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A Critical Empirical Analysis of the Influence of Nutritional Status and Physical Activity Patterns on Height of Indian Youth

Analisis Empiris Kritis Pengaruh Status Gizi dan Pola Aktivitas Fisik terhadap Tinggi Badan Remaja India

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ABSTRACT

Background: Recent research indicates a global trend of increasing average height, while in contrast, the average height in India is experiencing a concerning decline. Although genetic factors account for 60-80% of an individual's final height, environmental and social factors significantly influence it.
Objectives: The study objective was to analyze the height of the adults belong to Kerala and Tamil Nadu and its associated determinant factors.
Methods: Multi stage sampling method was adopted to identify study samples from two southern districts of India namely Tamil Nadu and Kerala. Different households were randomly selected from the chosen urban areas based on the convenience sampling technique, as per the framed inclusion criteria and included 100 male and female in the age group of 18 to 25 years. A well-structured questionnaire was used to elicit the socio economic, dietary habits, physical activity pattern and anthropometric measurements of the selected samples. SPSS software was used to analyze the data. Pearson Correlation Coefficient and Anova were used to interpret the determining factors.
Results: Pearson's correlation coefficient analysis (R=0.557, p-value=0.001) and Anova (F=144.8 and p-value<0.001) showed the positive significant relationship between nutritional status and height of the participants and moderate (R=0.311, p-value<0.001), but statistically significant positive relationship between physical activity level and height.
Conclusions: The study highlights alarming trends in nutritional status and physical activity among young adults, with both factors showing a significant association with individual height. Addressing these issues is crucial for improving height outcomes in future generations.

INTRODUCTION

Height is widely recognized as the significant indicator of the health and living standard of people. Historical data, primarily derived from skeletal remains, demonstrated a relatively stable average human height over the past two millennia, oscillating around 170 cm. However, with the advent of modernity, a significant rise in height has been noticed in industrialized nations, primarily attributed to improved nutrition, sanitation, and healthcare. On average, the current population is taller than their ancestors existed 100 years ago[1]. The average height of current youngsters is around 5 per cent taller than their ancestors with the most substantial gains occurring among European and Central Asian men, while South Asian men experienced only less increment[2].

Even though 60–80% of a person's eventual height is determined by genetics, environmental, dietary, lifestyle, and social factors all play a major role in maximizing that potential[3,4]. A person's capacity to attain their full inherited potential is influenced by the foods they eat, as well as by the quality, accessibility, and availability of healthcare services during their formative years[5,6]. It is well recognized that attainment of individual height is influenced by their nutritional status and other variables, which can be tracked back from the time of conception until late adolescence. Childhood malnutrition, specifically stunting during puberty period adversely affects the final height gain in adulthood[7,8].

A study conducted by JNU's Centre of Social Medicine and Community Health noted that there has been a significant reduction in the average height of Indians, as opposed to an overall increase in the average heights worldwide. The mean height increment of Indian males and females was found to be 3 cm (161 cm to 164 cm) and 5 cm (147 cm to 152 cm) in 2014 compared to 1914. This is observed to be much lesser than in countries such as South Korea, where average height of women and men increased by 20 cm and 15 cm in a century. A new

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research paper based on NHFS study also states that the average height of adults across the globe is increasing, but in India, the average height of adults is actually decreasing. India's average height is about 5 feet 5 inches, whereas the global average height is roughly 5 feet 7.5 inches for males. A study in Family Medicine and Primary Care states that the average height of an Indian man is 164.09 cm, and the Indian woman is 152.58 cm. Different regions of India show variations in the average height due to genetics, dietary patterns, physical activity levels and socioeconomic status[9].

National Family and Health Surveys looked at trends in the heights of Indian men and women between the ages of 15–25 and 26–50. It was observed that the mean height of women aged 15 to 25 decreased by 0.12 cm, but the mean height of women aged 26 to 50 increased by 0.13 cm. Men aged 15 to 25 witnessed a 1.10 cm reduction in mean height over that time, while men aged 26 to 50 showed a 0.86 cm decline[10,11].

NFHS also noted the decline in the average height of males and females who belong to the 15-25 yrs age group by 1.10 cm and 0.42 cm, respectively. It was observed that a five-year-old general caste girl was taller by 2 cm than the scheduled caste girl which showed the significant influence of community and religion in determining an individual's height. It showed the influence of socio-economic status on height[12].

As per the WHO estimation, about one per cent reduction in adult height due to childhood stunting can result in economic productivity loss of 1.4 per cent. Research conducted by the business association Assocham and the consulting firm EY estimates that India's annual economic loss from undernourishment is approximately 4 per cent[13]. It shows that the productivity of the nation is also correlated with height.

It was noted that height decreased with age after the middle of the 20th century, which is usually referred as a cohort effect. People who grow up in an expanding economy have better nutritional and epidemiological conditions and possibly even better health care. While food availability has substantially increased in India as a result of the Green Revolution, the challenge of providing adequate nutrition to each and every citizen of the country is far from being resolved. National Sample Survey Office (NSSO) data reveals that the consumption of traditional cereals and pulses has decreased among the Indians, which leads to a deficiency in essential nutrients such as protein, fibre, vitamins and minerals. Furthermore, a more recent Indian Consumer Market report from 2020 highlights that only one-third of our food budget is allocated to protein-rich foods[14,15].

Generally, urbanization provides easy access to health care, education and nutrition, all of which lead to better growth patterns. But in India, urbanization has not given equal access to health care and nutrition to all sectors of people due to urban poverty and overcrowding. Disparity in health care and nutrition access is more prominent in India irrespective of the geographical location.

The descending trend of average height of Indians opposed to the increase in the average height of men and women worldwide is an alarm to policymakers. Oversighting this issue may lead to irreversible physical and cognitive damage across generations. The silent erosion of our human capital underscores the urgency to address this public health issue. Finding the determinants of the height of the individual is an emerging need to improve the strength of our nation. Hence the present study was designed with the objectives to analyze and compare the heights of adults in two nearby states and determine the factors associated with the height of the individual.

METHODS

A multistage sampling technique was adopted to identify the study samples. In the first stage, two states, namely Tamil Nadu and Kerala, from the southern part of India were selected. From the selected states, two urban cities, namely Coimbatore from Tamil Nadu and Palghat from Kerala, were selected for the study. Coimbatore and Palghat are located near each other, with Palghat situated just across the border from Tamil Nadu into Kerala. This leads to similarities in population trends due to geographical and economic factors. People in India attain their full potential of adult height during their twenties that is, several years later than in developed nations. Hence, in the next stage, samples were identified based on the inclusive criteria, which comprised of age group (18 to 25 years), physically active males and females and persons without disabilities and chronic disease. Transgenders, persons above 25 years and below 18 years and physically challenged persons were not included in the study. The study samples were included based on the convenience sampling technique. Convenience sampling is a non-probability or non-random sampling technique in which study participants are drawn from the target population based on practical factors like ease of access, proximity, availability at a specific time, or willingness to participate.

About 100 individuals from different households, each in Coimbatore and Palghat, were included with their consent. A well-structured questionnaire was developed by including major components, namely socio-economic details, dietary habits and physical activity patterns. The developed questionnaire was validated and used for the data collection. Colleges situated in the two districts were approached to collect the data. In colleges, people from different economic groups could be identified in the chosen age group. Adult males and females in the age group of 18-25 years were included for the study based on their willingness. Each individual was approached personally and the data were collected to elicit the adequate information for the interpretation. In addition to these data, anthropometric measurements including height, weight, waist-hip ratio, waist height ratio and BMI, were recorded. The food intake was measured using the 24-hours recall method. The collected data were statistically analyzed using SPSS software and factors were compared between the two selected districts. The income levels of the samples were categorized as low (₹125,000 per year or less), middle (between ₹125,000 and ₹3,000,000 per year) and high income (above ₹3,000,000 per year) groups. Those who eats only vegan foods considered as Vegetarians, both animal and vegan

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foods as non-vegetarians and both vegan and egg were considered as ova vegetarians.

Pearson's correlation coefficient and ANOVA were applied to analyze the data. The study was reviewed and approved by the institutional ethical committee. Before the commencement of the study, the samples were oriented on the design of the study and the written consent was received from them.

RESULTS AND DISCUSSIONS

The present study included 47 per cent males and 53 per cent females in Coimbatore and 41 per cent males and 59 per cent females from Palghat. The study included adults aged 18 to 25 years, males and females. Among them, it was observed that the majority of the subjects included in the study were in the age group of 20 years to 25 years and less than 15 per cent were in the age group of 18 to 20 years.

Income Level

It was observed that more than half of the selected adults in both states belonged to the middle-income group. Comparatively, the low-income group was higher in Coimbatore (21 per cent) than in Palghat (18 per cent) whereas the high-income group was more in Palghat (27 per cent) than Coimbatore (16 per cent) among the selected adults.

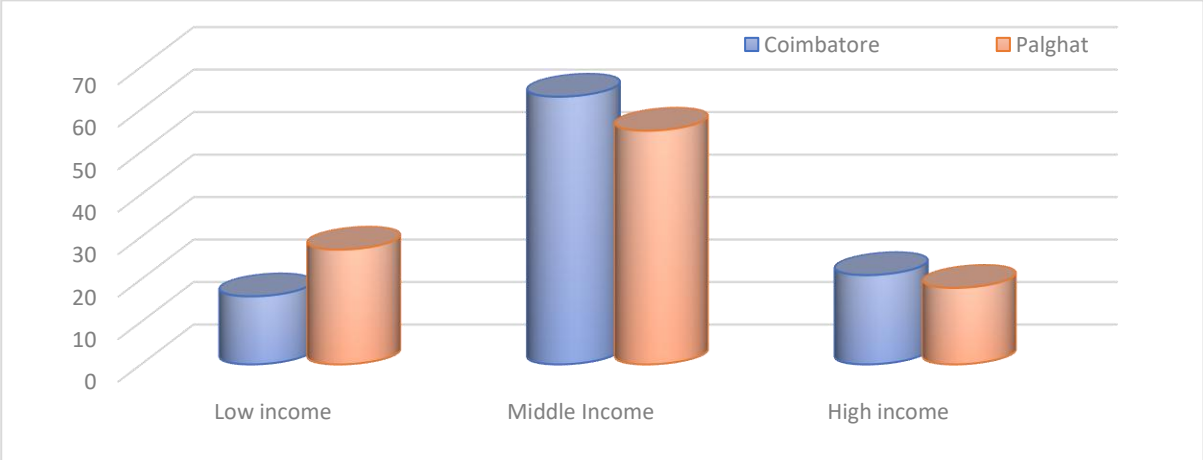

Figure 1. Income level of the selected samples

Dietary Habits

The dietary type analysis showed that more than three-fourth of the selected adults followed a non-vegetarian diet in both districts. Only 6 to 10 per cent were found to be ova-vegetarian and vegetarians. The present study results were in par with the observation stated by the National Family Health Survey. The National Family Health Survey (NFHS-5) (2020-2021) states that the majority of the population consumes some form of non-vegetarian food (fish, eggs, meat) on a regular basis in India and less than 25 per cent were found to be vegetarians. It also shows that over the five years preceding 2021, the prevalence of non-vegetarianism rose for males in 25 states and union territories and for women in 26 states and territories in India. There has been a steady rise in the number of persons eating non-vegetarian meals, particularly in the 15–49 age range[16].

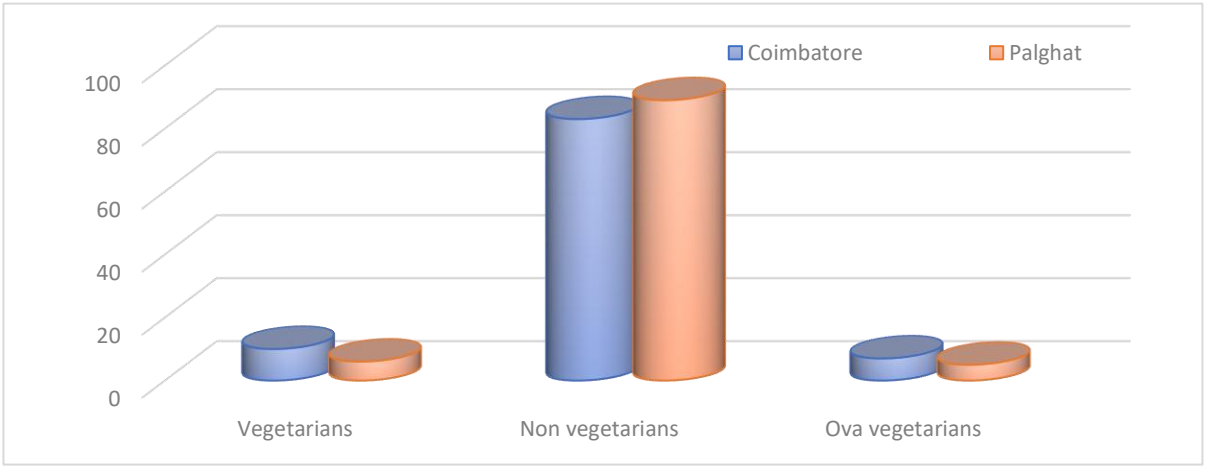

Figure 2. Dietary habits of the selected samples

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Food Intake

Meal pattern was the clear marker of diet quality and nutrient intake. It was found that more than one half of the selected subjects were consuming three meals along with snacks on most of the days. The present study results are in par with the results stated by Jisa et al., (2021) which stated that South Indians generally consume three meals regularly[17]. Dietary patterns and meeting the nutritional requirements play a key role in determining the overall health of an individual, including the height. The food intake pattern of the selected subjects was analyzed using the 24-hours recall method and it was observed that both males and females from two selected districts consumed cereals more than the recommended dietary allowances. But in pulses intake, the deficit was noticed from 24 per cent to 40 per cent which was almost similar in both the districts. The milk and milk products intake were found to be more than 50 per cent deficient compared to RDA. The vegetables, fruits, egg and meat intake were higher among the adults from Kerala compared to the selected adults from Tamil Nadu. The deficit was found to be less than 25 per cent in vegetable and fruit consumption in Kerala, whereas it was more than 33 per cent in Tamil Nadu. Worldwide, most of the population were consuming fewer fruits and vegetables than their daily requirement. Even in developed countries, a large gap was noticed between the actual intake and recommended number of fruits and vegetables despite continuous efforts through various nutrition intervention programmes[18].

High intake of fat was seen in both the states and the excess was more than 75 per cent among most of the adults. These results coincided with the results obtained from the NIN research (2019), which observed the high intake of visible fat (34.8 g) among the adults in the age group of 18 to 35 years[19]. It might be due to their regular intake of fast foods (16 – 29 per cent), bakery food products (37 per cent to 44 per cent) and fried foods (30 per cent to 39 per cent) outside the home. Eating out became very common among the urban areas, which is also shown in the present study where more than three-fourths of the selected adults in both the districts were eating out once a week. It was noticed that most of the selected adults were found to have unbalanced dietary patterns. This poor dietary habit leads to stunting and increases the risk of metabolic disorders.

Pearson's correlation coefficient analysis showed the positive and significant relationship between nutritional status and height of the participants (R=0.557, p-value=0.001). In this case, R=+0.557 indicates the moderate positive relationship between the nutritional status and height of the individuals. This implies that the dietary pattern of the individual has substantial influence on the height of the individual. The ANOVA showed a significant relationship between the nutritional status and height of the individual (F=144.8 and p-value<0.001).

Physical Activity Pattern

Various research findings state that physical activity can influence height by influencing the growth hormone secretion and by promoting bone health[20]. The physical activity pattern of the selected adults is given in table 1. The table states that moderate activity was very common among the male and female with respect to work in both the districts. A greater percent of the females was performing moderate activity with respect to work (74 per cent and 71 per cent) whereas in travel (35 per cent and 33 per cent) and recreational activities (58 per cent and 64 per cent) no activity was very common. No vigorous activity was seen among the females in travel and recreational activities.

Table 1. Physical activity pattern of the selected adults

Particulars	Coimbatore		Palghat	
	Male (n=47)	Female (n=53)	Male (n=41)	Female (n=59)
	%	%	%	%
Work				
Moderate	64	74	70	71
Vigorous	36	26	30	29
Travel				
Moderate	69	35	63	33
No activity	31	65	37	67
Recreational Activities				
Moderate	64	42	42	36
Vigorous	22	-	39	-
No activity	14	58	19	64

Among males, the moderate activities were observed among the maximum per cent of the selected adults. In recreational activities, vigorous activities were seen among the males in both the districts but the percentage was higher in Palghat (39 per cent) when compared to Coimbatore (22 per cent). It showed that sedentary levels of activities were predominant among the selected adults and the greatest per cent physical activity was not meeting the WHO physical activity requirement standards.

The 2016 India Report Card states that the majority of the Indian adults were found to be not active as per their WHO recommended levels and involved in sedentary activities in the whole day. The present study

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also states the similar observations[21]. The results obtained in the Pearson's correlation coefficient analysis showed a positive and significant relationship between the physical activity level and height (R=0.311, p-value<0.001). The results show that there is a weak to moderate, but statistically significant positive relationship between physical activity level and height.

Income and Height

National Institute of Nutrition (2020) revised the average height for Indian men as 5.8 feet (177 cm), and that for women as 5.3 feet (162 cm). When compared to this, the average height of the selected adults was much lower in both the districts[22]. Average height was analyzed based on the income level and given in table 2. Socio economic status influences the purchasing power of the individual, thereby influencing the food availability and intake. Hence the height of the individual was compared based on their income level.

Table 2. Average height of the selected samples with respect to income

Variable	Coimbatore		Palghat	
	Male (n=47)	Female (n=53)	Male (n=41)	Female (n=59)
	Mean(cm) ± SD			
Low Income	167.90±4.20	155.92±6.06	170.60±5.68	154.03±6.96
Middle income	169.20±4.78	152.50±5.31	168.20±2.68	154.10±4.36
High income	169.30±3.97	155.50±3.82	169.40±2.19	157.10±4.28

The height of the males in the high-income group was comparatively higher when compared to other income groups in Coimbatore whereas the low-income group females have a higher height in comparison with other income groups. In Palghat, the low-income group males and high-income group females show greater height in comparison with others. The present study results were controversial with the results given by Rascoe et al., 2024 which observed a linear correlation between height and income. In-depth analysis of data is different dimensions is needed to find out the clarity in this aspect[23]. The present study was limited to only two cities in two different states with a small group of the population. Further research is needed by including a greater number of subjects with food and lifestyle diversity to find the greater influential factors of height other than genetics.

The study critically analysed the factors influencing the height of the samples. But it is limited by the minimum number of samples and restricted geographical locations. More comprehensive analysis of influencing factors in broader perspectives require large size of samples from greater number of geographical locations.

CONCLUSIONS

In this study, the average height of the men and women in two different geographical locations was found to be lesser than the global average. The height was found to have a strong positive correlation with nutritional status compared to physical activity. There was no significant relationship with income level. The present study highlights the alarming trends in nutritional status and physical activity among young adults, which have a significant positive association with height. Addressing these issues is crucial to improve the health status of the future generation as well as the economic status of the nation.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

The authors state emphatically that they have no competing interests. The study was conducted using the own fund of researcher and did not receive funds from any other institution.

AUTHOR CONTRIBUTIONS

SL: conceptualization, methodology, formal analysis, writing-original draft; RK: data collection and analysis; AK: data collection and analysis; SP: conceptualization, supervision, writing-review & editing.

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