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Original Research Article

Energy imbalance and its association with obesity among medical students: a cross-sectional evaluation of dietary intake and physical activity

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ABSTRACT

Background: Excess energy intake and insufficient energy expenditure are the fundamental factors in the development of obesity. Due to demands of rigorous academic schedule, irregular eating patterns, consumption of convenience foods and limited time for involvement in physical activities, medical students are at risk for development of obesity. Implications of these are quite significant as it increases the risk for metabolic syndrome and cardiovascular disorders. Considering these, this study was done to evaluate factors responsible for excess calorie intake which can further add to targeted interventions.
Methods: 264 undergraduate students were included in the study. 24 hrs recall, monthly FFQs, data on fast food intake including energy spent for physical activity were collected by questionnaire approved by NIN, ICMR. Based on BMI they segregated into normal, overweight and obese. DEI, DEE and energy spent in physical activities were calculated by standardized formulae. Excess energy was calculated (DEI-DEE) Kcal/day. Correlation and regression statistical analysis were done to identify the risk factors for excess calorie intake.
Results: Excess calorie intake was significantly higher in overweight and obese individuals. Linear regression analysis showed physical activity significantly affecting BMI ($p<0.001$) (95% CI= 2.87-4.06).
Conclusions: Body weight is thus dependent upon amount of calorie intake and its balance with energy expenditure with physical activity playing a significant role in maintaining healthy weight.

Keywords: Body mass index, Cross-sectional studies, Eating behaviour, Energy intake, Energy metabolism, Fast foods, Medical students, Obesity, Physical activity, Risk factors

INTRODUCTION

Overweight and obesity are described as abnormal or excessive fat build-up, which increases the risk of cardiovascular disease, type 2 diabetes mellitus, musculoskeletal disorders, and cancer. The incidence of obesity is rising due to sedentary lifestyles, bad eating habits, and expanding urbanisation.[1] Young adults (18 to 25 years old) are a susceptible population that is more likely to become obese because they are transitioning from youth to adulthood and are going through major changes in their social, behavioural, psychological, and biological aspects of life. [2]

In 2022, 2.5 billion individuals aged 18 and over were overweight, accounting for 43% of all adults, which was higher by 25% as seen in 1990. Both genders had an identical proportion of overweight adults over the age of 18 (43% for men and 44% for females).[3] Worldwide adult obesity has been doubled from 1990-2022 whereas, adolescence obesity is quadrupled. Over 390 million children and adolescents (5-19 years) were overweight in 2022 with 160 million living with obesity. By 2030, over half of the world's population will be obese under this scenario. [4] Once a high-income country problem now it is on the rise in low- and middle-income countries too. 44 million women and 26 million men in India above 20 years are found to be obese in 2022 which shows a dramatic increase from 1990. The global trend suggests 27.8% of Indians will be overweight and 5% obese by 2030.[5] Meta-analysis of studies from past two decades has shown 8.4% prevalence of childhood obesity in India.[6] Adolescents with obesity are at an increased risk for development of many co-morbidities. Which is found to be 50-100% higher if suffering from childhood or teenage obesity. With obesity there is prevalence of impaired glucose tolerance leading to T2DM along with it dyslipidemia and hypertension increase the risk for CVD beginning from adulthood via atherosclerotic changes, systolic and diastolic dysfunction and increase in left ventricular mass.[7,8]

Though obesity is the consequence of multifactor including environment, psychosocial factors and even genetic variants, imbalance between energy intake and expenditure remains one of the major etiological causes. Dietary and physical activity patterns may be an individual responsibility, but to cater and find its solution needs supportive environment and committees to promote available, affordable and accessible behavioral and lifestyle management.[9]

Daily energy expenditure (DEE) comprises of energy expended in physical activity, energy needed for digesting and processing food called as diet induced thermogenesis (DIT) or specific dynamic action (SDA) and energy expended at rest to maintain life i.e. resting or basal metabolic rate (BMR). Energy for metabolic and physiological functions of humans is derived from chemical energy bound in food and its macronutrients.[10] Prolonged positive energy imbalance due to increase energy intake and concurrent reduction in physical activity is the impelling cause of obesity epidemic.[11] Clinical trials have shown that reducing energy density is effective for weight loss and weight loss maintenance.[12]

Debate still exists which behavior holds the utmost responsibility but solution must always involve the change in combination of energy intake and expenditure. Medical students are at jeopardy of development of obesity because of demanding course structure and time schedule, sedentary lifestyle with minimum physical activity, exposure to stressful environment and change in food habits. Efforts should be undertaken to develop effective strategies to understand the basis of energy imbalance in them and overcome it.

With this background the present study was done to estimate the energy imbalance among the medical students and identify the lifestyle variables responsible for it.

METHODS

Study setting and study population

The present study was conducted in the department of biochemistry, Kalinga Institute of Medical Sciences (KIMS), a tertiary health-care teaching hospital located in the eastern part of India. The study was carried out over a period of six months (January 2022 to December 2022).

This was a questionnaire-based, retrospective cross-sectional study involving 264 undergraduate medical students from the IV, V, and VI semesters. Prior to the commencement of the study, Institutional ethical clearance was obtained from the institutional ethics committee. Written informed consent was obtained from all participants after adequate orientation regarding the objectives, methodology, and implications of the study.

Students with medical conditions known to influence metabolic parameters- such as thyroid disorders, Cushing's syndrome, and polycystic ovary syndrome (PCOS)- were excluded. Participants receiving medications that could affect metabolic status, including antidepressants, selective serotonin reuptake inhibitors (SSRIs), corticosteroids, and antiepileptic drugs (valproate, carbamazepine, gabapentin, lamotrigine, and topiramate), were also excluded. In addition, students with incomplete dietary information or missing data on physical activity were excluded from the final analysis.

Sample size

The sample size was calculated using Cochran's formula for estimating proportions in cross-sectional studies.

In the absence of prior prevalence data, the value of p was assumed to be 0.5, which provides the maximum sample size and ensures adequate power. The margin of error was set at 5% (0.05), with a 95% confidence level. To account for an anticipated non-response rate of 5%, the adjusted sample size was calculated. Based on feasibility and availability of eligible participants, a final sample size of 264 undergraduate medical students was included in the study.

Data collection

General information about socio-demographic characteristics like age, gender, medical history, lifestyle factors (tobacco smoking, alcohol intake) were collected by questionnaire-based approach.

Anthropometric data collection

Height was measured to nearest meters using calibrated measurement rod. Weight was measured by electronic portable weighing scale in kg. BMI was calculated as body weight (in kg)/ height (in m^2) (kg/m^2). Participants were further classified as normal (18.5-24.9 kg/m^2), overweight (25-29.9 kg/m^2) and obese (>30 kg/m^2).[13] Waist circumference was measured in cm at the midpoint between lower border of ribcage and iliac crest.

Dietary intake and physical activity data collection

Dietary intake data was collected by 24 hours dietary recall and monthly food frequency questionnaire (FFQ).[14] In 24 hours recall method, daily consumption of three main meals (breakfast, lunch, dinner) including snacks were recorded. Based on the energy value of each food the energy intake was calculated. Portion size estimation and frequency of consumption of food items based upon monthly intake was reported. Respective energy yield through reported frequency was derived from nutritive value of Indian foods database by National Institute of Nutrition by ICMR.[15] FFQ consisted of food items commonly taken by the students staying in hostel, which included the validated food items in FFQs. Frequency of food items was recorded as once daily, weekly and monthly basis. Intake of fast food was also recorded through a separate questionnaire.

Physical activity was assessed based upon the recall-based questionnaire of specific activities during work and leisure time including any strenuous work done in 24 hours. Short term recall was preferred to avoid forgetfulness and indicate individual's typical physical activity on a daily basis. Categories of individual response regarding type of activity and time spent in concerned response was used to measure metabolic costs in terms of Kcal. Monthly expenditure was calculated based on the collected data.16

Daily energy expenditure of each participant was calculated by the following formula:

DEE = BMR+ energy needed for physical activity + DIT.[17]

DEE = Daily energy expenditure in kilocalories/day

BMR = basal metabolic rate

DIT = diet induced thermogenesis

Basal metabolic rate in kilocalories per day was calculated by the Mifflin-St. Joer equation.[17]

For males: (10×W) + (6.25×H) - (5×A) + 5

For females: (10×W) + (6.25×H) - (5×A) -161

W=Weight (Kg); H=Height (cm); A=Age (in years)

Diet induced thermogenesis (DIT) i.e, the energy required to process the types and quantities of the food will be roughly calculated as 10% of the kilocalories ingested.[17] Excess energy intake was calculated (DEI-DEE) Kcal for each participant.

Statistical analysis

All the continuous data were described using mean, standard deviation and categorical data by their frequency (%). Factors were compared using t-test, Wilcoxon rank sum test and chi-square test. Pearson correlation coefficient or Spearman's correlation coefficient was used to understand the linear relation between the two parameters. To identify risk factors for obesity logistic regression was used. The variable found significant under univariable regression analysis was the candidate variable for multivariable regression analysis after considering multi-collinearity. All the tests were interpreted at 5% level of significance. All the statistical analysis was done using STATA software version15.1.

RESULTS

The mean age of the participants is 21.55±1.25 years with predominance of female gender (54.17% versus 45.83%). SBP and DBP were found to be within normal range. BMI was 24.02 kg/m^2. Daily energy intake (DEI) via 24 hours recall was 2304.75±452.02 kcal whereas, by monthly FFQ it was 2325.47±1030.22 kcal approximately. DEE by 24 hours recall and monthly FFQ were (1865.57±336.51 versus 2072.75±365.58 respectively. DEI-DEE via 24 hours recall questionnaire was higher compared to monthly FFQ (Table 1).

Table 1: Anthropometric and dietary details of the study population.

Parameters		Mean±SD
Age (in years)		21.55±1.25
Gender	Male	45.83% (n=122)
	Female	54.17% (n=143)
BMI (kg/m^2)		24.02±31.13
SBP (mmHg)		120.92±7.12
DBP (mmHg)		78.57±5.94
Physical activity (in Kcal)		605.19±95.79
DEI (24 hours recall) (in Kcal)		2304.75±452.02
DEE (24 hours recall) (in Kcal)		1865.57±336.51
DEI (monthly FFQ) (in Kcal)		2325.47±1030.22
DEE (monthly FFQ) (in Kcal)		2072.75±365.58
DEI-DEE (24 hours) (in Kcal)		439.17±537.38
DEI-DEE (monthly FFQ) (in Kcal)		252.71±936.18
Fast food calorie intake (in Kcal)		760.59±595.52

BMI: body mass index, SBP; systolic blood pressure; DBP; diastolic blood pressure; DEI; daily energy intake; DEE: daily energy expenditure.

Table 2: Relationship between excess calorie intake (DEI-DEE) and obesity in terms of BMI among the study population.

DEI-DEE (in Kcal)	BMI	Mean±SD	P value
24-hour Recall	Normal (n=120)	272.93±507.09	<0.001**
	Over weight (n=52)	464.92±528.92	
	Obese (n=92)	641.49±516.28	
Monthly FFQ	Normal (n=120)	42.50±1033.15	<0.001**
	Over weight (n=52)	250.79±852.69	
	Obese (n=92)	527.99±777.46	

BMI: body mass index; DEI; daily energy intake; DEE: daily energy expenditure; FFQ: food frequency questionnaire. **p<0.001

Table 3: Regression analysis showing relationship between excess calorie intake and other factors.

	Beta	P value	95.0% confidence interval for B	
			Lower bound	Upper bound
Sleep	0.061	0.200	-14.787	70.161
BMI (kg/m^2)	0.042	0.426	-7.567	17.874
Physical activity (Kcal)	0.624	0.000**	2.870	4.069
SBP (mm of Hg)	-0.014	0.821	-10.220	8.114
DBP (mm of Hg)	0.050	0.405	-6.238	15.408
Fast food calorie intake (Kcal)	0.056	0.245	-0.034	0.135

**P<0.001, BMI: body mass index, SBP; systolic blood pressure; DBP; diastolic blood pressure.

Table 4: Correlation of different parameters with excess calorie intake (24 hours recall and FFQ).

Parameters	DEI-DEE (24 hours recall)	P value	DEI-DEE(FFQ)	P value
Age (in years)	0.164	0.008**	0.055	0.376
BMI (kg/m^2)	0.286	≤0.0001**	0.174	0.005*
SBP (mm/Hg)	0.199	0.001*	0.148	0.016*
DBP (mm/Hg)	0.188	0.002*	0.137	0.026*
WC (cm)	0.276	0.0001**	0.235	0.0001**
Physical activity	0.654	0.0001**	0.206	0.001*
Sleeping	0.070	0.263	0.010	0.876
Fast food intake	0.146	0.017*	0.749	0.0001**

*p<0.05, **p<0.001. DEI; daily energy intake; DEE: daily energy expenditure; FFQ: food frequency questionnaire; WC: waist circumference.

Excess calorie intake was significantly higher in overweight and obese groups compared with normal weight individuals (Table 2). Linear regression analysis showed that physical activity is significantly affecting BMI (Table 3). Correlation between excess calorie intake and different parameters showed a positive association with age, BMI, SBP, DBP WC and physical activity. Fast food intake also showed to correlate with excess calorie intake (Table 4).

DISCUSSION

Transition age of approaching adulthood, change in present eating habits and impact of lifestyle pattern in terms of stress and lack of physical exercise imposes the medical undergraduates to the risk of overweight and obesity. This leads to the increase in incidence and prevalence of lifestyle related disorders in the approaching years.[18] Excessive food intake and lack of physical activity are the major prevailing predisposing conditions behind causation of obesity.[19] Positive energy balance though assured as the cause, still lack of effective solution has been put forward either by the reformers, government, society and even at the individual level. In our study 34.84% of the student population presented with obesity whereas, 19.7% were overweight. In accordance to India's Ministry of Health and Family welfare data 20.6% of female and 18.9% of males of age group 15-49 years are obese. So, in comparison to this obesity in our population was higher than the general population. Recent data collected through systematic review and meta-analysis showed a combined prevalence of overweight and obesity was 24% (overweight =18% (95% CI: 17%-20%), obesity =9% (95%CI: 7-11%).[20] This shows that compared to general population certain subgroups of adolescents are more vulnerable and susceptible to development of

obesity. Dietary habits with irregular meals, skipping meals, insufficient intake of fruits and nuts, consumption of fast food, lack of physical exercise, sedentary way of lifestyle may be the associated contributory factors.[15,16]

Basic components of energy balance include energy intake and energy expenditure. When intake equals to the expenditure the body energy is said to be stable and in balance. But when the intake exceeds, a state of positive energy balance sets in and it eventually results in increase in body mass mostly the fat mass. Daily energy expenditure (DEE) basically consists of energy costs in BMR (basal metabolic rate), which implies to the amount of energy necessary to fuel the body at rest, DIT (diet induced thermogenesis) which includes energy expended in absorbing and metabolizing the food consumed, which comprises 8-10% of total energy ingested and the energy used in physical activity. The most variable component among these is the energy used in physical activity. Energy balance is subject to physiological control, which maintains stability from day to day variations maintaining energy balance and preventing shifts in body mass. But excessive intake in long term results in loss of body's limit to control the system.[21,22] In our study excess calorie intake of (439.17±537.38) Kcal /day in accordance to 24 hours recall and, 252.71±936.18 Kcal/day according to monthly FFQ was seen. This finding is in support to NHANES (National Health and Nutrition Examination Survey) data, which suggested that there was average increase of 168 Kcal/day for men and 335 Kcal/day for women in daily energy intake from 1971-2000. A physically active person can well maintain the energy balance and hence body weight. Sedentary lifestyle may accumulate energy and result in weight gain in long term. A significant association between excess calories intake and high BMI was observed in our study ($p<0.001$). Our findings are in congruence with findings of a study where they showed 11 times increased risk for development of obesity and excessive calorie intake (OR=10.75, $p<0.05$).[23] Regression analysis has pointed towards physical activity as an important contributing factor which can affect the excess calories intake and increase in BMI. Similarly, in various studies physical activity is considered as an important variable ($p<0.001$, OR=0.59) with significant relationship with central obesity.[23,24] The idea of energy balance via regulated physical activity dates back to 1950s when Mayer and his colleges found physical activity as the most important factor behind maintenance of energy balance. But they even conferred that this regulation is only possible till a minimum threshold of physical activity or energy throughput above which energy intake and expenditure are very sensitive to each other. Whereas, below this they are less sensitive to changes in each other and hence, maintaining a healthy body weight needs strict calorie restriction for a long time period.[25,26] We found a significant correlation between excess calorie intake with age, SBP, DBP, BMI and WC. Intake of fast food also contributed to excess calorie. In few studies BMI has been significantly associated with excess energy intake. Positive and significant statistical association was also obtained between BMI and physical activity.[27-29] Our findings are against certain studies where they have even found decrease in obesity prevalence among college students pointing towards awareness regarding weight control among them but no such observation was seen among medical students which may be attributed to lifestyle to lifestyle and stress facing being more prevalent among them.[30]

Being a questionnaire-based, retrospective cross-sectional study, the findings are subject to recall and reporting bias, particularly in relation to dietary intake and physical activity, and causal relationships cannot be established. As the study was conducted in a single tertiary-care urban institution, the results may have limited generalizability to medical students in other settings. Additionally, dietary assessment using 24-hour recall and food frequency questionnaires, though validated, may not fully capture day-to-day variations in intake, and physical activity was assessed subjectively rather than by objective measures.

CONCLUSION

Body weight is dependent upon the amount of calories intake into the body and its balance with the energy expenditure. Our findings have implicated that excess calorie intake has a prolific impact on increase in BMI and physical activity as an expense to calorie expended has a greater role in maintenance of healthy weight. Hence, it is now the need of the hour to provide multidimensional policy relevant to control the current trends and incorporate strategies to promote healthy behavior from early adulthood, leading an active life with healthy eating habits and sufficient physical activity. Strategies for long term weight maintenance can be done at hostel level by appointing a dietician in every medical hostel to prepare food chart substituting low energy dense foods for higher energy dense foods. Even awareness should be created and recommendation of preventive measures to tailor and personalize dietary pattern and physical activity at individual level for a sustainable weight loss should be initiated.

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