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Anthropometric and Socio-Economic Determinants of Dietary Diversity Scores in University Students

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ABSTRACT

Eating habits, particularly, diversity of diets of university students, are not reported. **Objectives:** To investigate the dietary habits with special consideration of the dietary diversity score of university students at Bacha Khan University Charsadda (BKUC). **Methods:** A cross-sectional study design was conducted on a sample (n=200) of students from various teaching departments. Data on anthropometry and dietary intake were collected. Dietary diversity score (DDS) was calculated by employing a normal food category score scheme. Data on anthropometrics (height, weight, BMI, waist circumference (WC), and waist-to-hip ratio (WHR), and socioeconomic were recorded in a questionnaire. Group differences were evaluated using one-way ANOVA and t-tests for evaluating differences in DDS based on SES and the anthropometric measures. **Results:** As expected, significantly higher scores of DDS were found in the subjects who had higher economic status ($p<0.001$). A high negative relationship existed between DDS and anthropometrics (BMI, WC, and WHR), especially in the female students ($p<0.05$). The intake of grain, fruit, vegetable, dairy, and protein, and an improved intake in DDS quartiles ($p<0.01$), once again validated DDS as a solid measure of dietary diversity and intake. **Conclusions:** It was concluded that higher DDS are associated with better intake of special food categories and better anthropometric indicators. These findings reinforce the importance of promoting dietary diversity to promote health and prevent chronic disease.

INTRODUCTION

In the context of human nutrition and health, and disease prevention, dietary diversity (DD) is a developing field [1]. DD has been considered one of the qualities of a healthy diet on a global scale [2]. To attain dietary adequacy and optimal growth and development, a diverse diet that includes all the food groups, meat, vegetables, fruits, grains, and dairy products is necessary [3]. "The number of different foods or food groups consumed over a given reference period" [4] has been defined as dietary diversity. An omnivorous diet that includes the right macro- and micronutrients may increase hunger, especially in kids, and lower the risk of developing chronic illnesses like cancer, diabetes, metabolic syndrome, and cardiovascular diseases (CVDs) [5]. One indicator that has been considered is the Dietary Diversity Score (DDS). DDS, which has been linked to socioeconomic status (SES) and anthropometric measurements, is becoming more widely acknowledged as a crucial indicator of the overall quality of diets [6, 7]. Although previous research highlights the connection between DDS and nutritional outcomes, little is known about how underlying factors like income and nutrition-related knowledge influence dietary patterns and food choices, especially in lower- and middle-income environments [8]. Understanding the factors that influence dietary diversity is particularly important in Pakistan, where nutritional shifts are taking place, and underweight and overweight youth malnutrition still exists. Additionally, university students are in a special time of life

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where they have more freedom to choose their foods and are more susceptible to bad eating habits. In Pakistan, they are still a community with little knowledge of eating habits. As a result, this study is supported not only by the importance of dietary diversity as a public health indicator on a global scale but also by the local need to comprehend the relationships between dietary diversity and variables like SES, waist circumference (WC), body mass index (BMI), and waist-to-hip ratio (WHR) in a university setting. By concentrating on Bacha Khan University, Charsadda students, this study seeks to produce context-specific insights that could guide focused interventions to encourage young people to adopt healthy eating habits.

This study aims to investigate dietary habits with special consideration of the dietary diversity score of university students.

METHODS

This cross-sectional descriptive study design was conducted at the Bacha Khan University, Charsadda. The sample was calculated to identify significant DDS associations with corresponding sociodemographic or behavioral variables (e.g., income, education, frequency of meals). A power analysis was performed using G*Power version 3.1 based on the following assumptions: Effect size (Cohen's f^2) = 0.15, reflecting a medium effect size that is typical for cross-sectional DDS studies, using statistical power ($1 - \beta$) = 0.90, to have a 90% chance of finding a true association, significance level (α) = 0.05, for two-tailed tests and number of predictors = 6–8 (e.g., age, gender, household size, income level, education, meal frequency, food access, physical activity). Based on these criteria, the minimum sample size needed was 150 participants for multiple linear regression. In order to enhance generalizability and allow for potential non-response or missing data (~20%), the sample target was elevated to 180–200 participants, providing adequate statistical power for subgroup comparisons. In addition, as no exact local prevalence of low DDS in university students in KP was known, reference prevalence rates were assumed from regional reports that indicated 30–50% of young adults possess low dietary diversity, particularly amongst students in semi-urban areas. Students from all academic departments (n=16) (Faculty of Sciences and Faculty of Arts and Humanities) of the Bacha Khan University Charsadda, were chosen at random to serve as sample subjects. Convenience sampling was used for the selection of participants based on the population at each of the 16 academic departments. Participants with diabetes, cardiovascular diseases, any kind of malignancy, or any other infection history in the last 6 months from the time of data collection were not allowed to participate in the study. Prior written informed consent was taken from all the participants. Data on demographics (sex, age, marital status, education, socioeconomic status (SES) were collected by a structured self-report survey. A questionnaire was administered, which gathered the information of socio-economic status (gender, age, marital status, current education degree/program, and economic status). Participants were asked to report their average monthly household income to gauge their economic condition. Each of the three categories, namely "good", "medium", and "weak", was made as on their responses to their economic status. Anthropometrics (weight, height, WC, and HC) were measured using standard protocols as previously reported [9]. BMI was calculated from height and weight data. Subjects were categorized according to BMI following WHO criteria; BMI < 18.5kg/underweight; the normal range was 18.5-24.9kg/m2, overweight- 25.0-29.9kg/m2, and obese-30 kg/m2.Waist-to-hip ratio (WHR) was calculated by dividing WC by hip circumference. High values were defined as ≥ 1 for men and ≥ 0.8 for women [10]. Dietary data were collected in a semi-quantitative food frequency questionnaire (FFQ) that included food items and a standard portion size [11]. Data were analyzed by SPSS (Version: 20.0; IBM Corp., Chicago, IL, USA). Individual variables in both genders were examined for normalcy using the Kolmogorov-Smirnov test. The χ^2 test was used to look at the impact of gender on DDS in each of the DDS quartiles. To report on the characteristics of the subjects under study, descriptive statistics were used. The qualitative factors were presented as frequency graphs and tables, whereas the quantitative data were presented as mean ± standard deviation. Kruskal-Wallis and Mann-Whitney U tests were used for analysis to find the difference between SES and DDS. ANOVA was used to determine the difference between DDS and anthropometric indices. Differences were considered significant at $p<0.05$. The study was approved by the ASRB, BKUC. Ethical clearance was obtained from the Ethics Review Board of BKUC. We separated diets into five main categories—grains, fruits, vegetables, meats, and dairy products in order to calculate DDS [12]. Subgroups were created by further segmenting the main groups. A person must eat at least half of a food group every day to be classified as a consumer of that group. As previously reported, each food group was awarded two points. Four quartiles were created from the DDS: less than 3.0, 3.0–5.5, 5.6–8.5, and greater than 8.5. Ten was the highest DDS. The Food Guide Pyramid was used to classify DDS [12].

RESULTS

The Dietary Diversity Score (DDS) variations among the different socioeconomic attributes of the students are shown. Mean DDS was slightly non-significantly higher in male (4.32) than in female (4.11) ($p>0.05$). DDS was significantly impacted by marital status, with married

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students having a significantly higher mean DDS (5.11) than those single (3.31) ($p<0.05$). Additionally, there was a notable difference in DDS between various self-reported economic levels. As expected, the highest DDS (4.24) was reported by participants in strong economic status, followed by those in medium (3.19) and weak (2.11) economic conditions ($p<0.05$). However, there was no significant correlation between educational attainment and DDS ($p>0.05$), suggesting that respondents' better dietary diversity was not always correlated with higher education (Table 1).

Table 1: Comparison of DD Across Sex and Other Socioeconomic Characteristics

Parameters		n (%)	Mean of SD	p-Value*
Sex	Male	120 (60.0%)	4.32 ± 1.23	0.208
	Female	80 (40.0%)	4.11 ± 1.12	
Marital Status	Married	45 (22.5%)	5.11 ± 1.34	0.000
	Single	155 (77.5%)	3.31 ± 1.45	
Self-Reported of Economic Status	Good	40 (20.0%)	4.24± 1.56	0.000
	Medium	105 (52.5%)	3.19 ± 1.57	
	Weak	55 (27.5%)	2.11 ± 1.67	
Educational Level	BS	130 (65.0%)	4.11 ± 1.56	0.831
	MS/MPhil	66 (33.0%)	4.24± 1.76	
	PhD	4 (2.0%)	4.32 ± 1.32	

DDS=dietary diversity score; socioeconomic status; *p-value=calculated using Kruskal-Wallis (for comparison involving two groups) and Mann-Whitney U (for comparison involving more than two groups) tests.

The distribution of several anthropometric parameters among male and female students across quartiles of the DDS is analyzed. Overall, there was a pattern where better DDS was linked to better anthropometric profiles, especially in females. A statistically significant rise in height was observed in both genders across DDS quartiles (p for all trends<0.05), indicating a potential relationship between dietary variety and physical stature, maybe as a result of long-term nutrition. Although the difference was only statistically significant in females ($p=0.015$), weight fell across DDS quartiles in both sexes, suggesting that greater dietary diversity may be linked to healthier body weights in women. Similar to this tendency, BMI decreased considerably across DDS levels in both genders (p for all trends<0.05), indicating that people with more varied diets are better at managing their weight. WC and WHR showed a comparable inverse relationship. In males (WC: $p=0.020$; WHR $p=0.019$) and in females (WC: $p=0.014$; WHR $p=0.003$), both measures dramatically dropped as DDS increased. This suggests that people with more diversified diets have better fat distribution and may be at lower risk for cardiometabolic disease. Along with decreasing WC and WHR, hip circumference (HC) increased significantly in females ($p=0.020$) but did not alter much in males ($p=0.300$). This could indicate that women with higher DDS have healthier body compositions. All things considered, these results highlight a strong correlation between greater dietary diversity and better anthropometric results, particularly for women. This suggests that encouraging a diverse diet may improve physical health and possibly reduce the risk of obesity-related disorders (Table 2).

Table 2: Anthropometric Parameters of Male And Female Students Across Quartiles of the DDS

Anthropometric Parameters	Sex	Quartiles of DDS				p*	p**
		Q_1 (< 3.0)	Q_2 (3.0 to 5.5)	Q_3 (5.6 to 8.5)	Q_4 (> 8.5)		
Height (cm)	M (85)	166.0 ± 12.3	164.7± 8.23	167.8 ±8.90	171.3 ± 47.9	0.030	0.004
	F (105)	154.0 ± 11.2	158.1 ± 5.73	159.7 ± 8.6	161.1 ± 6.8	0.010	
Weight (kg)	M (85)	65.1 ± 18.9	64.5± 11.5	62.7 ± 10.9	60.5 ± 7.9	0.106	0.000
	F (105)	56.7 ± 13.7	55.9.26 ± 7.8	54.6 ± 11.3	52.7 ± 6.6	0.015	
BMI (kg/m^2)	M (85)	23.6 ± 4.6	23.7± 3.6	22.2 ± 3.8	20.6 ± 3.5	0.016	0.243
	F (105)	23.9± 5.3	22.4 ± 3.7	21.4 ± 3.6	20.3 ± 3.1	0.043	
WC (cm)	M(85)	91.3 ± 3.86	90.2 ± 6.8	90.1 ± 9.2	88.3 ± 10.0	0.020	0.900
	F (105)	86.2 ± 10.86	83.6 ± 7.8	83.8 ± 10.3	82.70 ± 8.7	0.014	
HC (cm)	M (85)	102.1 ± 6.7	102.6 ± 4.9	102.6 ± 6.5	103.1± 9.8	0.300	0.010
	F (105)	100.5 ± 7.9	101.6 ± 8.1	102.7± 7.5	104.2 ± 8.7	0.020	
WHR	M (85)	0.89 ± 0.07	0.88 ± 0.05	0.88 ± 0.07	0.85 ± 0.10	0.019	0.000
	F (105)	0.85 ± 0.08	0.82 ± 0.07	0.82 ± 0.09	0.79 ± 0.07	0.0.3	

BMI=body mass index; DDS=dietary diversity score; WC=waist circumference; HC=hip circumference; WHR=waist-to-hip ratio; p*-value was calculated using analysis of variance. p**=comparison between means of male vs female. Values are presented as mean ± SD

A distinct and statistically significant pattern emerges from the study of food category intake across Dietary Diversity Score (DDS) quartiles: people with higher DDS reported eating more portions of all food groups, vegetables, grains, fruits, dairy products and meat, and cereals. Compared to those in the lowest quartile (Q1), who reported only 1.4 ± 3.7 and 1.2 ± 2.33 servings/day, respectively, participants in the highest DDS quartile (Q4) consumed significantly more nutrient-dense foods, especially fruits (4.7 ± 3.5 servings/day) and vegetables (3.7

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± 3.62 servings/day). Likewise, consumption of meat, dairy, and grains rose steadily with DDS, showing that those with more varied diets not only consume more of each food group, but also consume more of each one (Table 3).

Table 3: Comparison of Differences of Food Servings among Quartiles of DDS

Food Groups	Quartiles of DDS				p*
	Q_1 (<3.0)	Q_2 (3.0-5.5)	Q_3 (5.6-8.5)	Q_4 (>8.5)	
No of Students	6141	34	15	10	-
Grains	0.11 ± 0.22	0.7 ± 0.84	1.5 ± 0.7	1.9 ± 1.0	0
Meat and Cereals	0.1 ± 0.7	0.8 ± 1.2	1.2 ± 0.8	2.7 ± 1.7	0.001
Vegetables	1.2 ± 2.33	1.62 ± 2.7	2.0 ± 2.5	3.7 ± 3.62	0.04
Fruits	1.4 ± 3.7	1.9 ± 1.65	2.1 ± 2.8	4.7 ± 3.5	0.001
Dairy Product	0.02 ± 0.10	1.2 ± 0.5	1.5 ± 0.8	2.5 ± 1.1	0.001

DDS=dietary diversity score.*p-value=calculated by ANOVA/Kruskal-Wallis test. Values are as mean ± SD

DISCUSSION

A positive association between DDS and daily intake of all major food groups existed in this study. Participants in higher DDS quartiles consistently consumed more servings of grains, vegetables, fruits, meat, and dairy, reflecting better diet quality and nutrient adequacy. These results reinforce DDS as a practical indicator of healthy eating patterns and highlight the value of dietary diversity in promoting balanced nutrition. This study observation is in line with the results of other studies that indicate that the greater the intake of important food groups, the higher the Dietary Diversity Score (DDS). In Malaysia, Tiew *et al.*, achieved a similar finding that a high DDS level indicated greater consumption of fruits, vegetables, and protein-rich food [13]. On the same note, a study by Esfahani *et al.*, and Azadbakht *et al.*, revealed that those with high DDS ate more meats of all major food groups and obtained their nutrient adequacy ratios much better [14, 15]. In this research, the correlation is high compared to the patterns found otherwise observed between DDS and some of the significant anthropometric characteristics, particularly among the female participants. The body weight, BMI, WC, and WHR also showed a downward trend with an increase in DDS, especially in female. This suggests that those with more diversified diets typically have healthier body compositions [16]. This confirms earlier findings that better weight management and decreased central adiposity are associated with a more varied diet [17], which frequently reflects a larger intake of fruits, vegetables, and foods high in fiber [18]. According to research, a varied diet may help avoid undernutrition and overweight by promoting a more balanced calorie intake and better metabolic health [19]. This is supported by the inverse link between DDS and BMI. In the present study, although both sexes' height increased statistically significantly with DDS, this could be due to the cumulative impact of improved nutrition in early childhood for those who continue to eat a variety of foods. It's interesting to note that hip circumference (HC) rose considerably with DDS in females but not in males. This, along with decreases in WC and WHR, may suggest that women with greater DDS have healthier fat distribution patterns. The findings also highlight how crucial it is to encourage diversified, well-balanced meals that are full of all the necessary food groups in order to improve public health outcomes, particularly in countries where monotonous diets may predominate. Diet diversity can help in the management of malnutrition widely prevalent in Pakistan [20-22].

CONCLUSIONS

It was concluded that the dietary diversity score is positively related to health parameters assessed by anthropometry and also socio-economic status in a group of students of Bacha Khan University, Charsadda.

Authors Contribution

Conceptualization: ST
Methodology: ST, AZ, IA
Formal analysis: ST, AZ, IA
Writing review and editing: ST, AZ, IA

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

All the authors declare no conflict of interest.

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