sargodha, Pakistan was followed.

Conflict of interest

The authors declare no conflict of interest.

List of symbols, units and abbreviations

BMI= Body Mass Index
TBW= Total Body Water
BW= Body Water
Kg= Kilograms
Cm= Centimeter

m= Meter

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