

THE EFFECT OF PHYSICAL ACTIVITY LEVEL AND CALORIC CONSUMPTION ON WEIGHT CUTOFFS IN YOUNG STUDENTS AND DEVELOPMENT OF A TARGETED SNACK BAR

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KEYWORDS

Anthropometric measurements, Body Mass Index, Flax seeds, Nine-point hedonic sensory scale, Physical Activity Level.

ABSTRACT

Young adults are crucial to the sustainable future of any community, making their physical and mental development, as well as overall well-being, a priority concern. This study examined the weight categories of 288 female college students, aged 18 to 20 years, in relation to their Physical Activity Level (PAL) and calorie consumption. Additionally, a snack bar was formulated to provide at least one-fifth of their daily calorie and nutritional needs. Data collection was carried out using a structured interview schedule, on their daily activity patterns, anthropometric measurements, and dietary intake. Based on Asia Pacific BMI cutoffs, the findings indicated that approximately 15% of the students were underweight, 18% had a normal weight, 48% were overweight, and 22% were obese, with overweight individuals being the largest group. PAL data showed majority of the students (78%) to be sedentary workers, followed by 20% with moderate and 2% with heavy physical activity levels. The dietary intake data revealed 28% students to consume less than 1660kcal daily, 34% to consume 1661-2130 kcal, and 37% to consume 2131-2720 kcal. Highly significant associations were found between PAL and BMI, energy intake and BMI, and PAL and energy intake. Following these results, a nutritious snack bar was developed using ingredients such as oats, dried dates, flax seeds, nuts, almonds, and jaggery. Sensory evaluation of the bar, based on a nine-point hedonic scale, yielded maximum mean score for colour (8.8 ± 0.42), followed by taste (8.4 ± 0.21), overall acceptability (8.3 ± 0.48), texture (8.2 ± 0.35) and flavor (7.9 ± 0.48). A bar of 50g contained 418.25 kcal, 11.6g protein, 61.37g carbohydrates, 14.19g fats, and 4.05mg iron..

1. Background

Young college students exhibit a vibrant and energetic demeanor, significantly contributing to the vitality of a nation's youth. Ensuring the engagement and health of the younger generation is essential for the well-being, productivity, and long-term prosperity of a country. Consequently, a nation's development and empowerment depend heavily on the overall well-being of its youth, encompassing nutritional status, physical health, and fitness. The productivity of a nation is closely tied to the nutritional and health status of young adult women, who play a vital role as active contributors to society. Thus, the health and well-being of this demographic are critical for national progress. Presently, there are growing concerns about issues such as excessive workloads, mental stress, homesickness, and peer influences (Kaur, 2021). College students often face disruptions in their eating habits due to these pressures, coupled with an unbalanced lifestyle and unhealthy dietary choices. Many students commonly adopt poor eating behaviors, such as skipping meals, consuming fast food, frequent snacking, and eating out (Yadav, 2015). Additionally, environmental and sensory cues in their surroundings can significantly influence calorie intake (Hock & Bagchi, 2018). These unhealthy habits, developed during this critical phase, can lead to the onset of long-term health problems in the future. Recent research highlights the need for adolescents and young adults to adopt healthier lifestyles due to the increasing prevalence of health issues. Maintaining a balanced diet and engaging in regular physical activity can significantly reduce the risk of these ailments. Studies have underscored the dangers of excessive energy consumption combined with a sedentary lifestyle (Pal et al., 2020). Physical activity levels (PALs) have been shown to correlate with mortality risk (Matthews, 2019). In particular, sedentary behaviors, such as prolonged time spent in social media over phone, are associated with unhealthy snacking patterns, including insufficient intake of fruits and vegetables and excessive consumption of energy-dense, high-fat foods (Araujo et al., 2023). Given the profound impact on physical health, overall condition, and quality of life, it is essential to engage in varying levels of physical activity until the ages of 25–30 to maximize the development of motor skills and physical fitness (Gorniak et al., 2016).

2. Methodology

The current study aimed to examine the relationship between Physical Activity Level (PAL) values, daily calorie intake, and various BMI categories among 285 randomly selected female college students aged 18–20 years. With their informed consent, data were collected using an interview schedule that captured information on their daily activity routines, anthropometric measurements, and dietary intake. Standardized tools and techniques were employed to ensure accurate data collection. Further an effort was made to develop a healthy Snack bar for satisfying instant short-term hunger with focus on fitness, health and nutritional value aspects of youth and provide at least 1/5th daily requirement of nutrients and calorie. As wide range of plant-based ingredients can be utilized in the production of multigrain bars, such as cereals and their derivatives, oilseeds, nuts, fruits, vegetables, and plant by-products. These ingredients are rich sources of fiber and also contain compounds with antioxidant properties (Kowalska, H, 2023). A grain based bars are appealing as they can be conveniently consumed between meals to temporarily curb hunger (Coello, K., 2022). Additionally, they can be made from various plant-based ingredients, offering both

nutritional value and health benefits. So for the present study basic ingredients selected were oats, flax seeds, dried dates, peanuts, almonds, and jaggery, which were procured in raw form from local market. The developed bars were organoleptically evaluated by 30 college students, using nine-point hedonic scale and nutrient content was calculated terms of calories, proteins, fats, iron and zinc.

2.1 Preparation and Standardization of the Snack bar - The bar was prepared using above mentioned ingredients and standardization was done for a serving size of 50 g. Table 1 depicts the proportion of different ingredients combined to develop the bar.

Table 1: Proportion of different ingredients in Snack bar

Food product	Oats (%)	Dried dates (%)	Flax seeds (%)	Peanuts (%)	Almonds (%)	Jaggery (%)
Snack Bar	40	15	5	15	5	20

Steps followed in development of Snack bar

Procurement of dry ingredients from the local market
↓
All the ingredients were then weighed
↓
Ingredients like, Oats, Flax seeds, Nuts were roasted and then ground in a mixer
↓
Dates were soaked, deseeded and then made into paste
↓
Jaggery was melted at 100°C and stirred until thread like consistency was obtained
↓
All the ingredients were then mixed and shaped into rectangular bars using mold
↓
Bars were cooled in the freezer for 5-10 minutes and stored in an air-tight container in the freezer



Plate 1: Image of developed Snack bar

3. Result and Analysis

The following paragraphs present findings of the present study, organized under various subheadings.

3.1 Subjects classified based on varying ranges of PAL

The analysis of the data revealed that among the 288 participants, the majority (78%) were classified as having a sedentary activity level, followed by 20% in the moderate activity category and 2% in the heavy activity category. Additionally, based on BMI cutoff values, around 15% of the students were identified as underweight, 18% had a normal weight, 48% were categorized as overweight, and 22% were obese, with the overweight group being the largest. (Table 2).

Table 2: Subjects across different weight categories classified based on varying ranges of Physical Activity Level (PAL)

Physical Activity Level (PAL)	Number of subjects	Underweight (BMI<18.5)	Normal weight (BMI 18.5-22.9)	Overweight (BMI 22.9-24.9)	Obese (BMI >25)
Sedentary (<1.4)	222 (78.0)	36 (16.28)	37 (16.75)	96 (43.44)	53 (23.53)
Moderate (1.4 to 1.8)	58 (20.0)	6 (10.34)	9 (15.80)	35 (59.65)	8 (13.80)
Heavy (1.8 to 2.3)	8 (2.0)	-	4 (50.00)	4 (50.00)	-
Total	288 (100)	42(15.0)	50 (18.0)	135 (48)	61 (22)

Figures in Parentheses denote Percentages

Source: Nutrients Requirements for Indians, NIN, ICMR 2020

Based on the Physical Activity Level (PAL) values by National Institute of Nutrition (NIN), Indian Council of Medical Research (ICMR), 2020 there are seventy eight per cent of the subjects engaged in sedentary activities. Out of which majority were coming under overweight (43.44%) and next is obese category (23.5%), highlighting a link between a sedentary lifestyle with being overweight and obese. A similar pattern was observed among those with moderate activity levels, where nearly 60 per cent were overweight, indicating a connection between moderate activity and overweight status. This was followed by nearly 14 per cent who were obese and another 15.80 per cent with a normal weight, with only 10 per cent classified as underweight. In the heavy PAL category, out of 8 participants, 4 (50%) were overweight, while another four subjects (50%) had a normal weight, with no cases of underweight or obesity. Overall, the findings point to a notable concern regarding the prevalence of overweight individuals across different activity levels.

3.2 Subjects classified based on varying ranges of calorie intake (EAR,NIN, ICMR, 2020)

The analysis of calorie consumption data revealed that approximately 37% of the participants had a daily intake ranging from 2131 to 2700 kcal, followed by 34% consuming between 1661 and 2130 kcal, and 28% consuming less than 1660 kcal

(Table 3). Additionally, when categorized by BMI, the majority of underweight individuals (45%) consumed fewer than 1660 kcal per day. In contrast, participants in the normal weight and overweight categories primarily consumed below 1661 kcal (28%) and 2131- 2720 kcal (60%), respectively. Among obese individuals, 39% had a daily calorie intake exceeding 2130 kcal.

Table 3: Subjects across different weight categories falling under varying ranges of daily calorie intake

Daily calorie intake (EAR kcals)	No. of subjects	Underweight (BMI<18.5)	Normal (BMI 18.5-22.9)	Overweight (BMI 22.9-24.9)	Obese (BMI >25)
<1660	82 (28.42)	37 (45.12)	23 (28.00)	18 (22)	4 (4.88)
1661 - 2130	100 (34.78)	5 (5.00)	26 (26.00)	53 (53.00)	16 (16.00)
2131 - 2720	106 (36.8)	0	0	64 (60.40)	42 (39.60)
Total	288 (100)	42 (14.40)	49 (17.20)	135 (47)	62 (21.40)

Figures in Parentheses denote Percentages

Source: Estimated Average Requirements (EAR), Nutrients Requirements for Indians, NIN, ICMR 2020

Table: 4 ANOVA for Physical activity, BMI and Calorie Consumption

Parameters	P- value
Physical activity with BMI	0.001*
Calorie Consumption with BMI	0.00*
Physical activity with Calorie intake	0.006*

*significant difference (p<0.05)

The results from ANOVA analysis indicate significant relationships between the parameters analyzed. In the analysis of Physical Activity with BMI the p-value of 0.001 is less than the threshold for significance (0.05). This suggests a statistically significant association between physical activity levels and BMI. Changes in physical activity might be related to variations in BMI. For instance, higher physical activity could lead to a lower BMI or vice versa, depending on the direction of the relationship. Likewise in Calorie Consumption with the p-value of 0.00 (approximated, typically written as <0.001) indicates a very strong statistical significance between calorie consumption and BMI. BMI is likely influenced by calorie consumption. For instance, consuming more calories than required could increase BMI, whereas a calorie deficit might decrease BMI. Lastly with Physical activity with Calorie Intake the p-value of 0.006 is also below the 0.05 threshold, indicating a significant association between daily activity and calorie intake. The level of daily activity might affect calorie consumption. For example, individuals with higher daily activity may require or consume more calories to meet their energy needs.

All the relationships tested show statistically significant associations ($p < 0.05$). This means the variables are likely related, and their interplay could provide insights into how lifestyle factors like physical activity and calorie intake influence BMI.

Table: 5 Mean values of BMI, PAL and Daily calorie intake

Category	Mean BMI	Mean PAL	Mean daily calorie intake (Kcals)
Underweight	18.19	1.28	1400
Normal	20.91	1.36	1801
Overweight	24.10	1.38	2430
Obese	29.89	1.29	2649

3.3 Sensory scores and Nutrient content of the Snack bar

The developed snack bar was evaluated based on various sensory attributes, including colour, texture, taste, flavour, and overall acceptability. The mean overall acceptability score of 8.3 ± 0.48 indicated a high level of preference among the judges. Additionally, the mean scores for individual attributes were 8.8 ± 0.42 for colour, 8.2 ± 0.35 for texture, 8.4 ± 0.21 for taste, and 7.9 ± 0.48 for flavor (Table: 6).

Also, the nutrient content of the developed snack bar was calculated based on the nutritional values of raw ingredients (ICMR, 2017). The snack bar of 50g was found to have 418.25kcal, 11.6g protein, 61.37g carbohydrates, 14.19g fat, and 4.05mg iron (Table:6), fulfilling nearly $1/5^{\text{th}}$ of the daily requirement of nutrients of a college student.

Table: 6 Mean Sensory scores and Nutrient content of the developed Snack Bar (Weight - 50g)

Mean Sensory Scores				
Colour	Texture	Taste	Flavor	Overall acceptability
8.8 ± 0.42	8.2 ± 0.35	8.4 ± 0.21	7.9 ± 0.48	8.3 ± 0.48
Mean Nutrient content				
Energy (kcal)	Protein (g)	Carbohydrates (g)	Fats (g)	Iron (mg)
418.25	11.645	61.375	14.19	4.059

4. Conclusion:

These results show that daily calorie intake is the factor largely influencing the BMI of the female college students. Hence, it needs to be maintained to an optimum level in order to avoid the increasing problem of obesity. Physical activity was identified as one of the factors influencing body weight and should not be overlooked. It can be

adjusted according to the body's needs to achieve an ideal BMI, particularly in obese subjects, who exhibited the second-lowest mean Physical Activity Level (PAL). College students prefer ready to eat tasty innovative food products, therefore, developing a Snack bar, providing minimum of 1/5th of daily nutritional requirements, could be a good option. To conclude, it can be stated that maintaining a balanced diet and be aware of the importance of modifying the diet whenever required is essential in obtaining the desirable body weight, while also giving adequate attention to physical activity of individuals.

The findings indicate that daily calorie intake is a primary factor impacting BMI in female college students, emphasizing the need to keep it at an optimal level to address the growing issue of obesity. Physical activity also plays a role in body weight management and should not be neglected; it can be tailored to meet the body's needs to support an ideal BMI, especially for obese students, who recorded the second-lowest mean Physical Activity Level (PAL) in the present study. Given the preference of college students for convenient, tasty, and innovative food products, developing a snack bar that meets at least one-fifth of daily nutritional requirements could be an effective option. In conclusion, maintaining a balanced diet, understanding the importance of dietary adjustments as needed, and prioritizing adequate physical activity are essential for achieving and sustaining a healthy body weight.

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