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Mood Disorders Associated with Increase Consumption of Empty Calorie Foods Among University Students in Karachi

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Abstract. Macro and micronutrients both play an essential role in the cognitive and emotional functions of the brain. Excessive intake of empty calorie foods may deprive brain with essential micronutrients which in turns often results into mood changes and impacts the overall performance of the individuals. The aim of this study was to determine the relationship between consumption of empty calorie foods with mood disorders among young adults. A cross-sectional study design was opted for data collection. It was conducted in two universities in Karachi (one private and other one was public) among 627 students (18-25 years old) studying in different disciplines. Students were asked to fill three questionnaires to take information about: (i) sociodemographic information (ii) Food frequency questionnaire to obtain information about consumption of empty calorie food items (including fried/fast food, sweet snack foods, salty snacks and sugar-sweetened beverages) (iii) Mood disorders were assessed by a validated tool "Depression, anxiety and stress scale-21 (DAAS-21)". The correlation analysis conducted using Spearman's rho to analyze the correlation between the consumption of all four categories of empty. Overall, 474 female and 152 male students with majority belonging to 18-21 years (54.5%) of age group comprised our study population. Majority of the study participants were within the "Normal range" of depression, anxiety and stress scores. On statistical analysis, it was found that higher consumption of empty calorie foods was positively correlated with higher levels of depression, anxiety, and stress (P-value = <0.05). This study concludes that the consumption of empty calorie foods is positively correlated with depression, anxiety and stress symptoms among young adults and is a growing public health concern. Due to study design limitations and self-reported data, it is difficult to generalize the findings and further research is needed to establish causality and explore the impact on different populations.

Keywords: anxiety, brain, DAAS-21, empty calorie food, stress

Introduction

The brain is one of the most energy consuming organ of the human body that take advantage of approximately 20 percent of daily total caloric intake *i.e*. around 400 calories/day (Lachance *et al*., 2015). The fundamental source of energy for brain is glucose that is required for neuronal, non-neuronal as well as for signaling brain activities (Blázquez *et al*., 2022). Therefore, the continuous supply of energy in the form of energy currency that is ATP is critical for various functions of the neurons such as for the maintenance of ion gradient across neuronal membrane, exocytosis of neurotransmitters as wells as for synaptic functioning (Snow *et al*., 2018). Although glucose is mainly responsible to fuel brain functions but studies also proved that balanced nutrition affects the cognitive processes, learning capability and memory as well as thinking activities (Huang *et al*., 2019). Conditions *e.g*. anxiety, depression and stress are considered as mental health disorders which may progress to more threatening diseases *e.g*. psychosis and schizophrenia (Rehm *et al*., 2019). The common symptoms of mood disorders include constant feeling of sadness, gloominess, irritable mood and helplessness (Shin *et al*., 2022). Epidemiological studies revealed the inverse relationship between healthy dietary pattern *e.g*. increased consumption of fruits, vegetables and nuts and risk of depression (Lassale *et al*., 2019). Empty calorie foods reflects processed food that are calorie rich but poor in nutrients (Dominguez *et al*., 2022). It is clear from the research studies that life style changes and alterations in eating habits has welcomed not only different metabolic diseases but also profoundly effects the brain development and brain physiological processes. In young adults *e.g*. University students, the prevalence of unhealthy lifestyle (smoking, poor diet, physical inactivity) is observed at high rate (Bennasar-Veny

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et al., 2020). These adverse lifestyles along with the other factors *e.g*. social and economic aspects could inversely influence this population. Another study conducted in USA reported that about 50% of empty calories from diet among 2-18 year old children was based mainly on soda, fruit drinks, dairy desserts, starchy desserts, pizza and whole milk with the largest contribution provided by sugar-sweetened beverages (Reedy *et al*., 2010). Research has found a low serum levels of four amino acids *i.e*. methionine, phenylalanine, tryptophan and tyrosine, as well as antioxidants vitamins including retinol, tocopherol and ascorbic acid in patients with depression (Islam *et al*., 2020) and this decreased serum level of these amino acids is directly associated with the low synthesis of some neurotransmitters like serotonin and norepinephrine synthesized from tryptophan and tyrosine respectively and the decreased level of these neurotransmitters is related with the development and progression of depression. Besides this, a low intake of branched-chain amino acids (BCAAs) is also found to be associated with developing feelings of anxiety and depression (Koochakpoor *et al*., 2021). Because no study has been done to elucidate effects of high intake of empty calories on human psychological conditions in Pakistan, This study focus our attention on detecting psychological changes associated with increased intake of empty calories on young adults. This research will result in new knowledge and understanding towards the mood alterations associated with intake of empty calories, which will eventually lead to dietary care among individuals in the future. Beside this, institutes also participate in improving the mental health status of their individuals by implement strategies for the promotion of nutrients rich foods among individuals as part of sustainable development so that mood disorders are less likely to occur. The current study analyzed the mood disorders among university students on the basis of consumption of empty calorie food intake patterns.

Material and Methods

Study design and setting. The study aims to investigate the relationship between empty calorie food consumption and mood disorders among university students. This is a cross-sectional (observational) study conducted in a private and a public sector university in the city of Karachi, Pakistan. The study sites were Ziauddin University (North Nazimabad Campus) and Federal Urdu University of Arts, Sciences and Technology. These universities were selected for their diverse student populations, representing both public and private sectors. A self administered validated questionnaire was used as a study tool.

Participants. The target population was young adults *i.e*. university students mostly enrolled in undergraduate degree programs of various discipline including Human Nutrition & Dietetics, Biochemistry, Chemistry, Education, Statistics, Eastern medicine, Psychology, business administration etc. The sample size was calculated by single population proportion formula. Prevalence of depressive symptoms (42.66%) among university students was taken from the findings of a systematic review and meta-analysis of twenty-six studies involving 7652 university students of Pakistan (Khan *et al*., 2021). The calculated sample size was 372, but we collected data from 627 students to reduce margin of error. The sample size was exceeded because the study design had limitations and the data was self reported, thus the sample size was inflated.

Ethical considerations. Ethical approval for this research study was taken from the "Ethical Review Committee" of Ziauddin University (ERC no. 5690622SSOM). Participants were guaranteed for confidentiality of the data.

Sampling method. A convenience sampling technique was applied and students were approached inside the university premises.

Inclusion criteria was: (i) both male and female students (ii) 18-25 years old (iii) study in any department of the selected study site (iv) belongs of any ethnic background.

Exclusion criteria include: (i) students with psychiatric disorders or medication use (ii) students with some chronic illness (iii) students already taken some multivitamins or nutritional supplements. The main reason behind excluding students with chronic psychiatric illness or consuming nutritional supplements was because these conditions could significantly influence mood disorders and may alter over all nutritional intake.

Data collection procedure. The data collection for this research study was conducted between October to December 2023 by trained data collectors. Participants were approached directly on campus by the data collectors. The participants were instructed on how to fill the form and administered by the data collectors if they required assistance.

Study participants asked to complete three questionnaires:

(i) A self-constructed questionnaire to get details of the sociodemographic characteristics and health status of the study participants including age, sex, education level, economic status, weight, height, medicine or nutritional supplement use etc.

(ii) Second questionnaire consists of 26-items checklist regarding Consumption of empty calorie foods/ beverages. Empty calorie foods reflect processed food that are calorie rich but poor in nutrients (Dominguez *et al*., 2022). The questionnaire will assess frequency of intake of these food items as never/occasionally, 1-3 times a week, 4-6 times a week, daily, more than once a day. This 26 items food checklist is adopted from a study (Lin *et al*., 2020) conducted in Taiwan in which 21 food/beverage items was grouped into the following categories: fried/fast food, sweet snack foods (*i.e*., candy, chocolate, cookies, brownies, doughnuts, cakes, pastries, pies, jelly, puddings, sweetened shaved ice desserts or ice cream, popcorn), salty snacks (*e.g*., chips) and sugar-sweetened beverages (*i.e*., carbonated beverages, sugar-added processed juice, lactic acid drinks, sports drinks, instant powered drinks, chocolate beverages and tea with added-sugar and/or toppings). This 21-item checklist was modified in this study according to culture and eating practices in our region that were identified after pre-testing of the study tool and face-validation from three subject experts. Each category was analyzed as a separate outcome variable.

(iii) Mood disorders was evaluated by the instrument DASS-21 (Depression, Anxiety and Stress Scales). This tool has been validated for the target population in other countries (Lee *et al*., 2022) but had not been used in Pakistani university student's population yet. Lovibond, 1995) consisting of 21 items which are categorized under three scales; the stress scale (items 1, 6, 8, 11, 12, 14 and 18), the depression scale (items 3, 5, 10, 13, 16, 17 and 21) and the anxiety scale (items 2, 4, 7, 9, 15, 19 and 20). Each item was answered according to the presence and intensity of each symptom in the last week on a 4-point Likert response scale, the limits of which are the answer nothing and the answer most of the time. The total score was calculated with the sum of the items belonging to that scale and varies between 0 and 21 points. A higher score indicates a higher participant symptomatology.

For DAAS-depression: normal (0-9), mild (10-13), moderate (14-20), severe (21-27) and extremely severe (28+). For DAAS-anxiety: normal (0-7), mild (8-9), moderate (10-14), severe (15-19) and extremely severe (20+). For DAAS-stress: normal (0-14), mild (15-18), moderate (19-25), severe (26-33) and extremely severe (34+).

Data collection was followed by the ethical standards and participants' confidentiality was maintained throughout the process, ensuring that the data were handled responsibly. Data was cross-checked by data collectors and principal investigator to reduce missing data. In case of incomplete forms, the participants were reproached to avoid biases in the results.

Data analysis. Before analysis, data was scrutinized for normality through Shiparo-wilk test and homogeneity thorough Levene's test. After that, the data coding, its processing, and then analysis was performed using statistical software SPSS (version 20.0). The sociodemographic characteristics, consumption of empty calorie foods and variability in mood disorders of different subgroups of the study participants was described by frequency and percentages. Spearman's rank correlation coefficient was used to analyze the correlation between consumption of all four categories of empty calorie food items scores (categorized into high and low consumption groups) with depression, anxiety and stress scores categorized into normal, mild, moderate, severe and extremely severe. A correlation of 0-0.19 was considered very low correlation, 0.2-0.39 was low correlation, 0.4-0.59 moderate correlation, 0.6-0.79 high correlation and above 0.8 very high correlation.

Result and Discussion

Characteristics of study population. The total sample of 626 students included 122 from a private university and 504 from a public university. The majority of the study population (75%) were students enrolled in Science-related programs, such as Agriculture, Chemistry, Biochemistry, Human Nutrition, Sport Science, Microbiology, Pharmacy, Zoology, Botany, Computer Science, Physics and different Engineering fields. The characteristics of the participants involved in the study are presented in Table 1.

Frequency of consumption of empty-calorie food items. Table 2 shows the frequency distribution of empty-calorie food consumption among students. The most commonly consumed food items on daily basis

Table 1. Characteristics of studied population

Category	Frequency	Percentage
Gender		
Male	152	24.3
Female	474	75.7
Age		
18-21	341	54.5
22-24	262	41.9
Above 25	23	3.7
Ethnicity		
Punjabi	91	14.5
Sindhi	60	9.6
Balochi	14	2.2
Pathan	100	16
Urdu speaking	325	51.9
Memon	12	1.9
Others	24	3.8
Marital status		
Single	607	97
Married	19	3
Religion		
Muslim	613	97.9
Christian	7	1.1
Hindu	5	0.8
Others	1	0.2
Educational level		
Bachelor's Year 1	161	25.7
Bachelor's Year 2	150	24.0
Bachelor's Year 3	122	19.5
Bachelor's Year 4	179	28.6
Others	14	2.2
Origin		
Urban	546	87.2
Rural	80	12.8
Economic status		
Low income	78	12.5
Middle income	484	77.3
High income	64	10.2
Self-employment		
Yes	480	76.7
No	146	23.3

by university students from the all four food categories are French fries (fried/fast food), biscuits (Sweet snack foods), chips (Salty snacks) and tea (Sugar-sweetened beverages). Table 2 shows the most frequently consumed food items among the university students. In Table 2, we categorized these consumption frequencies into low and high categories. Low consumption includes categories 'Never/Occasionally' and '1-3 times a week', while high consumption includes '4-6 times a week', 'daily' and more than once a day.

Food items	**Frequency of consumption level**	
	High	Low
Fried/fast food	43	583
Sweet snack foods	62	564
Salty snacks	27	599
Sugar-sweetened beverages	168	458

Depression, anxiety and stress scores among study population. Fig. 1 shows depression (DASS-depression), anxiety (DASS-anxiety) and stress (DASS-stress) symptoms at different severity levels. Cutoffs for the levels DASS subscales are:

For DAAS-depression: normal (0-9), mild (10-13), moderate (14-20), severe (21-27) and extremely severe (28+), for DAAS-anxiety: normal (0-7), mild (8-9), moderate (10-14), severe (15-19) and extremely severe (20+), for DAAS-stress: normal (0-14), mild (15-18), moderate (19-25), severe (26-33) and extremely severe (34+).

Based on findings, the highest range with respect to the severity level is "normal" in all three conditions. After that depression fall in mild range with ratio of 14.2%, for anxiety the most prevalent range is moderate with ratio of 15.7% and stress fall in the mild range with ratio of 24%.

Association between frequency of consumption of empty calorie foods and depressive and anxiety & stress symptoms. The correlation analysis conducted using Spearman's rho (Table 3) revealed the statistically significant positive correlation between the consumption of all four categories of empty calorie food items and depression, anxiety and stress scores.

Mental health problems are the predominant health related issues in a population because of their increasing prevalence, advancement and complexity in the treatment process are the leading cause of disability globally (Nochaiwong *et al*., 2021). A mental disorder is defined as a "clinically significant impairment in an individual's intellect, emotions and behavior which can result in a cognitive decline" (Garg, 2024) and it is well evident that age group encompasses adolescence and young

Table 2. Frequency of consumption of empty-calorie food items (N=626)

Food items	Never/occasionally	1-3 times a week	4-6 times a week	Daily	More than once a day
Fried/fast food					
French fries	223	281	61	41	17
Pizza	446	120	41	6	12
Hamburgers	514	69	27	8	7
Fried chicken	389	180	38	7	12
Shawarma	456	126	27	8	9
Samosas	313	210	73	20	10
Spring rolls	414	134	53	13	11
Sweet snack foods					
Candy	293	183	63	68	16
Chocolate	240	224	96	52	12
Biscuits	148	266	85	113	12
Brownies	418	144	31	18	14
Doughnuts	498	84	24	9	11
Cake	436	133	30	17	10
Pastries	488	73	43	13	9
Pies	543	42	19	11	11
Jelly	462	90	35	28	11
Puddings	527	54	27	8	10
Ice cream	262	256	77	19	11
Popcorn	352	171	60	32	10
Salty snacks					
Chips	108	285	102	110	17
Roasted peanuts	437	115	43	16	15
Sugar-sweetened beverages					
Soft drinks	284	218	53	48	22
Packaged Juices	277	223	70	45	10
Sports drinks	501	75	27	18	5
Tea	109	90	38	245	143
Coffee	413	116	40	36	20

Table 3. Association between food intake and P rceived stress or depressive symptoms

Food items	Depression		Anxiety		Stress	
	Spearman's rho correlation	P value	Spearman's rho correlation	P value	Spearman's rho correlation	P value
Fried/fast food	0.164	0.000	0.118	0.003	0.132	0.001
Sweet snack foods	0.116	0.004	0.168	0.000	0.094	0.018
Salty snacks	0.166	0.000	0.135	0.001	0.113	0.005
Sugar-sweetened beverages	0.113	0.005	0.087	0.029	0.104	0.009

Non-parametric correlation (Spearman's rho); Correlation is significant at the level of 0.01 **level (2-tailed), * 0.005.

adult people are at risk of developing mental disorders and according to an estimation half of the mental disorders manifested before the age of 65 originated in adolescence and 75% by age 24 (Kessler *et al*., 2005). So, the Lancet commission on child health and wellbeing emphasizes on a significant investment in approaches

to prevent these mental health issues as they are increasing among children and young people (Patton, *et al*., 2016). Lifestyle plays a pivotal role in the development and progression of mental health disorders.

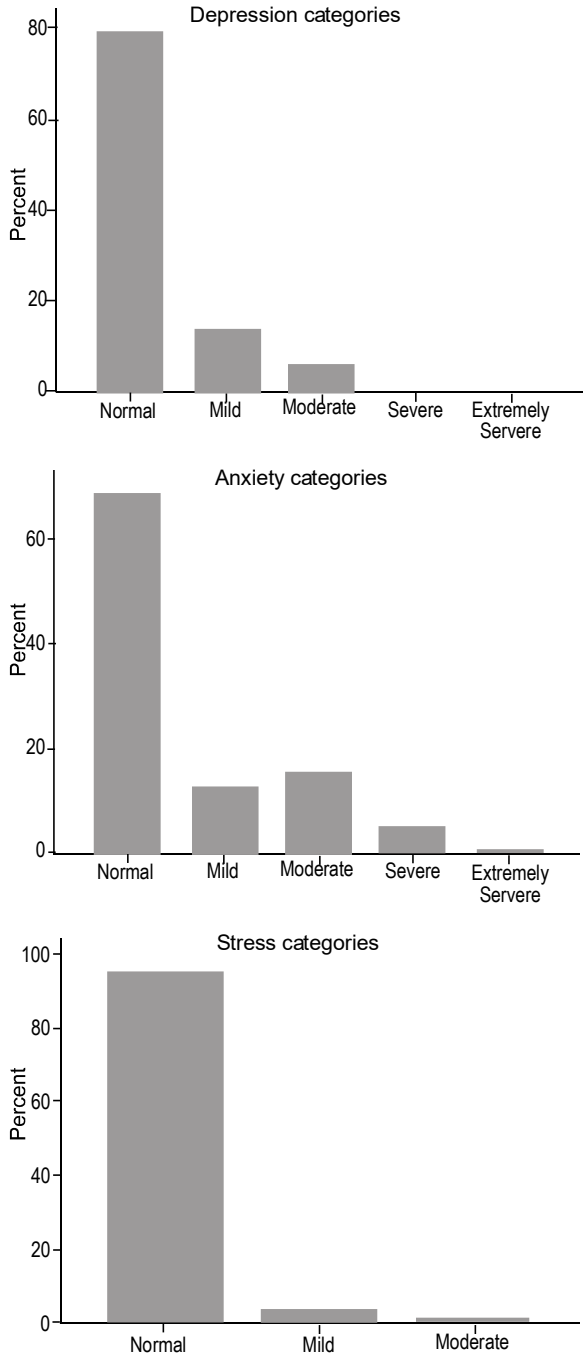


Fig. 1. Frequency in weighted percentages of DASS-21 among students with respect to severity (depression, anxiety and stress) (N= 626).

According to a study conducted by Firth *et al*., 2020, life style factors including physical activity *e.g*. sports, sleep quality and duration, nutrition, distressing habits, and work stress in personal life effects the mental health status of the individuals and adequate physical activity and nutritious diet lessen the probability of mental disorders.

In order to strengthen the information systems, evidence and research for determinant of mood disorders among young adults, the present study aimed to evaluate the effects of higher consumption of empty calorie foods on mental health of university students. Mental health status was determined by an established and validated screening tool DAAS-21 which was designed to measure depression, anxiety and stress. It includes three seven item subscales to measure symptoms of depression, anxiety and stress in the study population, (i) Depression subscale measures dysphoria, hopelessness, low self-esteem, self-depreciation, lack of interest, anhedonia, and low positive affect, (ii) Anxiety subscale assesses autonomic arousal, musculoskeletal symptoms, situational anxiety and subjective experiences of anxious arousal and (iii) stress subscale measures difficulty relaxing, tension, agitation, irritability and negative affect (Lovibond and Lovibond, 1995). In this study, it is observed that the majority of participants exhibited normal severity levels across all three conditions. Notably, depression was found to be mild in 14.2% of the cases, while anxiety was predominantly moderate, affecting 15.7% of the participants. Furthermore, stress levels were mild in 24% of the cases.

Food frequency questionnaire assessed the frequency of consumption of empty calorie food items among our study population reveals that university students' daily diets are characterized by a high frequency of consumption of certain food items across four categories. Specifically, french fries (fried/fast food), biscuits (sweet snack foods), chips (salty snacks) and tea (sugar-sweetened beverages) emerge as the most commonly consumed items. So when analyze the correlation between consumption of empty calorie food with parameters of mood status, it is found a significant positive correlation among all four groups of empty calorie food items with depression, anxiety and stress. It has been found a significant positive correlation between the consumption of empty-calorie foods and levels of depression (P value = <0.001), anxiety (P value = <0.001) and stress (P value = 0.001). (Zieliñska *et al.*, 2022) in a study concluded that research shows

that the mediterranean diet pattern can reduce the risk and symptoms of depression, anxiety and stress, while western eating styles that are rich in empty calorie foods can increase the risk and severity of depression, stress and anxiety in adolescents.

The present study found that majority of study participant belongs to the middle-income group (77%) and 76% were self-employed. It means they are food secure and their food options are largely depends on their taste and choices. In addition, majority of participants were female (75%), it is because according to the report the trends of student's enrollment are changing from the last decade in Pakistan (Kaleem *et al*., 2017). More women are enrolled in higher education than men, so it is obvious from sample size as well.

Food choices are an important factor in the development of mood disorders among young adults and university students. However, other factors such as study or examination stress, economic status and environment also contribute. As increase intake of high calorie foods *e.g*. French fries or sugar sweetened beverages with limited intake of healthy food *e.g*. milk, fruits, vegetables etc. Results in intake of less amount of macro and microelements than recommended values and it impairs the proper functioning of the nervous system. A diet high in refined sugars and fats can influence neuro-transmitter function, inflammation or gut health, which in turn may impact mental health (Lassale *et al*., 2019).

The present study has few strengths and limitations. This study is first of its kind conducted in Karachi, Pakistan as it solely focused on the university students who are more vulnerable to mental health issues due to study stress. Also, it had been tried collecting data from both public and private universities of Karachi, considering the differences existing across the education sectors. It also focuses on overall frequency of mental disorders and empty – calorie food consumption patterns of young adults which can possibly help the policy makers to make decisions for improvement for addressing public health issues.

A lot of effort was made to conduct the study in the possible manner, however, due to limited resources, there are a few unavoidable limitations to this study. Firstly, it is tried to get a sampling frame but we couldn't find it from the universities due to confidentiality of student's data. Thus, it was were unable to make the sample size representative of the entire target population and prevalence could not be estimated. This may affect the generalizability of the findings of this study. Also, there are potential biases related to self-reporting in the food frequency questionnaire or mental health status.

Therefore, nutrition education programs in universities, and different other strategies *e.g*. seminars and lectures to the students about selection of healthy food choices and physical activities, in addition to strategies to cope up with the stress situations and mental health support are demand of current scenario. Young adults are at an important stage of their life. Their physical and mental health is mandatory for their social interactions, academic success and emotional control. So, improving food choices can improve the mental health of this age group, and thus may enhance their abilities.

Conclusion

Our results indicate that higher consumption of empty calorie food is associated with anxiety, depression and stress among young adults. Therefore, focusing on the education programs at university level as well as authentic information about healthy food choices from social channels can support these individuals to eat healthy food and thereby it will have a positive impact on their improved cognitive functioning, better emotional regulation, etc. may lead to their success in every aspect of life. This can lead to improvements in their overall well-being and success across various aspects of life.

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Conflict of Interest. The authors declare that they have no conflict of interest.

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