EVALUATION OF PHYSICAL GROWTH STANDARDS, NUTRITIONAL STATUS AND DIETARY PATTERNS AMONG THE SCHOOL AGE-CHILDREN OF HIMACHAL PRADESH: A CROSS SECTIONAL STUDY

A
Thesis
Submitted for the Award of the Ph.D. degree of
PACIFIC ACADEMY OF HIGHER EDUCATION AND RESEARCH UNIVERSITY

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2023

DECLARATION

I, **NEETU SAINI D/O MR. TEJ SINGH SAINI** resident of C/O Pathania Infotech System, Ner Chowk, Teh. Balh, District Mandi, Himachal Pradesh, - 175008, hereby declare that the research work incorporated in the present thesis entitled **"Evaluation of Physical growth standards, Nutritional status and Dietary patterns among the school age-children of Himachal Pradesh: A cross sectional study"** is my original work. This work (in part or in full) has not been submitted to any University for the award or a Degree or a Diploma. I have properly acknowledged the material collected from secondary sources wherever required.

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Dr. VARSHA CHOUDHARY
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CERTIFICATE

It gives me immense pleasure in certifying that the thesis **"Evaluation of Physical growth standards, Nutritional status and Dietary patterns among the school age-children of Himachal Pradesh: A cross sectional study"** and submitted by **NEETU SAINI** is based on the research work carried out under my guidance. He / she have completed the following requirements as per Ph.D. regulations of the University;

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ACKNOWLEDGEMENT

First and foremost, I offer my obeisance to ***THE ALMIGHTY GOD*** for his boundless blessings which accompanied me in all the endeavors and for giving me the strength to make this accomplishment.

I would like to extend my deepest gratitude to my Supervisor, **Dr. Varsha Choudhary**, PAHER University, Udaipur for her ingenious suggestions, relentless support and guidance, untiring patience during my course. Her immense knowledge and plentiful experience have encouraged me all the time in my academic research.

Next, my thanks to my Co- Supervisor **Prof. RAJIB BISWAS**, who most diligently and painstakingly guided and led me from stage one to the culmination of my research project. This thesis represents not only my work at the keyboard but also the tireless efforts of my Co-guide who made it possible for me. As my teacher and mentor, he has taught me more than I could ever give him credit for here.

I am very thankful to **Prof. RAMESHWAR AMETA**, Dean, Faculty of Science, PAHER University, Udaipur for his keen support during the course of the entire research work.

I place on record, my sincere thanks to **Prof. Hemant Kothari**, Dean, PG Studies, PAHER University, Udaipur, for their continuous encouragement and support to access the infrastructure required for the completion of my research work. Their continuous guidance and motivation contributed to the successful completion of this study.

I thank **Prof. Suresh C. Ameta**, **Dr. Neetu Shorgar**, **Dr. Seema Kothari**, **Dr. Paras Tak** and **Dr. Priyanka Jhalora** for their cooperation and valuable guidance during the complete research tenure.

I feel proud and happy to convey my sincere thanks to all the seniors, co-workers, staff members of PAHER University, Udaipur, who helped me to complete this project successfully.

I must express my very profound gratitude to my father **Mr. Tej Singh Saini**, mother **Mrs. Nalini Saini** and to my Partner **Mr. Neeraj Pathania**. They have been a constant source of inspiration and support to me throughout my career and life.

I express profound thanks to my father–in–law, **Shri Kashmir Singh Pathania** and mother–in–law, **Mrs. Pushpa Pathania**, for their constant love, patience and support during the entire period.

My special thanks to my brother-in law **Dr. Ajay Guleria** and sister-in -law **Mrs. Rajni Gandha Guleria** to help me in all possible ways at every step during the entire period of my academic research and in every sphere of my daily life.

I am very thankful to all my colleagues and friends for their continuous encouragement and support during this entire period of writing and shaping thesis. I express my gratitude to my dear friend **Kanchan Parmar** who not only encouraged me in my moments of despair but was also there whenever I needed.

I would like to thank all the school Principals to allow me for conducting my research especially **Dr. K.P. Sharma** to help me every time and provide all possible facilities.

Once again, I wish to thank one and all, who helped me in fulfilling my objectives. This project has been completed with the help and co-operation of many people with whom I came in contact during the period of my research.

I am very grateful to **Dr. Surya Prakash Vaishnav**, Assistant Professor, PAHER University and friend for his valuable suggestions and encouragement throughout the period of my research.

The final one, my distinctive thanks to ***Nav Nimantran Thesis Printing & Binding, Udaipur,*** Admin Team ***Mr. Hemant Sharma and Mrs. Kusum*** for their role in shaping this research, creative design work and bringing out this document meticulously, neatly and timely.

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PREFACE

Malnutrition among children and adolescents is a major public health concern worldwide. Therefore, number of parameters are used to access the growth pattern and nutritional status among children.

Growth patterns can be evaluated through growth monitoring. It helps to understand growth standards and any potential growth problem. Therefore, growth monitoring is considered as an important clinical and public health practice to assess whether a child from a particular country, state or community is developing normally.

Food provides nutrition and promotes growth and development. Thus, the standard of growth is directly influenced by the level of nutrition. Poor nutrition hinders optimal growth with negative health outcomes, these conditions are termed as malnutrition.

Growth monitoring can assess physical growth profile for a group of population in terms of presence and extent of growth problem and thereby reveals conditions of malnutrition. Subsequently, this provides an opportunity to take preventive and supportive actions to promote proper nutrition for betterment of health and well-being.

In comparison to other states of India, studies reporting nutritional status of adolescent school children of Himachal Pradesh is scanty. With this fact the present study is conducted to access the nutritional status of Himachali children in relation to their physical growth standards and dietary pattern.

It is anticipated that the results from the current study might be used as a baseline for subsequent research as well as for public health policies and programs aimed at improving the nutrition as well as overall health status of school-aged children in this hilly state.

The present study is cross- sectional in nature and conducted among 1467 school going Himachali adolescents' in the age group of 10 to 17 attending both government as well as private schools.

Three categories, i.e., stunting, thinness, overweight, and obesity was assessed according to public health criteria recommended by World Health Organization (WHO) expert committee. The z-scores of the Height-for-Age index were used to assess stunting while the z scores of the BMI-for-Age index were used to assess the other nutritional categories.

Dietary assessment was evaluated from self-reported intake pattern of the subjects during the last two weeks prior to the study through a questionnaire. Intake frequencies were recorded for seven categories of healthy or essential food groups that included milk, fruit, dairy products, cooked vegetables, green leafy vegetables, salads, and pulses and six categories of unhealthy food groups including junk food that are consumed as snack items and include savory snacks, fast foods, sweets, cake/pastry, candy/chocolates, soft drinks, and other sweetened beverages.

As compared to different parts of India, the results obtained in the present study were quite impressive. A lower prevalence of different categories of malnutrition was observed as compared to other parts of India.

The overall prevalence of stunting among boys was 7.5% and among girls 9%. The prevalence of thinness was 19% among boys and 12% among the girls. Only 6% boys and 5 % girls were overweight and overall prevalence of obesity among boys and girls was 2% and 3% respectively.

Dietary assessment revealed high consumption of healthy foods and low intake of unhealthy foods by majority of the children.

Given the fact that the majority of the Himachali communities are still maintaining their traditional socio cultural norms, this preservation has led to minimum infiltration of urbanization. Therefore, it is appreciated that the same has been reflected in the diet pattern and subsequent nutritional standard of the Himachali children.

These facets can also be implemented as a strength-based approach to bring positive behavioural and social change to improve the health and nutritional condition in other population setting.

ABBREVIATIONS

S. No.	Abbreviation	Full Form
1.	WHO	World Health Organization
2.	HAZ	Height-for-Age
3.	BMIAZ	BMI-for-Age
4.	WAZ	Weight-for-Age
5.	BMI	Body mass index

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CHAPTER – I

INTRODUCTION

1.1 GROWTH AND DEVELOPMENT

The evolutionary history of all organisms is a saga of the gradual development of survival mechanisms. The most fundamental survival mechanism is growth. The process of growth in the life cycle of a human being is fascinating. It comprises of fetal growth and the growth of the neonate into an adult. The fetus grows and develops inside the uterine environment which is extremely stable and provides a protective niche for the developing fetus. At birth, the fetus leaves this niche and gets delivered into the external environment. Human growth starts from this point of time. This is called postnatal phase of growth which differs completely from the fetal growth.

The external environment has a wide range of varying physiochemical stimuli that impose extreme physiological demand for the infant. To cope up with these demands, for the sake of survival, the infant undergoes several adaptive changes. These changes are brought about by the process of growth and development. Growth and development is a process that involves a desirable level of morphologic, cognitive, functional, metabolic and nutritional development which are fundamental for achieving an optimal level of health. Therefore, growth is considered as an indicator of health.

Health is a multidimensional concept. It is defined as a "state of complete physical, mental and social well-being and not merely the absence of disease or infirmity"[1]. This implies that health encompasses several domains. The domain of physical well-being represents the state of physical health of an individual. It indicates the status for morphologic and functional development. Morphological development reflects the physical growth status of an individual.

1.1.1 PHYSICAL GROWTH

Physical growth is a complex and continuous process of physical developmentin terms of physical size and morphology and functionality, by which an infant develops into an adult. Physical growth commences through different phases which are described as growth during infancy, childhood, and adolescence. The pattern of growth and development is mostly determined by the genetic makeup of an individual. However, other than genetic factors, a complex interaction between nutritional, hormonal and environmental factors also influence the growth process.

Growth also depends on gender; boys have different growth pattern as compared to girls.

1.1.2 HEIGHT AND WEIGHT

Height and weight are considered as the two most fundamental anthropometric measurements that reflects physical growth.Each phase of development has its own characteristic features and pace of development, and in each phase depending upon the interaction between different factors, the height and weight increases at a particular pace. These are reflected in a measurable increase in body shape and size.

The increase in height and weight at different phases of growth are described in terms of growth velocity and growth spurt. Growth velocity is the measurable increase in height and weight at a fixed period of time. Growth spurt refers to the maximum gain of height and weight during a growth phase.

1.2 GROWTH MONITORING

The normal growth pattern continues with a standard level of gain in both height and weight with chronological age. This is associated with age and sex specific development of secondary sexual characters including the patterning of muscle and fat mass. The characteristics of normal growth and development in different growth phases, i.e., during infancy, childhood and adolescence and the growth spurts and velocities in each phase have been established by decade long scientific studies.[2]

Normal pattern of growth requires optimum health condition. Therefore, the growth standards are considered as the barometric measure of overall health condition. Health conditions of infants, children and adolescent's population are considered as indicators of the well-being of the society as they represent the future generation of any society.

Growth patterns can be evaluated through growth monitoring. It helps to understand growth standards and any potential growth problem. Therefore, growth monitoring is considered as an important clinical and public health practice to assess whether a child from a particular country, state or community is developing normally.

Food provides nutrition and promotes growth and development. Thus, the standard of growth is directly influenced by the level of nutrition. Poor nutrition hinders optimal growth with negative health outcomes, theseconditions are termed as malnutrition.

Growth monitoring can assess physical growth profile for a group of population in terms of presence and extent of growth problem and thereby reveals conditions of malnutrition. Subsequently, this provides an opportunity to take preventive and supportive actions to promote proper nutrition for betterment of health and well-being.

1.3 GROWTH STANDARDS AND GROWTH REFERENCES

In nutritional studies, for the purpose of growth monitoring and to determine the level of growth standards, the height and weight of a study population at a particular age are compared with certain growth criteria. According to WHO two types of growth criteria are used for assessment purpose; the growth standard and growth reference[3].

The growth standard represents the pattern and standard of normal growth of children under conditions of optimal nutrition and health. The growth standards of height and weight are available as charts or tables which gives the growth pattern of these children from 5 to 19 years of age in terms of their height, weight and BMI at different age group separately for males and females. Growth standard charts are prepared by the World Health Organization[4]following a worldwide survey across several nations and therefore allow to compare the growth pattern of children of all countries, races, and ethnicity against a single standard**.**

Although growth standards are used worldwide to assess the overall health condition of the community, it is however proposed that comparing the growth status of a particular study population against the WHO growth standard can overestimate the prevalence of malnutrition of apparently normal children particularly, in the context of developing countries like India[5-6].

As an alternative solution to this problem, growth references are used to assess normal growth. Growth references describe the existing growth pattern of children for a particular community, country or population at a particular period of time growing in the best possible state of nutrition and health in a given community. However, the best possible state of nutrition might not represent the optimal condition, and therefore, unlike the growth standards the growth references may not represent an optimal level of growth. Growth curves obtained from growth references, known as reference curves therefore need to be updated at least once a decade and with the recent rising incidence of obesity, as they are likely to define overweight children as normal[7].

1.4 GROWTH INDICES

Height and weight, although considered as the two most sensitive anthropometric indicators of physical growth, do not help to detect various clinical and sub clinical forms of growth deficiencies and malnutrition alone, and therefore need to be transformed to suitable growth indices. An index is defined as a combination of variables[8].

Growth indices also called growth indicators, are constructed by combining height and weight with age and sex of the individual. They indicate age and sex specific normal level of height and weight. Objectively, they compare the height or weight of a child or adolescent (study population) with the expected value of height or weight of a child or adolescent of the same age from a reference population. The reference population is considered as the population of children and adolescent with normal growth pattern. Such comparisons, help to detect any growth deficiencies among the study population.

Growth deficiencies is the inability to gain normal height at a particular age, or the inability to attain a normal weight for a particular height. Given the fact that nutrition determines growth, these indices, by detecting growth deficiencies, serve as important proxy measures of nutritional standard and detect conditions that evolves from nutritional imbalance or deficiencies. Simply stating, these indices detect conditions and levels of malnutrition. So, these growth indicators are also termed as nutritional indicators. In public health and epidemiological studies, these indices are used as a valuable tool to assess the nutritional status of a given population and to compare nutritional standards between populations. Three sex and age specific indices are most commonly used for the evaluation of growth and nutritional status in children's and adolescents up to 19 years of age. They are height - for - age (HAZ), BMI - for - age (BMIAZ), and weight-for-age (WAZ)[9].

1.4.1 HEIGHT- FOR AGE

The Height – for – Age (HAZ) is a height- based indicator and indicates linear growth. It compares whether a child or adolescent has achieved the expected level of height as compared to a child from healthy well-nourished reference population of same age. A low HAZ indicates age related short stature condition known as stunting. This indicates linear growth retardation which means a child has failed to achieve a standard linear growth at a particular age.

Height increases over years and inadequate nutrition over a long period of time leads to failure to attain an expected stature at a particular age. Therefore, stunting reflects a state of chronic malnutrition.

1.4.2 BMI-FOR-AGE

Body mass index (BMI) is a quotient which is used to identify if an individual has an abnormal weight in proportion to their height. It is calculated as weight divided by height and expressed in kg/m^2[10]. BMI gives an indication of the relative amount of body fat. Worldwide data on BMI reveals that increased BMI is related with physical inactivity, and consumption of high calorie food and increased BMI is associated with the risk of chronic diseases[11].

BMI is transformed to an index called BMI - for - age (BMIAZ) which is considered as a weight- based index. It compares the BMI of a child at a particular age with the BMI of a child representing the reference population of similar age group. Given that the BMI reflects relative fatness of the body, early studies on BMI for age were mainly used to identify conditions of overnutrition that includes overweight and obesity. In practice, using BMI and transforming it to BMIAZ, has been successfully used in nutritional studies to assess the risk for overweight, and obese conditions[12]. Both overweight condition and obesity are considered as chronic state of malnutrition.

More recently, the importance of low BMI has also been recognized to identify undernutrition. In accordance, low BMIAZ scores indicate condition of under nutrition termed as “thinness”. BMIAZ has been recognized as the best direct indicator of thinness during adolescence[13]. Thinness is considered as a direct indicator of acute state of malnutrition [14].

1.4.3 WEIGHT-FOR-AGE

The weight-for-age index determines if one is underweight or not, where underweight can be defined as inadequate weight related to age. This index indicates both chronic and acute malnutrition. Weight for-age is inadequate for monitoring growth beyond childhood due to its inability to distinguish between relative height and body mass, hence the use of this indicator is restricted for use in children up to 10 years of age[9].

1.4.4 CUT-OFF VALUES FOR DEFINING STUNTING, THINNESS, OVERWEIGHT AND OBESITY

The nutritional indices, the HAZ and BMIAZ, are expressed quantitatively either as percentiles or Z- score values. While the percentiles represent ranks, the Z scores are considered as continuous variables and represents standard deviations of the parameter concerned, for example, the height in case of HAZ, or BMI for BMIAZ[15].

Z – scores are considered as standardized measure which could be compared across age and sex for the assessment of the nutritional status of children and adolescents up to 19 years of the age. According to the World Health Organisation (WHO) stunting and thinness should be defined against certain Z-scores, which are considered as cut-off values. A cut off value represents a standard Z score of height and BMI of the reference population[16]. According to WHO, a standard deviation of -2 of the reference population should be considered as the cut- off z score. This means that if a subject's height or BMI is less than the – 2SD value of height or BMI of the reference population of the same age group the subject will be considered as stunted and thin (wasted) respectively. Furthermore, if the height and BMI of the subject from study population, is less than the – 3SD score of the reference population of same age group, it will be considered as a case of severe stunting or severe wasting respectively[4,16]. The Z scores of – 2SD or -3 SD are lower cut-off values which define conditions of poor or under nutrition represented by stunting and wasting (thinness).

Overweight and obesity also represent malnutrition and more specifically, they are considered as conditions of overnutrition. They are defined by higher cut-off values. Conventionally, percentile scores of the reference population are used instead of z scores, to define overweight and obesity conditions. Overweight is defined by a cut-off value of BMI of > 85^{th} to < 95^{th} percentiles and obesity is defined by a cut- off -value of BMI ≥ 95th percentile of the reference population of the same age.[17].

More recently, the overweight has been defined as a BMI > 1 SD and obesity as a BMI > 2 SD, of the WHO reference population[9,18].

1.5 DIET AND DIETARY PATTERNS

Nutrients are essential to maintain growth and physiological functions. We obtain nutrients from the daily intake of different variety of foods. The combination of different kinds of food is called diet. The daily pattern of food and beverage intake in

terms of variety, quantity, quality and the frequency with which they are habitually consumedis called dietary pattern[19].

As the foods vary widely in their nutrient content, food combinations determine the nutrient content of the diet which is important for the health consequences of the food. It determines the standard of nutrition**.** For positive health outcome and adequate nutrition, the dietary pattern must be sufficient from its nutrient content. On the other hand, inappropriate diet pattern and food habits can fail to provide the daily nutritional requirements and can cause both under nutrition and over nutrition.

This adverse pattern couples with the physical activity and affect systemic health as reported in various studies[20-22].

Evaluation of the dietary standard includes adequacy of diet, dietary contents and their appropriate and inappropriateness, the pattern for daily meal intake, and spacing's between meals, eating behaviour and preferences for food. Various socio-cultural, economic and environmental factors influence food preference. They include food related beliefs, the availability of foods, the ability to purchase and prepare food, promotion of food by advertisement. Healthy dietary patterns can be induced by efforts from different government, non-governmental agencies and nutrition communities to promote healthy diet[23].

Evaluation of dietary pattern and subsequent determination of nutritional sufficiency provide evidences to formulate dietary guidelines. Dietary guidelines are the evidence-based statements on food choices to meet the nutritional requirement and to reduce the risk of malnutrition and chronic diseases[24].

1.6 EFFECT OF GLOBALIZATION ON DIETARY PATTERN

Over the last few decades global scenario of dietary patterns has changed. Populations are moving from traditional diets to more highly processed diets. Traditional diets are high in fibres and micronutrients, but processed foods are usually high in sugar, low in fibre, fat, salt, and less nutrient dense. Therefore, these changes are leading to nutritional inadequacies. This pattern of change is described as the 'nutrition transition[25].

Nutritional transition is progressing with a rapid pace and affecting people of all age groups across countries, communities and socio-economic status. These transitional patterns are outcome of socio- cultural, economic and technological transformation

and are more prominent in lower- and middle-income countries. These dietary and activity shifts have direct implications for non-communicable diseases, which are more aptly termed as nutrition-related non- communicable diseases.

With the ongoing nutritional transition there is also a rising trend of obesity. Children and adolescents are suffering from both under nutrition (stunting and thinness) and overnutrition (overweight and obesity). The simultaneous existence of both these extremities of malnutrition is more prevalent in the communities of the developing and underdeveloped countries, this condition has been termed as the double burden of malnutrition which has become an important public health issue worldwide[25].

Worldwide data available on adolescent nutrition and dietary pattern point towards low consumption of fruits and vegetables, meal skipping habits, consumption of substantial amount of fast food in diet and not having family meals[26-29].

India is undergoing nutritional transition which has been triggered by diverse sociocultural, economic and marketing policies[30]. This resulted in a significant change in the lifestyle and dietary habits especially of the urban population of India[31-33].

Nutritional transition among Indian population is conspicuous too. The traditional culture specific home-cooked meals are getting rapidly replaced with read-ready-to - eat and processed fast food in the urban community[34-35]owing to the simultaneous introduction of western culture and opening of multinational food companies, the Indian food market has experienced a paradigm shift in the last few decades with transition in nutritional status within the various Indian populations.

1.7 BACKGROUND OF THE STUDY

1.7.1 THE IMPORTANCE OF ADOLESCENT PERIOD

Adolescents are the persons within the age group of 10-19 years[36]. They are the largestcohorts in today's world than ever before[37]. Adolescent comprises 16% of total world population[38]. Asia has more than half of the world's adolescents. Most of these adolescents (90%) live in low-and- middle- income countries (LMICs)[4,39]. According to the census 2011, 20% of population of India are adolescents[40-41].

The adolescent period is divided into 2 phases- early adolescence which span from 10 to 14 years and late adolescence period which is between 15 to 19 years[37].The adolescent period of life is seen as second window of opportunity for "catch up growth"[42] and a significant period of growth and maturation in human development.

This period is characterized by rapid physical growth, and psychological development. A substantial amount of adult height, weight, and bone mass is gained during this period. Moreover, this is a period of significant deposition of muscles in boys and fat in girls.

To meet these growth requirements and rapid growth spurt, the physiological need for nutrients during adolescent period is immense, in fact this period of life has the highest nutritional demand. Therefore, dietary adequacy in this phase of life is of utmost importance to achieve optimum growth & development. This can be fulfilled by the consumption of a high-quality nutritional diet coupled with good lifestyle and hygienic practice coupled with a planned physical activity for improving & maintaining physical fitness.

During adolescent an individual undergo extreme psychosocial cultural- emotional changes which influence their lifestyle, food habits, food preferences, and other health related behaviours. This may lead to erratic nutritional pattern affecting both nutrient intake and need. Therefore, adolescent period is also considered as a period of nutritional vulnerability[43]. Studies have identified various sociocultural and economic factors as determinants of adolescent malnutrition[44].

Food habits developed in adolescent period have several long-term nutritional implications and consequences. It has been reported that the food habit and pattern that develops during adolescence influence the food related behaviours of adulthood[45]. Therefore, providing healthy nutrition during adolescent period can have significant long-term health benefits and on the contrary, adverse nutritional condition in this period of life can make the adolescents prone to sub clinical cardiovascular disease, type II diabetes and obesity[46].

The domain of adolescent's health and nutrition condition bear immense importance for community health as the adolescents are the future workforce and bearers of next generation. In addition, the nutritional standards of the adolescents girls who are future mothers contribute significantly to the nutritional status of the community and improvement in Adolescent nutrition of girls can also break intergenerational malnutrition cycle and improve the pregnancy outcome[47-48]. Identification of health and nutritional status of adolescents also can predict the future development of illness. It has been reported that inadequate nutrition during this period can potentially retard

the growth and sexual maturation and can also increase the risk of chronic diseases at a future age.[4,39,49].

1.7.2 THE IMPORTANCE OF NUTRITIONAL STUDIES

It has been reported in international literatures that there is a paucity of data on how the nutritional status is affected by different health related behaviour, nutritional preferences, everyday life context and sociocultural and economic factors when one transit through the age of adolescent[44].

Examination of the patterns of diet and preference for different kinds of food is critical for understanding the nutrition transition among different populations and communities, which also holds true for adolescents and adults. It is essential for the development of appropriate health policy and programmes

Nutritional studies worldwide, have reported the prevalence of anthropometric indicators like underweight, stunting, overweight and obesity, which are often indicated as proxy measures of changes in dietary habits and food consumption pattern[50]. Although these prevalence data on nutritional standards make important contribution to the understanding the overall nutritional conditions, these findings need to be complemented and substantiated by data on actual pattern of food consumption and preferences is necessary for a fuller understanding of the drivers of dietary change. These studies are not only important for formulating nutritional policies in a broader public health context, but can also provide guideline for development of improved methods and metrics for agri-health research[51].

1.7.3 SOCIO-CULTURAL AND DEMOGRAPHIC CONDITIONS OF HIMACHAL PRADESH

Himachal Pradesh (HP) is a hilly state in Northern India. The state is bordered by four Indian state and also by the autonomous Tibet region. The unique geographical feature of the state has influenced the socio-economic, and cultural pattern of the state population. The state has a population of 68,84,602[41] with a large majority (90%) living in rural areas. It consists of 12 districts, 123 tehsils spread over 55,673 sq km area. Youth constitute about one third of the total population.

Himachal Pradeshis considered to be the most progressive hilly state of India and has made remarkable socio-economic development during the last few decades owing to the remarkable efforts that was taken to reduce poverty and establishing the state with

the best human development outcome in India. There has been a significant drop in the poverty level which has benefitted all social group across rural and urban areas of the state.

The state has also undergone transformation and development in its agriculture, horticulture and animal husbandry sector[52]. Himachal has also made tremendous improvements in various demographic indicators such as life expectancy, infant mortality rate and crude death rate. Between 1981 and 2011, Himachal's literacy rate has almost doubled and is one of the most literate states of india with a literacy rate of 83.78%. According to Human Development Report 2018, Himachal ranks as the third best[41]performing states in the country after Kerala and Goa.

However, there is still a concern for the nutritional status of Himachali children and adolescents. A health survey report on adolescents and youths of Himachal Pradesh reported that 44 percent prevalence of underweight and 5 percent prevalence of overweight and obesity among the surveyed population[53].

Given the fact, that Himachal Pradesh is a home to about 1.5 million adolescents in the age group of 10-19 years, that constitute 22 percent of Himachal Pradesh's total population and that the effect of socio cultural economic and technological developments in Himachal will open avenues for infiltration of global nutritional trends among the Himachali communities, it is expected that such transformations will also affect the adolescents of Himachal.

However, there is a paucity of data on nutritional standard and dietary pattern of Himachalischool going adolescent population. In the last decade only, three studies have reported about the dietary adequacy and dietary pattern including junk food consumption of Himachali adolescents and children[54-56]. Other three studies have reported on the anthropometric profile of Himachali children and adolescents[57-59].

1.8 SCOPE OF THE PRESENT STUDY

The physical growth standards of children and adolescents are considered as the markers of the progress of human societies. Therefore, the domains of children and adolescent nutrition, health and physical development have always gained academic importance. Investment in adolescent nutrition with the aim of development of health and nutritional status of school age children and adolescents is associated with positive health outcome of the future society. Adolescent nutrition and health research

can provide insights into the extent of growth and nutritional related problems of this population. Such efforts can also address their health and developmental needs which could be taken into consideration in order to achieve improved health and development outcomes for the population as a whole.

In view of the above background and scope, the present study has been conducted with the following aims and objectives.

1.9 AIMS OF THE STUDY

1. Estimation of the growth standards of Himachali adolescent boys and girls
2. Assessment of malnutrition of Himachali adolescent boys and girls
3. Evaluation of dietary pattern of Himachali adolescent boys and girls

1.10 OBJECTIVES OF THE STUDY

1. To determine the mean height, weight and BMI of the Himachali adolescent boys and girls for all age groups from 10 to 17 years.
2. To estimate the Z scores of different growth indices viz, height – for – age and BMI for age to assess malnutrition in terms of the growth standards.
3. To estimate the prevalence of different categories of malnutrition separately for boys and girls in relation to different age groups and adolescent categories.
4. To report the dietary pattern in relation to the intake frequencies of different food groups consumed during meal and snacks.
5. To study the breakfast habits and vegetarian and non-vegetarian pattern of the boys and girls
6. To study the relationship of dietary patterns with different nutritional categories.

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CHAPTER – II

REVIEW OF LITERATURE

2.1 PHYSICAL GROWTH AND MALNUTRITION

Physical growth, nutrition and malnutrition are closely interrelated terms. Inadequate nutrition hamper normal growth and results in malnutrition. The word, 'malnutrition' refers to an imbalanced state of nutrition that includes both nutritional deficiencies and nutritional excess in children and adolescents reflected in the physical growth pattern, mainly height, weight and BMI of the individual. Malnutrition includesstate of nutritional deficiencies also called under-nutrition that include stunting, thinness and wasting and state of nutritional excess that include overweight and obesity. Malnutrition is a complex issue and the leading cause of death and disease in the world. As a global public health problem, malnutrition affects both children and adults across the world[1]. It has been estimated that 32% of the global disease burden can be removed by eliminating malnutrition[2]. Malnutrition is also considered as serious health issue that affects children in developing countries[3].

Stunting that represents a chronic form of malnutritioncan be assessed by approximately 2 years of age[4]. Stunting (height- for- age) below 2SD off the world health organization WHO/CDC reference standards in adolescence especially important consideration for adolescent girls[5].The effects of stunting are manifold. Studies have reported that stunting is associated with increased risk of cardio-metabolic disorders including obesity and cognitive developmental delay in adulthood. Stunting can also lead to increased mortality and poor recovery from disease[6-7]. Pre-pregnancy stunting has been reported as a risk factor for poor pregnancy outcome and preterm birth[8].

In the present world the coexistence of multiple forms of malnutrition is also a global phenomenon. This indicates that there is a coexistence of stunting with wasting. In Indian context the overall prevalence of stunting and wasting has been reported around 9%[9].

The global estimate of wasted children was around 52 million in 2016 among which 70% (36 million) were Asian. In Indian context a rise in the wasting form of malnutrition was also reported[10-11]. The global prevalence of thinness has been estimated to be 8.4% for girls and 12.4% in boys and there has not been much declined in these prevalence rate during the last three decades[12]. Underweight also termed as thinness is defined as less than 2SD from median for body mass index (BMI).

In the recent times it has been estimated that prevalence of stunting has declined from 199.5 million to 144.0 million between 2000 to 2019 and this accounts to a global decrease from 32.4% to 21.3% per decade. Wasting and severe wasting have been reported to be 6.9% (Percent) and 2.1% (Percent) globally whereas highest prevalence of wasting prevails in the countries of south Asia[13].

It has been reported that in many countries different forms of under nutrition (stunting, underweight, thinness) coupled with micronutrient deficiencies is common among adolescence which results mainly from inadequate nutrition during early childhood. This in terms fails to meet the high nutritional demand of rapid growth which is required during adolescence[14].

In India, under nutrition is the leading cause of childhood morbidity and mortality. It has been estimated that in India one third of the new born have low birth weight of is a major public health problem. This carries with it the risk of infant mortality and growth failure among survivors[15]. Studies have shown that childhood under nutrition affects physical growth & cognitive development, impair the immune system and increases the risk of morbidity & mortality[16-18].

Over nutrition is a state of nutritional excess is called and include overweight, obesity. Over nutrition include overweight condition and obesity. These are associated with physical inactivity coupled with consumption of energy dense foods.

The overnutrition state particularly obesity leads to different diet-related non-communicable disease (NCDs) like certain types of cancers, type 2 diabetes, hypertension, and diseases related to the cardiovascular system and arteriosclerosis[19-22].Obesity is also found to be associated with micronutrients deficiencies like zinc, iron and vitamins A, C, D and E[23-24].

It is now being observed that both under and over nutrition coexists among the populations of the developing countries and India is also not an exception. This is termed as a “Double Burden of Malnutrition” and is observed to occur comparatively at all levels, be it household, national and community levels[25-26].Studies have also reported that obesity is more prevalent among urban children while under-nutrition is more in children from rural and slum areas [27].

Adolescence is a time when the physiological need for nutrients increases and thus the consumption of a diet of high nutritional quantity is particularly important[28]. Studies

have revealed that a balanced & appropriate diet during childhood and adolescence likely to reduce the risk of both immediate and long-term health problems[29-32]. In India adolescent population comprise one fifth of total population and it has been reported that early detection of morbidity can help in prompt treatment and prevention of serious complication[33]. Because the prevalence of malnutrition in adolescent is considerably less than that in children, relatively few studies have been carried out on this topic with school-age population particularly in the context of a developing country[34]. However, studies focussing on Nutritional standards of school-age children and adolescents in India did not convey an impressive report. Various studies have indicated a high prevalence of underweight and stunted children in adolescent age group particularly from rural parts of India[35-38].

Agarwalet. al. (1992)[39] studied the physical growth pattern of affluent children from eight Indian states within the age group of 5 years age to 18 years age. Anthropometric analysis revealed that there is little variation in the mean height of the boys and girls from different zones of India. For boys the 50th percentile value varies from 128 cm to 170 cm from 9 to 17 years. Similarly, for the girls the 50th percentile value of height varies from 129 to 157 cm for 9 to 17 years. The mean weight ranged between 24.4 kg and 58.6 kg for boys between 9 to 17 years and for girls the weight ranged between 26.9 kg to 48.4 kg between 9 to 17 years.

Kapoor and Aneja[40] studied the nutritional profile and disorders of adolescent girls with in the age group of 11 to 18 years from a mixed socioeconomic group. Under nourishment in terms of low BMI was reported for higher percentage of girls from low socioeconomic group.

Thakur et. al.[41] recorded the height, weight and BMI of school going adolescent from Gujarat western India within the age group of 10 to 15 years. The study showed that the girls were having better nutritional status than boys in terms of BMI. At 10 years the mean height recorded for boys and girls were 133.7 and 132.2 respectively. Similarly, at 15 years respective heights for boys and girls were reported to be 153.6 cm and 150 cm. Weight of the boys varied between 25 kg to 36.2 kg between 10 to 15 years and for the girls the weight was 26.1 kg to 38.0 kg. For both sexes weight gain was more in a later age group. Similar trend was also found in BMI values.

It has been reported that for youth age 10 to 19 years in countries like Ethopia, Nigeria, Senegal, Bangladesh, Mayanmar, Cambodia and India have the lowest BMI.

While the lowest BMI for children ages 5 to 19 years is found in East Africa, the lowest mean BMI in adolescents is found in South Asia[12].

Venkaiahet. al (2002)[42] determine the diet and nutritional status of rural adolescents from different states of India within the age group of 10 to 18 years. The girl's height varied from 128 to 152 cm and weight from 23 to 43 kg. The height of the boys varied from 128 to 161 cm and weight between 23 to 46 kg. According to the study prevalence of stunting was reported between 35 to 60% in boys whereas higher prevalence of stunting (more than 50%) among 16 and 17 years. For the girls the prevalence of stunting varied between 32 to 37% from 10 to 17 years. The study also showed that the prevalence of wasting in terms of BMI for age was more among the boys.

Das and Biswas (2005)[43] conducted a community based, cross-sectional study among adolescent girls aged 10 to 19 years from West Bengal. Stunting was more prevalent than thinness. For the lower age group 10 to 14 years prevalence of stunting was more (25.6%) as compared to the thinness (17.9%). Among the higher age groups (15 to 19 years) the prevalence of stunting was more (52.3%) as compared to thinnest (10.8%). The overall prevalence of stunting was 37.8% and thinness was found to be statistically significantly associated with literacy level of mother.

Medhiet. al. (2006)[37] assessed the growth and nutritional status of school age children's between 6 to 14 years from Assam. These subjects belong to lower socioeconomic groups and their anthropometric parameters were lower as compared to affluent Indian children and WHO standards. The mean height of both sexes at 9 years were about 125 cm and the height attained at 14 years for both sexes were about 147 cm. The mean weight for boys and girls at 9 years of was about 21 kg and at 14 years for both the sexes it was around 36 kg. The overall prevalence of stunting for the males and females were 52 and 56% respectively. The overall prevalence of thinness for the males and a female subject was found to be 52 and 57% respectively. The mean height of girls was higher at the ages 10,11 and 12 years than boys.

Bisaiet. al. (2008)[44] studied the nutritional status of tribal children of West Bengal is 1 to 14 years. For children's about five years of age the prevalence rate of stunting and wasting were found to be 21 and 17% respectively.

Chakraborti and Bharti (2008)[45] conducted a study to assess the nutritional status of tribal adolescents of Orissa, India aged 10 to 18 years. Adolescent growth spurts representing an increased rate of growth for different anthropometric measurements was obtained between14 to 15 years among boys and 12 to 13 years among girls. The parameters were also significantly lower than the WHO standard. Mean height for boys ranged between 129.7 and 159.2 between 10 to 18 years and mean weight between 24.2 to 47 kg. For the girls the mean height was ranged between 131.6 to 148.3 cm and weight between 26 to 41 kg. The prevalence of undernutrition was 54% among boys and 36% among girls and this difference appeared to be statistically significant. The highest percentage (%) of under nutrition was observed among 12-years-old boys (77.8%) and 11-years-old girls (60%).

Chowdhury S D et.al. (2008)[46] studied the prevalence of under nutrition among tribal children of West Bengal with in the age group of 5 to 12 years. The overall prevalence of stunting was obtained to be 14% for boys and 22% for girls. Wasting was 23% for boys and 36% for girls.

Dambhareet. al. (2010)[38] assessed nutritional status of school going adolescents in the age group of 10 year to 16 years from peri urban area off Wardha District Maharashtra, India. The overall prevalence of stunting was 72% among boys and 27% among girls. Stunting was also found to be higher in early adolescent group (67.5%) as compared to late adolescent group (32.5%).

Shivrama Krishna et. al. (2011)[47] conducted a cross-sectional study to assess the nutritional status of rural adolescent girls from South India within the age group of 10 to 19 years. The prevalence of wasting and stunting was found to be 54.8% and 32.2% respectively which decline with age.

Airi and Edwin (2011)[48] conducted a cross-sectional survey to assess the nutritional status of 11 to 15 years old adolescents from Himachal Pradesh, North India. The overall prevalence of stunting was found to be 14% and boys were more stunted as compared to girls. 22.6% of the subjects appeared to be underweight and again the boy's percentage of underweight (26%) were more than the girls (19%). Over nutrition was found among 40% of the subjects. More boys in the overweight category (22%) and more girls were found in obese category (10%).

Manna P K et.al. (2011)[49] investigated the physical growth and nutritional status of 5 to 12 years old children from low socioeconomic group from Northern part of West Bangal, India. From 9 to 12 years of age a significant difference in the both mean height and weight of boys and girls were observed and girls were found to be taller and heavier than boys. The mean height of the boys from 9 to 12 years varied between 122cm to 132cm and that for girls was between 124cm to 135 cm. Mean weight ranged from 23 to 27 kg for boys and 23 to 28 kg for girls within the age group of 9 to 12 years. However, for all age groups the height and weight were lower than ICMR standard. Moderate and severe stunting ranges between 3% at nine years to 46% at 12 years. The prevalence of stunting was significantly higher among boys (12%) as compared to girls (7%).

Maiti S et.al. (2011)[50] studied the growth and nutritional status of rural adolescent school girls within the age group of 10 to 14 years from Medinipur district of West Bengal. Height, weight were the principal perimeters assessed. The study revealed that the mean weight was 24.5 to 35.7 kg which was lower as compared to affluent Indian children and NCH standard. The mean height at 10 years was 130.5 cm which increased up to 145.5 cm at age 14 years. 23.6 to 32.6% of the girls in the age group of 10 to 14 years were found to be mildly stunted and 0.8 to 3.2% of the girls were found to be severely stunted.

SrivastvaA et. al. (2012)[51] examined the height, weight and nutritional status of the school aged urban slump children of Uttar Pradesh, India. The mean height and weight of boys and girls was lower than the international CDC standard in all the age groups. About 33% of the children appeared to be wasted; girls(37.4%) more than boys (31%). Overall prevalence of stunting was 20%; girls more (22%) than the boys (18%).

Longkumar T (2013)[52] studied the physical growth and nutritional status of Naga children aged 8 years to 15 years from North East India, Nagaland. The study revealed that girls were taller than boys till 13 years after which the boy's height increases. The mean height of boys ranged between 124.7 to 161.1 cm and 125.9 to 151.9 cm for girls. The weight varied between 24.1% to 48.8 kg for boys and 23.8 to 46.8 kg for girls with in the age group of 9 to 15 years. 34.3% of the boys and 25.9% of the girls were underweight with an overall prevalence of underweight 30% was observed. Prevalence of overweight subjects varied from 2% for boys and 2.5% for

girls. The distribution of underweight and overweight subjects across the gender appeared to be non-significant.

Patilet. al. (2013)[53] examine in the height, weight and BMI of adolescent subjects is 10 to 15 years. A progressive increase in mean height with age was observed among the boys with the maximum increase in height was found between 14 to 15 years. For the girls the progressive increase in the mean height was observed up to 13 years which indicated that the adolescent growth spurt was earlier in the girls. At the age of 11 years the mean height of the girls was significantly higher than the boys, after which the boys tend to be taller than the girls. The study revealed that adolescent growth continues for longer period in the boys. The mean height at 10 years for boys and girls were 146 and 142.2 cm respectively. At 15 years the boy's height was 168.4 cm and girl's height were 156.2 cm. The weight among the boys from 10 to 15 years ranged between 31.8 and 52.2 kg and for the girls the mean body weight was 34.4 kg at 10 years and 44 kg at 15 years. For both the sexes the height and weight showed an increasing trend with age.

Singh JP et. al. (2014)[54]conducted a cross-sectional study among a rural adolescence of 10 to 19 years of age in Uttar Pradesh, India. Nutritional status was assessed from height for age and BMI for age. Overall prevalence of stunting and thinness were found to be 19.5% and 26.7% respectively. Thinness was more prevalent among golf (53.3%) as compared to boys (46.7%). While stunting was almost 50% among both the sexes. Stunting was more prevalent among mid- adolescent group (46.3%) and thinness was more prevalent in early adolescent group (37%).

Shivprakash and Joseph (2014)[55] assessed the nutritional status of rural school going South Indian children within the age group of 6 to 12 years. The overall prevalence of stunting was 27.9% and this was more in boys as compared to girls (29.1% versus 26.5%). For both sexes stunting was more in the age group of 11 to 12 years.

Shashank and Chetan (2016)[56] conducted a cross-sectional study among south Indian children between the age group of 6 to 12 years. In the age group of 9 to 10, 10 to 11, and 11 to 12 years the prevalence of stunting was reported to be 18.5%, 14.8%, and 16% among the boys and 20%, 14.6% and 17% among the girls.

Katoch and Sharma (2016)[57] studied the nutritional status of school going children aged 5 -14 years from Jammu and Kashmir, North India. 36% of the children were

stunted, 9% were underweight, and 2% were wasted. Stunting was prevalent among female children and wasting was prevalent among male children.

Chandrashekharappa (2018)[58] evaluated the nutritional state of adolescent girls aged 16 - 19 years from Karnataka, South India. Prevalence of malnutrition based on BMI was minimum (18%) among the 18-years-old girls and maximum among 16-years-old (35%).

Pal et.al. (2017)[59] investigated the prevalence of malnutrition among 10 - 17 years old adolescents and evaluated its association with socio-demographic factors. The height of boys varied between 128.3 cm to 158.6 cm and for the girls the height ranged between 130 cm to 143 cm. From 10 to 12 years girls were taller than the boys after which from 13 year onwards the height of boys was increases. Maximum rate of growth for girls observed between 11 to 12, 12 to 13 and 14 to 15 years. Weight of the boys varied from 23.6 kg to 47.2 kg where as for the girls the weight ranged from 25.5 kg to 41.3 kg. From 10 - 12 years girls were heavier than the boys. However, from 14 year onwards the weight of boys increases. Stunting was most prevalent among 17-year-old adolescents (63.6%) and raised from 32.3% at 10 years to 63.6% at 17 years. An increased prevalence of stunting was observed among the subject with the increase in age. Age-wise prevalence of thinness was maximum in 10 and 12 years (57%) and minimum at 17 years (39%) which indicated that thinness was more in early adolescent as compared to the late adolescent group.

Sharma et.al. (2017)[60] evaluated the nutritional standard of school children age 6 - 15 years in rural area of Moradabad, India. Almost 10% of the subjects were moderately malnourished, 2% were severely malnourished and 4% were overweight and less than 1% were obese. Girls were more overweight as compared to the boys and boys were comparatively more malnourished than the girls. However, the difference did not appear to be statistically significant.

Ahmed et. al. (2018)[61] studied the double burden of malnutrition among school-going adolescent girls (10 to 19 years) in North India. Underweight was found more among the early adolescent group and the proportion of underweight, overweight and obese girls were 47%, 6%, and 3% respectively.

Rani D et.al. (2018)[62] studied the nutritional status of adolescent girls age 13 - 19 years from urban slum of Varanasi, India. 60% were undernourished and 4% were overweight. Under nutrition was maximum among the age group of 13 to 14 years.

Kumar et.al. (2020)[63] studied the growth pattern of school going children of Jharkhand, eastern India within the age group of 6 - 14 years. The height for boys from 9 - 14 years varied between 127.7 cm to 146.7 cm and for girls also 127.7cm to 146.7 cm. The median weight of the boys from 9 to 10 years varied between 22 kg to 33.9 kg and for the girls 24.2 kg to 33.8 kg.

Dorjee et.al. (2020)[64]accessed the nutritional profile of children and adolescent boys and girls of age between 2 - 18 years belonging to Limboo community of Sikim, North India. Mean Z-score for height for age, BMI for age were obtained to be -1.75 and -0.16 indicating that the most of the children were within the normal category.

Kumar et. al. (2021)[65] utilizing the data from 2016 Udaya project conducted by Population Council under the guidance of Ministry of Health and Family Welfare from Uttar Pradesh and Bihar to assess the nutritional standard of adolescent boys and girls aged 10 to 19 years. The result showed that thinness was more prevalent among adolescent boys (25.8%) as compared to girls (13%) whereas stunting was more prevalent among girls (39%) as compared to boys (25.6%). Coexistence of stunting and thinness was also more among the boys (9.7%) as compared to girls (6%). Thinness was more in early adolescent group (10 to 14 years) while stunting was more prevalent in the late adolescent group and this trend was observed for both the sexes.

2.2 DIETARY PATTERN AND MALNUTRITION

Diet is an important component of nutrition and as well as a major determinant of nutritional status. Dietary patterns are influenced by food related beliefs, food preferences and availability of healthy foods. Adverse changes in dietary intake can cause different form of malnutrition which can affect systemic health as reported in various studies.[66-68].

The diet adequacy can be expressed in terms of quality and quantity. The protein quality of a diet often serves as an indicator of overall diet quality and expressed in terms of protein energy ratio. Inadequate diet has been considered as a major reason for high level of malnutrition.

Malnutrition is strongly related to nutrient intake. Issues related to nutrient intake that results in malnutrition, include inadequate consumption of healthy foods, unhealthy food habits, and non-availability of daily foods. In the last few decades, the global food habits have changed dramatically. A transition from healthy to junk food is observed across global populations and it is increasing at alarming rate. Unhealthy junk food consumption patterns result in micronutrient deficiency and lowers body's capacity to fight with various infections and diseases. This shift in food patterns results in malnutrition including both under and over nutrition.

School children are a vulnerable group deserving attention for improve their health and nutritional status for active performance, learning and achievement. This requires sufficient energy and nutrient intake from a balanced diet. In accordance healthy food and snacks should be provided for optimal growth and the acquisition of early healthy diet habits[69].

2.3 FOOD INTAKE PATTERNS

Food intake patterns are studied in terms of their adequacies and pervasive nature. Pervasive intake pattern may include excess consumption of energy dense and nutrient scarce fast foods and inadequacies indicates fewer servings per day less than the recommended levels.

In many situations, particularly, in developing countries it is not always possible to provide balanced and adequate food for various economic and geographical constraints. It has been reported that food quantity and quality consumed by children in these situations are often inadequate with a lower than desirable intakes of fruits vegetables, dairy products and whole grains, required for proper growth and good health (Results from National school health and nutrition programme baseline survey in Malawi). REF[70 – 74].

Studies conducted in western developed countries reported that food intake of adolescents do not meet dietary guidelines[75-77].Globally there is a trend of consumption of energy dense nutrient poor foods along with less consumption of fruits and vegetables by the adolescents[76,78].

In addition to the pervasive pattern of food consumption, adolescents also have unhealthy eating habits like skipping breakfast and other meals and snacking on fast foods which has been reported by another studies[79-80].

In Indian context, studies have reported not only nutritional deficiencies among urban adolescents[81], but also, excessive fast-food consumption which was found to be associated with obesity[82]. The over consumption of energy dense foods are often coupled with under consumption of vegetables and pulses[83].

It is now established that low-quality diets are the single biggest risk factor for the global burden of the disease[84]. Thus, consumption of healthy diet is presently a globally accepted scientific census[85]. A healthy diet must have adequate quantities and proportions of fruits, vegetables, legumes, nuts and whole grains[86]. According to the guidelines given by world health organization intake of free sugars must be limited along with limited intake of salt, saturated fat and elimination of trans fats of all kinds. [87-88]. Restrictions has also been imposed on consumption of sugar containing beverages[89] as it has been associated with increased body weight.

Sidiga A et al 2010[69]reported that poor diet quality and food habits are related to impaired nutritional status in 13-18 years-old adolescents in Jeddaah leading to over-weight and obesity among Saudi Arabian Adolescents.

Matthys et.al.(2006)[90]conducted a study on breakfast consumption pattern of Belgium adolescents aged 13 to 18 years. The study revealed that overweight girls were eating a low-quality breakfast. It was also obtained from the study that consuming a good quality breakfast provided all micronutrients. The study concluded that adolescents who consumes a good quality breakfast had better overall dietary pattern.

Food poverty is a factor which directly affect the food consumption pattern. Food poverty is found among the lower socioeconomic class status. Molcho M. et. al. (2006)[91] conducted a study to investigate the association between food intake and food poverty among Irish school children. The study revealed that experience of food poverty was associated with the less consumption of fruits, vegetables among the girls and more savoury snacking pattern among the boys, both of which were indicative of a poor diet. Both girls and boys reporting food poverty were more likely to miss breakfast on big days.

Lien L (2007)[92] conducted a study to examine the relationship between regular breakfast consumption and mental distress and academic performance among the Norwegian high school children. This study reported that breakfast skipping practice is common among 10th grade students. And the girls were skipping breakfast more

often than the boys. Breakfast skipping has more pronounced effect on mental distress and academic performance on boys as compared to girls.

In an attempt to investigate the nature of dietary intake and its association with health outcomes McNaughton, S.A., et.al. (2008)[93] conducted a study on Australian adolescents. The study revealed three main dietary patterns among the studied population. The fruit, salad, cereals diet pattern was mainly followed in rural region of residence. High fat and sugar containing diet were more consumed by the male subjects, and fish pattern was inversely associated with age. More consumption of fruits and vegetables were inversely associated with diastolic blood pressure and this association was found to be statistically significant.

Gretchen et. al. (2009)[94] conducted a longitudinal study over five years to identify the dietary intake pattern among the adolescent population of Minosta. The study revealed that dietary pattern in adolescents differ from adults and the emergence of fast food diet pattern among middle adolescent boys.

Storeyet. al.2009)[95]conducted a study on Canadian adolescents to examine the nutrient intake with meal related behaviours. The study revealed that higher frequencies of suboptimal meal behaviours like skipping meals and breakfast and consuming meals away from home resulted in poor diet quality.

Christine et.al. (2009)[96] in a study conducted among school children of Colombia found that overweight among the children had a positive correlation with snacking dietary pattern which was statistically significant. Overweight was also found to be associated with higher socio-economic status and maternal obesity.

Macferlane et.at. 2009)[97] conducted a cross-sectional prospective study over 3 years to examine the association of body weight and BMI with family food environment. Different aspects of family food environment were considered which include breakfast eating patterns, food consumption while watching television, provision of energy dense foods by parents and consumption of energy dense food at home and away from home by the children. It was obtained that more frequent dinner consumption while watching television was associated with higher BMI Z- score and less frequent breakfast consumption and more frequent fast-food consumption at home were associated with higher odds of overweight longitudinally and cross-sectionally respectively.

Priya et.al. 2010)[98]conducted a study among nationally representative sample of US children/adolescents to examine the relationship between breakfast skipping and type of breakfast consume with the nutrient intake, nutrient adequacy and anthropometric indicators of physical growth. Subjects were divided into 3 groups based on breakfast related patterns; breakfast skippers, ready-to-eat cereal consumers and other breakfast consumer. Obesity was more prevalent among breakfast skippers. Ready-to-eat cereal consumers had lower intake so fat and cholesterol, and higher intakes of carbohydrates, dietary fibres and several micro nutrients as compared to the other two groups. The overall nutrient intake profile and adiposity indexes were better in ready-to-eat cereal consumers.

(Richter A et.al. 2012)[99] in a study identified the dietary patterns and three associations with the nutrient intake and lifestyle factors. The study identified 3 dietary patterns namely the western pattern, the healthy pattern, and the traditional pattern. The study showed that higher consumption of take away food, meat, confectionery and soft drinks were associated with higher energy density in which higher percentage of energy were derived from unsaturated fatty acids. These dietary patterns were also associated with low carbohydrate and lower densities of several vitamins and minerals. This traditional and western pattern of diet statistically resulted with lower age, lower socioeconomic status and more television watching hours among the girls and higher age groups particularly 16 to 17 years old among the boys. The dietary patterns were not found to be statistically significant corelated with the overweight.

Alvira et.al. (2012)[100] assessed the relationship between parental education and consumption frequency of obesity-related foods in European children. Low and medium parental education level group of children had lower frequency of eating, low sugar, and low-fat foods that comprised of vegetables, fruits, rice and whole meal bread. This study reported that intakes of vegetables, fruits, rice and water increased with increased parental education level; while the intakes of savoury snacks, fried meat and fish, fast food and sweetened beverages increased with decreasing education level.

Lippevellde et.al. (2013)[101] investigated the association of family- related factors with children's breakfast consumption and BMI. The study was conducted in 8 European countries. 11 family factors related to breakfast were considered in the study. These

include automaticity, availability, attention allowing to skip breakfast, negotiation, health belief communications, praising, eating breakfast together and parental self-efficacy. The study concluded that some family factors were significantly associated with children breakfast consumption and shaping children breakfast behaviour.

Evans et.al. (2014)[102]conducted a study on American school children aged 9 - 15 years to examine the relationships between eating frequency, meal frequency and snacking frequency with the total energy intake and diet quality. The study reported meal and snack frequencies were statistically significantly and positively associated with total energy intake, and the diet quality deferred by age category. The study also reported that snacking is associated with the better diet quality in elementary school-age children and lower diet quality in adolescents.

Laska et.al. (2014)[103] conducted a survey to examine the association between meal routines and meal practices among American college students. It was concluded that the meal timing and the contextual characteristics of eating like regularity, meal preparation at home, eating on the run, using media while eating, purchasing food on the campus influence, the choice of food and the quality of dietary pattern. Meal regularity and a meal preparation at home were associated with healthy dietary pattern.

Alviraet.al.(2015)[104]studied the prospective associations between socioeconomic status and dietary pattern in European children's over 3 food clusters; snacks and fast food, sweet food and sweetened beverages and fruits, vegetables and whole meal. Children with a higher educated parent and higher household income relied on healthy food cluster overtime while the migrants and children from lower Socio's-economic status had persistent unhealthy dietary profile.

Alshmmariet. al. (2017)[105]studied the growth profile and its association with a nutrient intake of Saudi children aged 2 -18 years. The study reported that both stunting and overweight/obesity groups had statistically significantly lower male intakes for critical micro nutrients as compared to normal children.

The WHO European childhood obesity service surveillance (COSI) was conducted among a large population of European children from 23 Countries with an aim to describe their diets and frequency of consumption of different categories of foods. The study revealed that regular breakfast habit was observed for most children

(78.5%) and fewer than half (42.5%) consumed fruits about (22.6%) consumed fresh vegetables and one in ten (10%) consumed sweet snacks and soft drinks[106]

A cross- sectional study conducted on adolescents between 16 and 19 years in Kilimanjaro region of Tanzania reported the coexistence of under nutrition and over nutrition among the studied group. Boys had a significantly higher intake of protein and carbohydrates while girls had a significantly higher intake of fats, which could be related with their physical growth status. The groups reported to assess more snack food outside the school area. There was also a difference in portion size consumed between a male and female[107].

A study conducted on Egyptian children on their dietary pattern, growth and nutritional status revealed that most boys and girls had three or less than three meals per day and 64% were regularly eating breakfast. The study found no association between lifestyle practices and stunting. The prevalence of underweight and stunting was higher among boys while girls tend to be overweight and obese. Statistically significant factors which contributed for overweight/obese were being more than three meals per day, eating while screening, irregular breakfast pattern and not taking vegetables[108].

Goel S. et. al. (2013)[109] conducted a study on adolescent girls of north India to examine the relationship between dietary pattern and overweight/obesity. The data revealed highly significant and positive relation between the consumption of fried foods and weight and BMI. It was obtained that most of the adolescent girls were skipping meals 60% and prefer savoury and sweet snacks and fast food (almost 90%). Hence, they were consuming excess of energy, protein and fat. The daily diet was also found to be containing inadequate amount of micro nutrients.

Kotechaet. al. (2013)[110] studied the food habits, food preferences and dietary pattern of school going urban adolescents of western India. Regular home prepared food was consumed by 80% of the adolescents. Nearly 60% of the subjects had their breakfast daily. Nearly 50% of the subjects were reported consumption of chocolate, candies and other fast-food items.

Soni and Katoch (2014)[111] conducted a study on dietary adequacy of school going children of Kangra and Kullu district of Himachal Pradesh. Most of the subjects were non-vegetarian. Intake of healthy food groups like cereals, pulses, green leafy

vegetables, milk and milk products was lower than the daily recommended level. While intake of fat was significantly higher among all the subjects. Intake of protein and other vitamins were also found to be lower than the recommended daily allowances.

Omidver and Bagum (2014)[112] assessed the food habits of south Indian urban adolescent girls to explore the relationship between the socio-economic status, food preference and dietary behaviour of different age groups. Data on adolescents showed that majority of them were underweight and skip meals. Higher percentage of underweight subjects was obtained in the lower socio-economic status and high proportions of overweight girls belonged to high socio-economic status. 68.7% girls were reported to consume fast foods on a regular basis. Daily consumption of fast food was higher among the girls from low socio-economic group.

Shafiee et.al. (2015)[113] investigated the mean intake of nutrient by adolescent boys from an urban population of South India aged 10 - 19 years and compared the intakes with RDA values recommended by ICMR. The study also investigated the food intake pattern in relation to social class. The study found inadequate levels of protein, calories, iron, calcium and beta-carotene level for all the subjects in relation to RDA. Highest quantities of proteins were consumed by obese boys followed by the normal boys and lowest among the wasted, stunted and stunted /wasted group. The intake of different nutrients by the children from nuclear and extended families were higher than those in joint families. The authors opined that because of smaller number of children in families each child gets importance or attention from parents which might have accounted for higher intake of proteins and calories among these groups.

Das et.al. (2016)[114] studied the dietary pattern and intake of nutrients and vitamins by adolescents in Himachal Pradesh in the age group of 11 - 19 years. Preference for home cooked meal and three meals a day was reported by majority of the subjects. Majority of the girls were vegetarian and majority of boys were non-vegetarian. A statistically significant difference in the mean intake of essential nutrients was observed across gender and intake on most of the nutrients by both the sexes were below the recommended dietary allowances level as suggested by ICMR.

Rathi N et. al. (2017)[83] reported the food consumption patterns in a sample of urban adolescents aged 14 - 16 years from eastern India Kolkata. The dietary intake of adolescents appeared to be poor in quality with 30% reported no consumption of

vegetables, 45% of the respondents did not consume any fruit. Consumption of energy dense snacks 3 to 4 times was reported by 70% of the subjects and nearly half of the subjects (47%) reported drinking three or more servings of energy dense beverages. Girls had more nutritious dietary intake than boys.

Mukherjee and Chaturvedi (2017)[115] conducted a study on dietary pattern and food preference of school children aged 5 to 11 years from Pune India. The study reported that snacks processed foods and fast foods were mostly preferred foods by the children. The most preferred food include snacks and fast food, sweets and non-vegetarian food. While milk, green leafy vegetables were the least preferred food items.

Gupta et.al.(2018)[116] studied the pattern of fast-food consumption by school aged children in rural Himachal Pradesh, India. The study reported that majority of the children 78% consumed at least one junk food items in the last 24 hours and 22% of the children consume two or more junk food items in the last 24 hours of the survey. Savoury snacks like chips were the most preferred junk food item followed by chocolate, bakery products and soft drinks. The contribution of this junk food to the total amount of fat contained in diet varied from 9 to 20%.

Kumar and Mishra (2019)[117] studied the nutritional status and dietary pattern of adolescent girls from urban slums of Agra North India. Although most of the respondent were found to be vegetarian, the dietary pattern indicated poor consumption of milk, fruits and leafy vegetables.

Singh et. al. (2021)[118]conducted a cross-sectional study among adolescent girls from urban slums of Varanasi district of Uttar Pradesh, India. Anthropometric profile, sociodemographic and socio-economic variables and dietary behaviour were studied. Half of the teenage girls were under-weight which was statistically significantly related with the lower educational standard of father. Being underweight was also related with increase in the number of family members. The study reported that less intake of pulses, green leafy vegetables and other vegetables few times a week is associated with being underweight.

From these previous findings it appeared that dietary inadequacies with more inclination to fast -food consumption is prevalent among most of the children and adolescent population of India.

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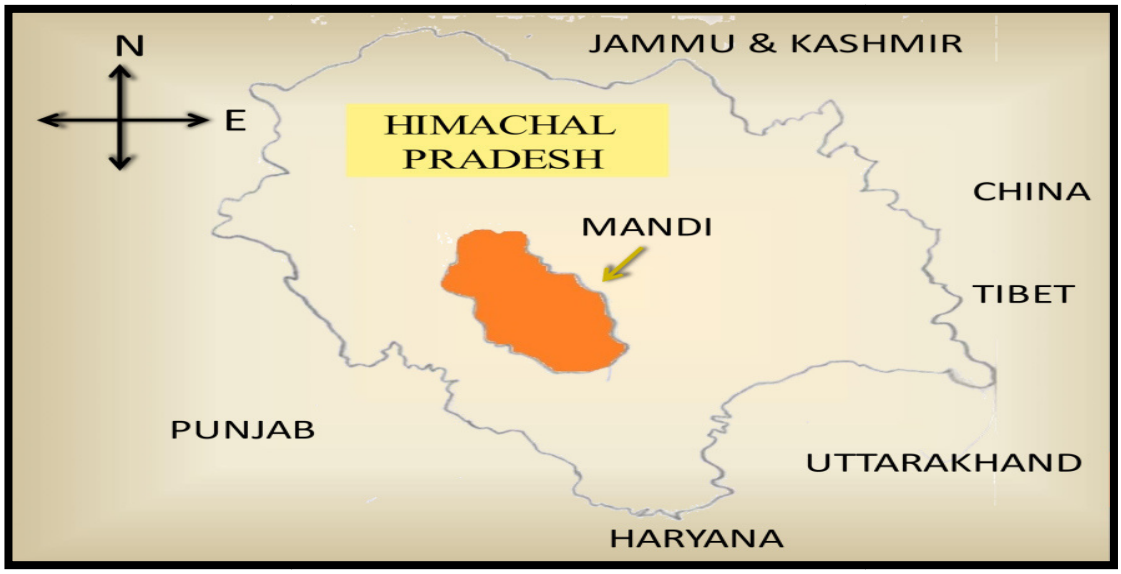
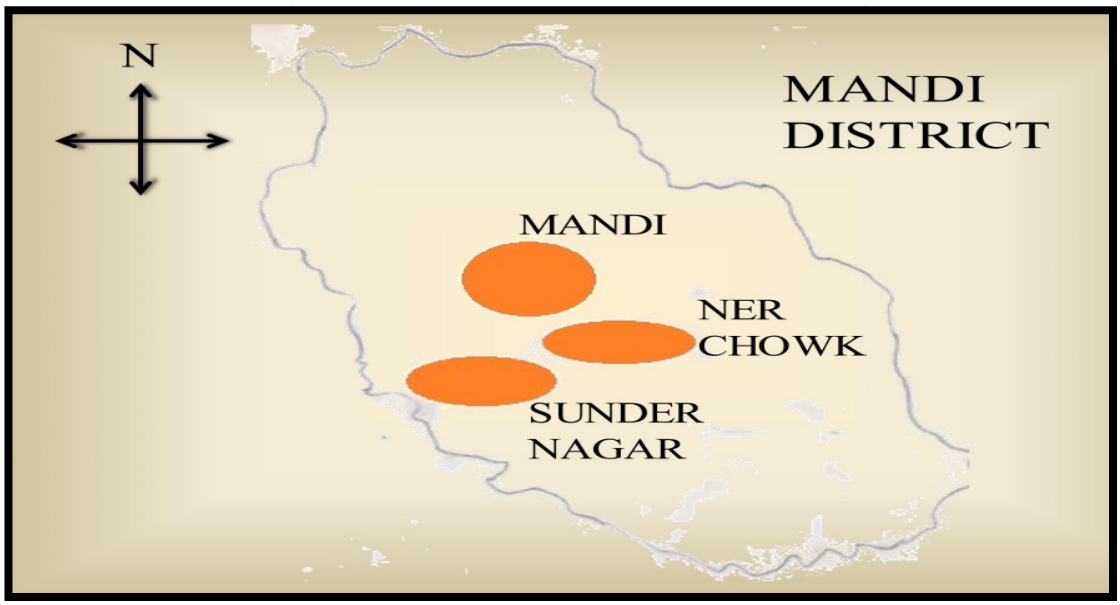
CHAPTER – III

MATERIALS AND METHODS

3.1 PLACE OF STUDY

This study was conducted in the Mandi district of Himachal Pradesh (HP). To avail the logistic advantage, a wider range of geographical locations including hilly regions of the districts were excludedand only the non-hilly zones and valley regions of the districts were selected. This includes three subdivisions of the Mandi district; MandiSadar, Balh, and Sundernagar. These zones cover urban, peri-urban, and as well as rural areas.





3.2 STUDY DESIGN

A cross-sectional survey design was adopted in the present study.

3.3 SUBJECT SELECTION

To avail subjects from all socio-economic strata, both private and government schools were selected. A multistage sampling approach was adopted in the present study. This

was followed by a stratified sampling procedure. The government and private schools were treated as independent sampling domains. The government and private school network lists in MandiSadar, Balh, and Sundernagar subdivisions of Mandi district were obtained from the school list of the Himachal Pradesh Board of School Education. The total number of government and private schools in these regions were found to be 7 and 16 respectively.

Within each school category domain, a multistage systemic design technique was adopted. 3 government schools (42.8%) and 6 private (37.5%) schools were selected. The students of two categories of school, studying in class seven to twelve standards within the age group of 10-17 years served as the sampling frame and each class was considered as a stratum. Next, random sampling was conducted from each class (stratum) as a part of the stratified sampling technique.

This approach of subject selection not only helps to control the district-wise variations. Furthermore, restricting the subject selection from non-hilly zones also allowed to control of the effects of lifestyle and food patterns of the subjects which vary greatly between the hilly and non-hilly regions. Moreover, selecting both government and private schools was based on the fact that it will allow comparing subjects across different socio-economic criteria as mentioned earlier.

3.3.1 INCLUSION CRITERIA

All the children with in the age group of 10-17 years who consented to participate in the study as per the design of the experiment were included.

3.3.2 EXCLUSION CRITERIA

The children suffering from any type of chronic disease or those who reported any illness during the last one month before the study date were excluded from the study.

3.4 SAMPLE SIZE CALCULATION

The study aimed to estimate the prevalence of malnutritional conditions in the target population. For a more conservative approach, a 50 % prevalence rate was selected for different categories of malnutrition; viz, stunting, thinness, and overweight. The following formula was used for calculating the adequate sample size for a prevalence study[1].

$n=Z^2P(1-P) / d^2$

Where n is the sample size, Z is the statistic corresponding to the level of confidence, P is expected prevalence, and d is precision (corresponding to effect size).

In the present study, the sample size was estimated from the following values:

z- The Z score at 95% confidence interval = 1.96

p - the assumed prevalence = 50 %

1- p = 50 %

d = precision level or margin of error = 5%

$$n = (1.96*1.96*0.5*0.5) \text{ X } 100$$

$$(0.5*0.5) = 385$$

However, presuming an attrition rate of 20%, the number of students that this study will coverwill be approximately 385 + (20 % of 385) = 385 + 77 = 462. The minimum number was rounded to 470. The final sampling frame consists of a total of 940 subjects.Considering this number individually for boys and girls, the final sampling frame consists of a total of (470 ×2)= 940 subjects, which was considered as the minimum number of subjects required for the study. Furthermore,to allocate equal proportion of students for each age groups from 10 – 17 years, a minimum of 58 children were required for each age group category.

3.5 ETHICAL APPROVAL

The ethical approval for this survey was obtained from the Institutional Ethics Committee (IEC) of Himachal Dental College, Sundernagar, District Mandi, Himachal Pradesh, IEC number 2017-24, dated:19.12.2017.

3.6 CONSENT FOR THE STUDY

Before the study, detailed explanations were given to the students about the purpose of the study and the extent of their involvement in presence of the respective class teachers. The same was also conveyed to their parents through the class teachers. The students were also informed about the informed consent letter. The parents of the subjects and the class teachers provided informed consent. Consents were obtained for the participation in anthropometric measurements, interviews, and discussions through questionnaires as required by the design and protocol of the study. Questionnaires were presented both in English and Hindi. Translations of the questions were done by an expert..

3.7 PHYSICAL MEASUREMENT

3.7.1 DETERMINATION OF AGE

The Date of Birth (DOB) was obtained from the school register which is based on the birth certificate presented at the time of admission. From this DOB, the exact age at the time of examination was obtained, using the survey date (vide questionnaire survey section) as reference and expressed as year, month and day. If the day was less than or equal to 15, the previous month was considered, and if the number of days was16 or more, the next month was considered to calculate the age in years and month. From the age, the participants were further grouped as early adolescents (10–14 years) and late adolescents (15–19 years).

3.7.2 DETERMINATION OF HEIGHT

Height was measured with an anthropometric rodwith shoes removed and head aligning in the Frankfurt plane. Readings were taken to the nearest 1 cm.

3.7.3 DETERMINATION OF WEIGHT

Weight was measured in kg by using a bathroom room-scale with minimum clothing and shoes removed to the nearest 500 grams.

3.7.4 DETERMINATION OF BMI

BMI was obtained as the weight in kg divided by the square of height in meter and expressed as $kg/m^{2.}$

3.8 ANTHROPOMETRIC ASSESSMENT OF NUTRITIONAL STATUS

Classification of nutritional status was made according to public health criteria recommended by a World Health Organization expert committee[2]. For analytic purposes, both undernutrition and overnutrition conditions were determined based on five outcome variables; 1) stunted 2) thin or wasted, 3) coexistence of both, or thin and stunted, 4) overweight, and 5) obese.

These conditions were assessed from the WHO recommended z-scores of two nutritional indices. The z-scores of the Height - for - age index were used to assess stunting while the z-scores of the BMI - for - age index were used to assess the other three categories, i.e., thinness, overweight, and obesity.

3.9 CALCULATION OF Z-SCORES

The HAZ-z score for an individual subject of the study population belonging to a particular age was calculated as:

(Measured height – Median height of the reference population of the same age) / SD of the ref population

For calculating the z-scores of BMIAZ, the Body Mass Index values of the study population were converted to exact z scores from the L, M, and S values of the reference charts of the corresponding age groups, using the following formula

- Z – score = ([BMI score of study population /M]^{L} – 1) / LS

Where L, M, and S are Box-Cox power, median, and coefficient of variation of the corresponding age of the reference population respectively[3].

3.9.1 CUT OFF VALUES OF Z-SCORES FOR DEFINING MALNUTRITION

Categories of malnutrition were defined according to the cut-off values of z scores presented in the WHO growth reference data for 5 – 19 years old adolescents[4-5].The following cut-offs for the Z-score of HAZ were used to define different categories of undernutrition as per HAZ:

Stunted = z-score < - 2SD to ≤ - 3SD,

Severely stunted = z-score < - 3SD

The following z scores cut-off values of BMIAZ were used to define the different conditions of under and overnutrition:

- Thin = z-score is < - 2SD to ≤ - 3SD,
- Severely thin= z-score = < - 3SD,
- Overweight = z-score > 1 SD
- Obese= z-score is > 2 SD

A subject was considered normal if the z-scores for both HAZ and BMIAZ were found to be > -2SD.

3.10 QUESTIONNAIRE SURVEY

A questionnaire was prepared to collect all necessary information as required by the study design. The primary questionnaire was initially prepared in the English language. Next, the questions were thoroughly checked and were translated into the local language (Hindi), and then back-translated into English to ensure translations were accurate. The initial question was pretested in a small sample of 64 male and female children within the age group of 10 – 17 years and necessary modifications were made as required according to their responses. The final questionnaire was again

translated into Hindi and back-translated once again into English to check the accuracy before administration.

The survey questionnaire comprised of the following sections;

1. **Reference Number** – The reference number is used to identify the schools, gender and serial number.
2. **Date and Place of the Survey** - This section includes the name, address, location and type of the school where the survey has been conducted and the date of survey. The date of survey was used to calculate the exact age in years and month according to DOB.
3. **Personal Information** – This section includes name of the student and contact details.
4. **Physical Parameters** – This section includes age, height, weight, BMI and Z score for stunting, thinnessand overweight, and nutritional status.
5. **Questionnaire on Dietary Pattern** – This section includes a standard food frequency questionnaire. The questionnaires were prepared to examine the self-reported intake frequency of seven categories of healthy and six categories of unhealthy food items consumed during the last two weeks before the study. Healthy or essential food groups included milk, fruit, dairy products, cooked vegetables, green leafy vegetables, salads, and pulses. Unhealthy food groups or junk food comprises savory snacks, fast foods, sweets, cake/pastry, candy/chocolates, soft drinks, and other type sweetened beverages.

The pattern of the questionnaire was adopted from the already validated questionnaire used for food frequency consumption[6-7]. The frequency of consumption of both healthy and unhealthy types of foods was obtained according to four response options; 1) daily, 2) most or ≥ 4days a week, 3) few or 1- 3 days per week, 4) never or once over 14 days. The responses were further dichotomised as high consumption (daily and most days a week), and low consumption (few days a week and never). Breakfast Pattern – Breakfast consumption pattern was assessed as regular intake (daily or 4 or more days a week), or irregular, i.e.≤ 3 days a week.

MEASUREMENT OF HEIGHT OF BOYS &GIRLS

MEASUREMENT OF BODY WEIGHT OF BOYS &GIRLS

EXPLAINING STUDENTS ABOUT THE STUDY IN FRONT OF CLASS TEACHERS

STUDENTS FILLING UP THE QUESTIONNAIRE FORM UNDER THE SUPERVISION OF THE RESEARCHER AND TEACHERS

3.11 STATISTICAL ANALYSIS

Descriptive statistics including measures of central tendencies (mean and median) and dispersion (standard deviations, standard errors, and 95% CI were used to describe continuous variables like height, weight and BMI, and z scores.

Student's t-test and one-way ANOVA were computed for mean comparison between two or more groups respectively. The level of significance was set at $p < 0.05$ level. Pearson's Chi-square test was used to compute the level of association between the different proportions, particularly to demonstrate the association of malnutrition categories with dietary patterns, according to the aims and objectives of the study. Statistical analysis was done using Microsoft excel (office 2019 version) and SPSS (version 16).

Statistical parameter such as mean, standard deviation, t- statistics and F- statistics are calculated as:

$$\textbf{Mean} = \frac{\text{Sum of all the observations}}{\text{Totol Number of observations}}$$

Standard deviation $$\sigma = \sqrt{\frac{\sum(x_i - \mu)^2}{N}}$$

$\boldsymbol{\sigma}$ = Standard deviation,

N = Size of Population,

$\boldsymbol{x_i}$= Each value from the population, and

μ = Population Mean

t - statistics $$t = \frac{\bar{x} - \mu_o}{S/\sqrt{n}}$$

$\bar{\boldsymbol{x}}$ = Sample Mean,

$\mu_{\boldsymbol{o}}$= Population,

S = Standard Deviation of the sample, and

n = Stands for the size of the sample

F - statistics F = Variance 1/variance 2

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CHAPTER – IV

RESULTS

4.1 SUBJECTS

Table 4.1 :Distribution of subjects

Variables	Age Group	Boys (N=718) N (%)	Girls (N=749) N (%)
Age	10 years	68 (9.5)	79 (10.5)
	11 years	75 (10.4)	106 (14.2)
	12 years	63 (8.8)	110 (14.7)
	13 years	112 (15.6)	90 (12)
	14 years	102 (14.2)	75 (10)
	15 years	131 (18.2)	89 (11.9)
	16 years	100 (13.9)	112 (15)
	17 years	67 (9.3)	88 (11.7)
Adolescent Stage	Early (10-14 years)	420 (58.5)	460 (61.4)
	Late (15-17 years)	298 (41.5)	289 (38.6)

The distribution of subjects is presented in the Table 4.1.Among a total of 1467 subjects,718 (48.9%) were boys and 749 (51.1%) were girls.A total of 420 (58.5%) of the boys and 460 (61.4%) of the girls belongs to early adolescent, and 298 (41.5%) of boys and 289 (38.6%) of the girls belongs to late adolescent group.

4.2 PHYSICAL CHARACTERISTICS OF THE SUBJECTS

4.2.1 HEIGHT OF THE SUBJECTS

Table 4.2 :Descriptive summary and comparison of height among boys and girls across different age groups.

Age (year)	Boys			Girls			Mean Dif.	t	p
	N	Mean	SD	N	Mean	SD			
10	68	136.8	5.78	79	139.4	6.45	-2.60	2.56	.012
11	75	140.9	6.08	106	142.1	7.79	-1.30	1.21	.229
12	63	146.6	7.33	110	148.1	7.53	-1.50	1.27	.205
13	112	156.4	9.14	90	153.4	5.93	3.00	2.69	.008
14	102	160.9	7.42	75	154.1	5.24	6.80	6.79	.000
15	131	167.2	7.01	89	155.4	5.28	11.8	13.5	.000
16	100	168.3	6.13	112	156.1	5.06	12.2	15.86	.000

Age (year)	Boys			Girls			Mean Dif.	t	p
	N	Mean	SD	N	Mean	SD			
17	67	168.8	5.84	88	156.6	5.48	12.2	13.3	.000
Total	718	155.7	13.28	749	150.7	8.76	6.90	11.7	.000
Early	420	148.3		460	147.4		0.9		
Late	298	168.1		289	156.0		12.1		

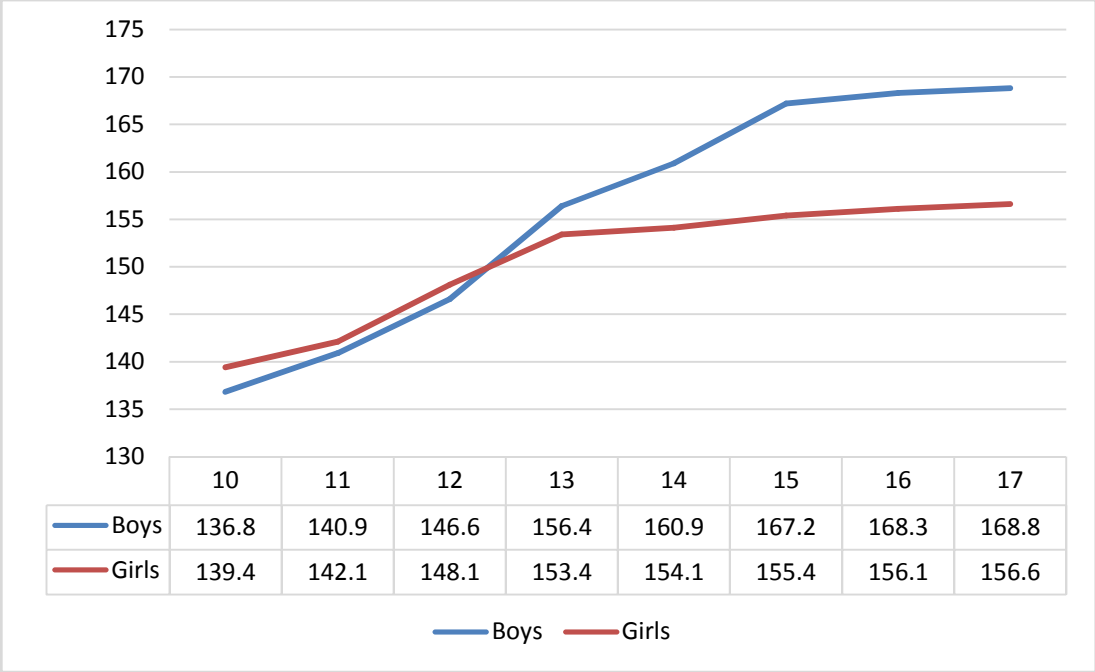
Descriptive summary of height of boys and girls at different age groups is presented in Table4.2. The mean height of the boys is 155.7 ± 13.3 cm and mean height of the girls is 150.7 ± 8.8 cm. The results showed a progressive increase in the mean height with age from 10 to 17 years for both the boys and girls. The height of the boys increased from 136.8 cm at 10 years to 168.8 cm at 17 years. Similarly, for the girlsheight increased from 139.4 cm at 10 years to 156.6 cm at 17 years.The total increase in mean height from 10-17 years for boys was 32 cm and 17.2 cm for the girls.

Major gain in height for the boys was 5.7 cm between 11 to 12 years, 9.8 cm between 12-13 years, 4.5 cm between 13 to 14 years and 6.3 cmbetween 14 to 15 years. From 15 to 17years the gain in height was negligible.

Major gain in height for the girls was 6 cm was between 11-12 years and 5.3 cm between 12 to 13 years. For other age groups the gain in height was negligible.

When the mean height of boys and girls at different age groups werecompared it was found that at 10 years, thegirls were 2.6 cm taller than the boys and this difference was statistically significant (p= .012). However, from 13 years onwards theboys become taller than girls and at each age group the difference in height between boys and girls were highly statistically significant.

Acomparative representation ofthe mean height of boys and girls at different age groupsis presented in Figure 4.1.



	10	11	12	13	14	15	16	17
Boys	136.8	140.9	146.6	156.4	160.9	167.2	168.3	168.8
Girls	139.4	142.1	148.1	153.4	154.1	155.4	156.1	156.6

Fig. 4.1 :Representation of mean height of boys (N= 718) and girls (N=749)

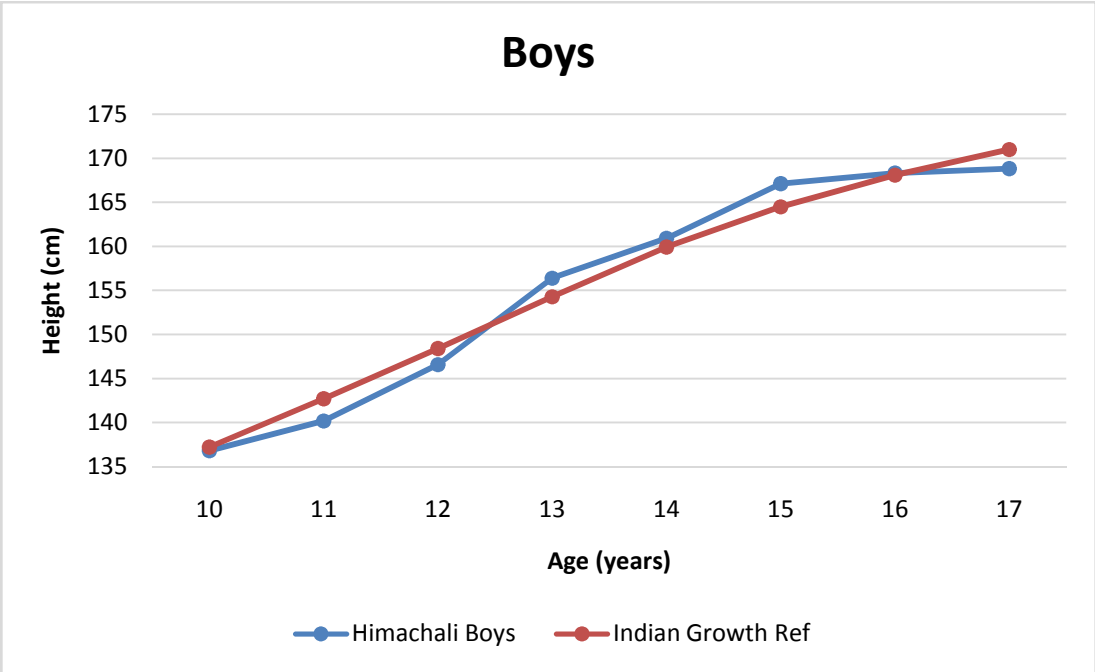


Fig.4.2 :Mean height of the boys at different age groups compared to the corresponding 50th percentile values of Indian growth standard

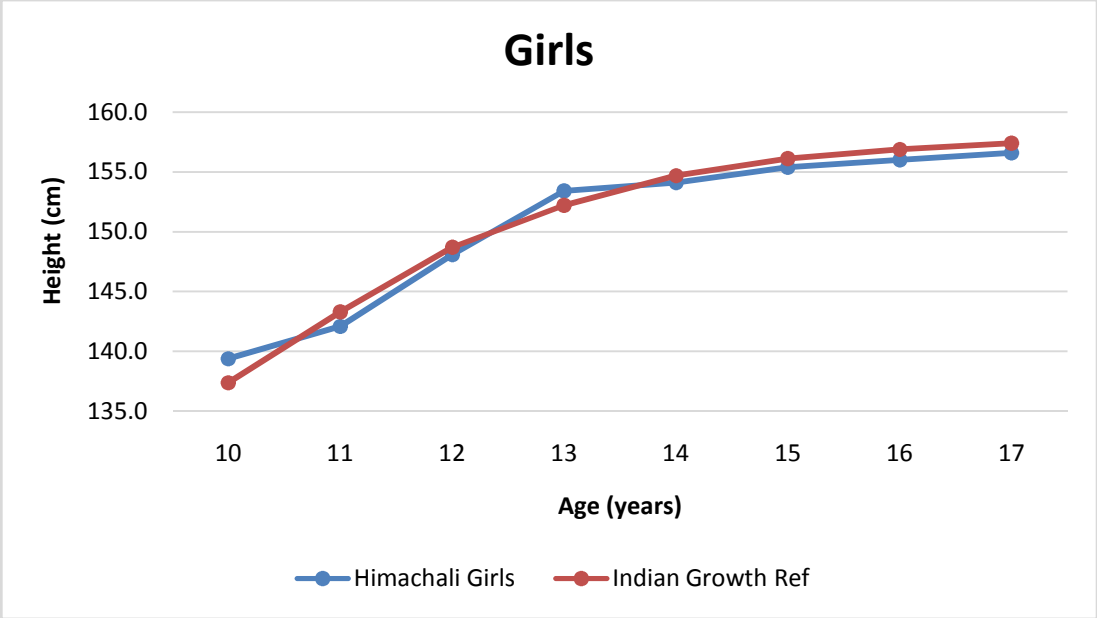


Fig.4.3 :Mean height of the girls at different age groups compared to the corresponding 50th percentile values of Indian growth standard

The mean height of Himachali boys and girls at 10 years of age was slightly lower and slightly higher than the 50th percentile of Indian growth reference standard respectively. At the age of 11 years and 12 years, the mean height of both sexes was lower than the 50th percentile. The mean height of the boys at 13 years to 15 years were higher than 50th percentile while the mean values of height for the girls at higher age groups (from 14 to 17 years) were lower than the 50th percentile. In summary, the mean height of the boys and girls differ differently when compared to the 50th percentile values of the Indian growth reference height of children[1]. (Figure 4.2 & Figure 4.3).

4.2.2 WEIGHT OF THE SUBJECTS

Table 4.3 :Descriptive summary and comparison of weight among boys and girls across different age group

Age (year)	Boys			Girls			Mean Dif.	t	p
	N	Mean	SD	N	Mean	SD			
10	68	28.8	5.52	79	29.3	4.85	-0.50	0.585	.560
11	75	32.4	6.85	106	32.2	6.51	0.20	0.199	.842
12	63	35.5	6.23	110	37.8	7.46	-2.30	2.068	.040
13	112	42.0	8.69	90	41.4	7.95	0.60	0.507	.613
14	102	46.8	8.01	75	43.5	7.39	3.30	2.80	.006

Age (year)	Boys			Girls			Mean Dif.	t	p
	N	Mean	SD	N	Mean	SD			
15	131	52.4	10.18	89	43.9	5.75	8.50	7.14	.000
16	100	53.6	8.78	112	46.2	8.65	7.4	6.17	.000
17	67	56.1	7.02	88	46.5	6.45	9.6	8.83	.000
Total	718	44.7	12.19	749	40.1	9.20	4.60	8.18	.000

Descriptive summary of weight of boys and girls at different age groups is presented in Table 4.3. The mean weight of the boys was 44.7 ± 12.2 kg and mean weight of the girls was40.1 ± 9.20 kg. The results showed a progressive increase in the mean weightwith age from 10 to 17 years for both the boys and girls. The weight of the boys increased from 28.8 kg at 10 years up to 56.1 kg at 17 years, resulting in a total gain of 27.3 kg. Similarly, for the girls, the weight increased from 29.3 kg at 10 years up to 46.5 kg at 17 years with a total gain of 17.2 kg.

Major gain in weight for the boys was 6.5kgfrom 12 to 13 years, 4.8 kg from 13 to 14 years and 5.6 kg between 14 to 15 years. Major gain in weight for the girls was 5.8 kg between 11-12 years and3.6 kg between 12 to 13 years.

Comparison of mean weight of boys and girls at different age groups showed that the 12 years old girls were 2.3 kg heavier as compared to the boys and this difference appeared to be statistically significant (p= .04).However, 14 to 17 years old boys were heavier and the differences of mean weight between boys and girls at these age groups appeared to be highly statistically significant.

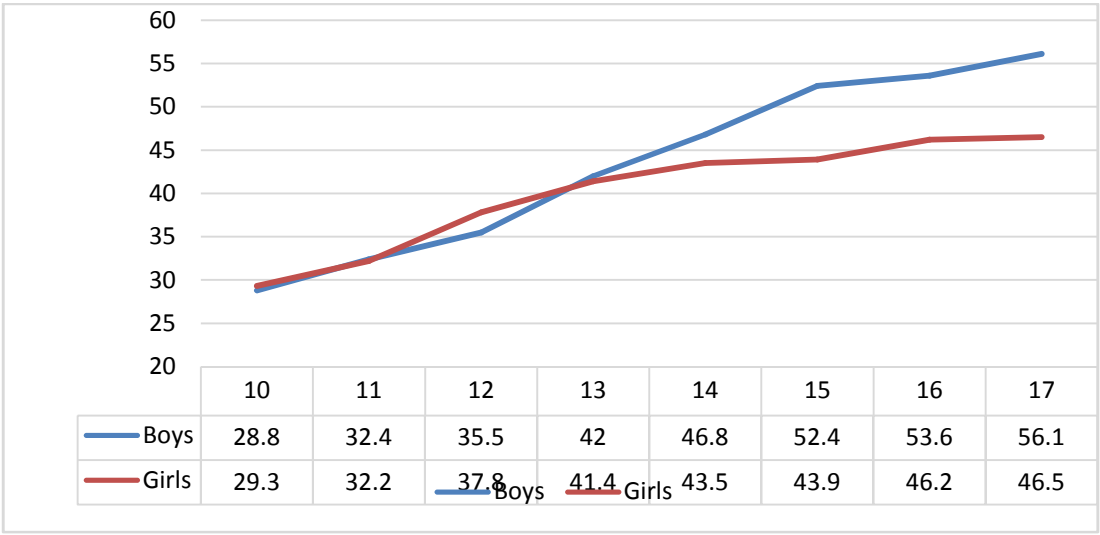


Fig. 4.4 :Representation of mean weight of boys (N= 718) and girls (N=749)

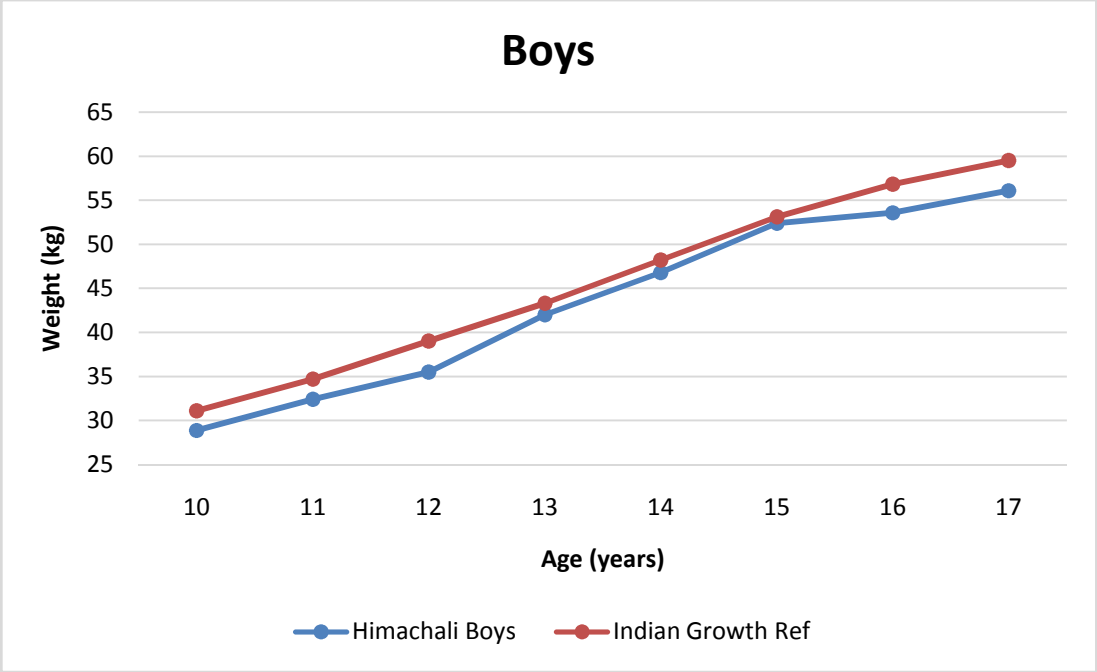


Fig. 4.5 :Mean weight of the boys at different age groups compared to the corresponding 50th percentile values of Indian growth standard

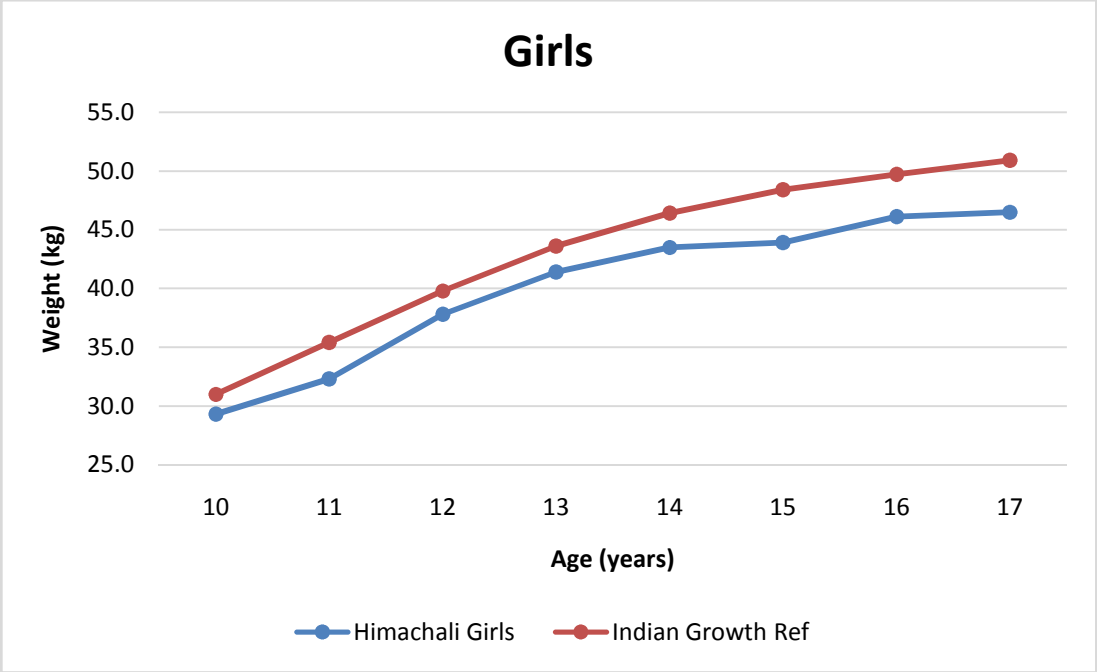


Fig. 4.6 :Mean weight of the girls at different age groups compared to the corresponding 50th percentile values of Indian growth standard

The mean weight of Himachali boys and girls at all age groups were lower than the 50th percentile of Indian growth reference standard. At 13, 14 and 15 years of age groups, the weight of the boys were just around the 50th percentile values. (Figure 4.5 & figure 4.6)

4.2.3 BODY MASS INDEX (BMI) OF THE SUBJECTS

Descriptive summary of the BMI of boys and girls at different age groups is presented in Table 4.4. The result showed that there is a progressive increase in the mean BMI with age for both boys and girls. The BMI of the boys increases from 15.3 at 10 years to 19.7 at 17 years. The BMI of the girlswas 14.9 at 10 years, which progressively increases to19.0 at 17 years.

No statistically significant differences in the BMI scores were observed between boys and girls across different age groups.

Table 4.4 :Descriptive summary and comparison of BMI among boys and girls across different age group

Age (year)	Boys			Girls			Mean Dif.	t	p
	N	Mean	SD	N	Mean	SD			
10	68	15.3	2.22	79	14.9	1.74	0.40	1.22	.22
11	75	16.3	2.68	106	15.9	2.45	0.40	1.041	.30
12	63	16.4	2.14	110	17.2	2.90	-0.80	1.911	.058
13	112	17.1	2.62	90	17.5	2.67	-0.40	1.07	.286
14	102	18.1	2.72	75	18.3	2.79	-0.20	0.476	.634
15	131	18.7	3.21	89	18.2	2.19	0.50	1.28	.202
16	100	18.9	2.70	112	18.9	3.37	0.00	0.00	1.00
17	67	19.7	1.95	88	19.0	2.36	0.70	1.97	.051
Total	718	17.7	2.94	749	17.5	2.94	0.20	1.30	.193

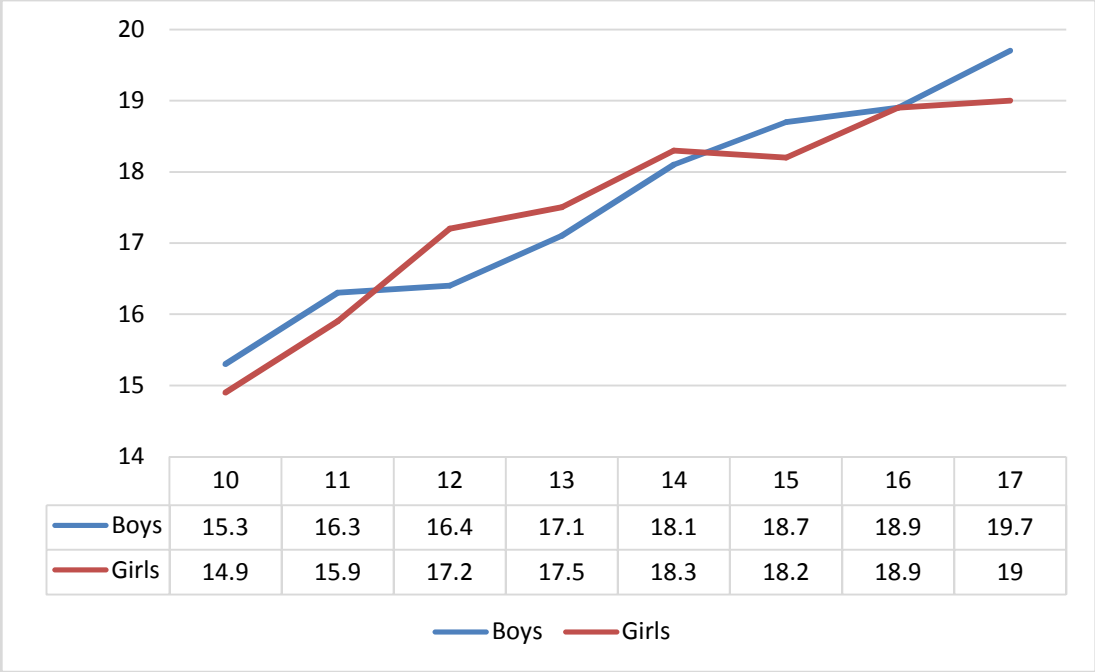


Fig. 4.7 :Representation of mean BMI of boys (N= 718) and girls (N=749)

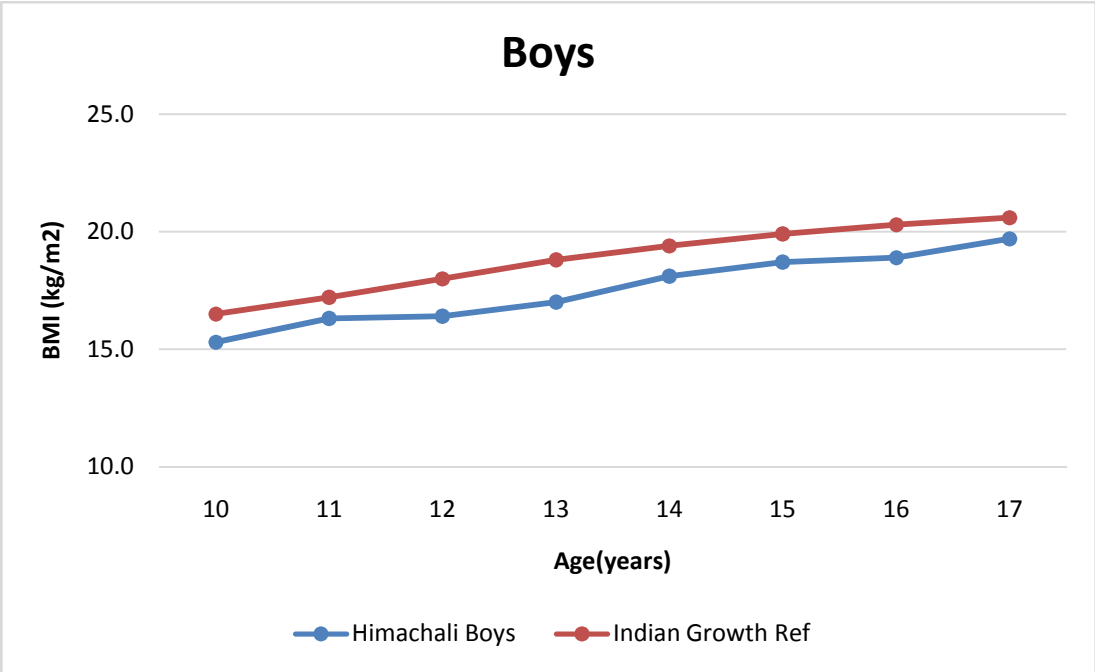


Fig. 4.8 :Mean BMI of the boys at different age groups compared to the corresponding 50th percentile values of Indian growth standard

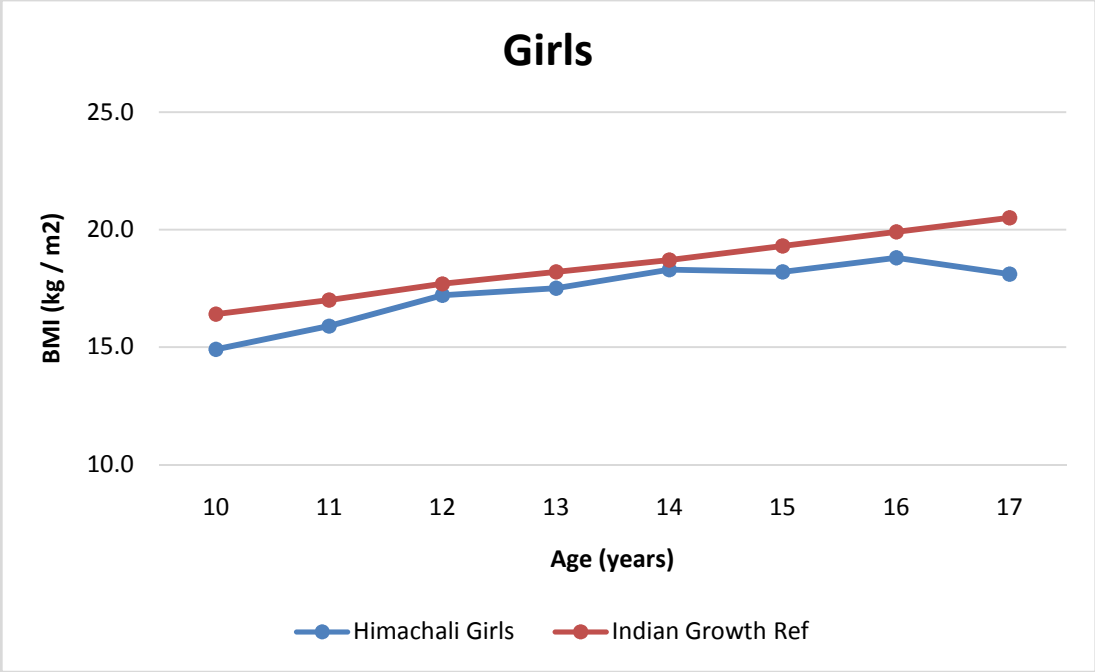


Fig. 4.9 :Mean BMI of the girls at different age groups compared to the corresponding 50th percentile values of Indian growth standard

Themean BMI of Himachali boys and girls at all age groups wereslightly lower than the corresponding 50th percentile values of Indian growth reference standard. (Figure 4.9 & Figure 4.9).

4.3 PREVALENCE OF MALNUTRITION

4.3.1 PREVALENCE OF STUNTING

Table 4.5 :Prevalence of stunting in boys and girls across different age groups. Values are presented as N (%)

Age Group (year)	Boys				Girls			
	N	Moderate Stunting	Severe Stunting	Total stunting	N	Moderate Stunting	Severe Stunting	Total stunting
10	68	6 (8.8)	0 (0)	6 (8.8)	79	2 (2.5)	0 (0)	2 (2.5)
11	75	5 (6.7)	0 (0)	5 (6.7)	106	19 (17.9)	0 (0)	19 (17.9)
12	63	5 (7.9)	1 (1.6)	6 (9.5)	110	11 (10)	3 (2.7)	14 (12.7)
13	112	10 (8.9)	1 (0.9)	11(9.8)	90	8 (8.9)	0 (0)	8 (8.9)
14	102	9 (8.8)	0 (0)	9 (8.8)	75	7 (9.3)	0 (0)	7 (9.3)
15	131	8 (6.1)	0 (0)	8 (6.1)	89	8 (9.0)	1 (1.1)	9 (10.1)
16	100	5 (5)	0 (0)	5 (5)	112	5 (4.5)	0 (0)	5 (4.5)
17	67	4 (6)	0 (0)	4 (6)	88	4 (4.5)	0 (0)	4 (4.5)
All age	718	52 (7.2)	2 (0.3)	54 (7.5)	749	64 (8.5)	4 (0.5)	68 (9)

The prevalence of stunting in boys and girls at different age groups is presented in Table 4.5. Majority of the boys and girls at all age groups were normal.

The rate of moderate stunting among the boys at different age groupsvaried from 5% to 9%. The rate of moderate stunting was maximum at 13 years (8.9%) and minimum (5%) at 16 years.The prevalence of severe stunting was negligeable, only one subject each in 12 and 13 years were found to be severely stunted. No age-related trend was observed in the rate of moderate stunting. The overall prevalence of stunting among boys was 7.5%.

Among the girls, the rate of moderate stunting varied from 2.5% at 10 years to 17.9% at 11 years. Intermediate rates of stunting were observed among other age groups. Severe stunting was observed in 12 years (2.7%) and at 15 years (1.1%), which is slightly higher than the boys. Like the boys, the rate of moderate stunting did not show any age-related trend. The overall rate of stunting among girls was 9% which is slightly higher than the boys (7.5%).

Table 4.6 :Mean and standard deviations of *Height - for - age* Z-scores for different stunted and not- stunted categories among boys and girls across different age groups

Age Gr	Nutritional Category	Boys			Girls		
		n	Mean	sd	n	Mean	sd
10 yrs	Not stunted	62	-0.40	0.78	77	-0.27	0.87
	Stunted	6	-2.16	0.16	2	-2.12	0.08
	Severe stunted	0					
11yrs	Not stunted	70	-0.54	0.80	87	-0.46	0.87
	Stunted	5	-2.49	0.23	19	-2.36	0.27
	Severe stunted	0					
12yrs	Not stunted	57	-0.64	0.77	96	-0.56	0.75
	Stunted	5	-2.47	0.20	11	-2.44	0.34
	Severe stunted	1	-3.04	.	3	-3.44	0.28
13yrs	Not stunted	101	-0.15	0.96	82	-0.54	0.71
	Stunted	10	-2.39	0.28	8	-2.30	0.27
	Severe stunted	1	-4.12	.			

Age Gr	Nutritional Category	Boys			Girls		
		n	Mean	sd	n	Mean	sd
14yrs	Not stunted	93	-0.51	0.78	68	-0.85	0.64
	Stunted	9	-2.48	0.27	7	-2.23	0.28
	Severe stunted	0					
15yrs	Not stunted	123	-0.36	0.77	80	-0.81	0.59
	Stunted	8	-2.35	0.28	8	-2.38	0.27
	Severe stunted	0			1	-3.48	.
16yrs	Not stunted	95	-0.63	0.71	107	-0.90	0.69
	Stunted	5	-2.48	0.20	5	-2.45	0.25
	Severe stunted	0					
17yrs	Not stunted	63	-0.76	0.73	84	-0.90	0.79
	Stunted	4	-2.29	0.20	4	-2.41	0.36
	Severe stunted	0					
Total	Not stunted	664	-0.47	0.81	681	-0.67	0.77
	Stunted	52	-2.39	0.25	64	-2.36	0.28
	Severe stunted	2	-3.58	0.77	4	-3.45	0.23

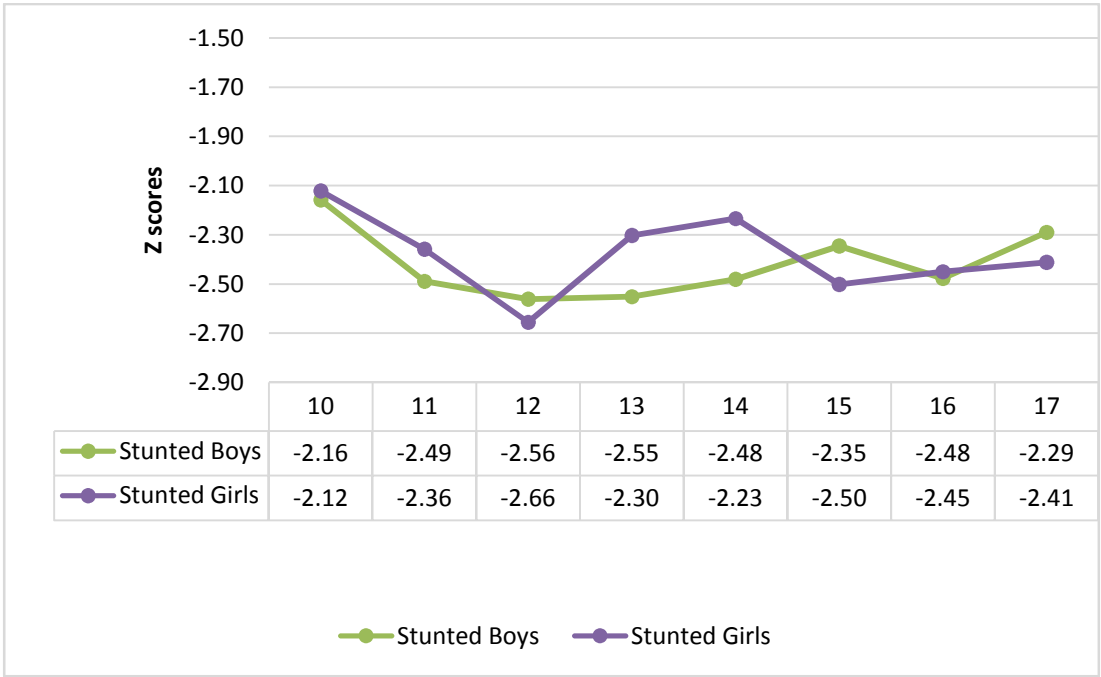


Fig. 4.10 : Z-scores of *Height - for - age* for normal and stunterd boys and girls across different age groups

The Z-scores of non-stunted, stunted, and severely stunted boys and girls at different age groups is summarized in Table 4.6. The paired representation of the Z-scoresof stunting for boys and girls in different age groups is presented in figure 4.10.It appeared that the Z-scores of stunting obtained for boys and girls at in most of the age groups except at 13 and 14 years,were almost similar.

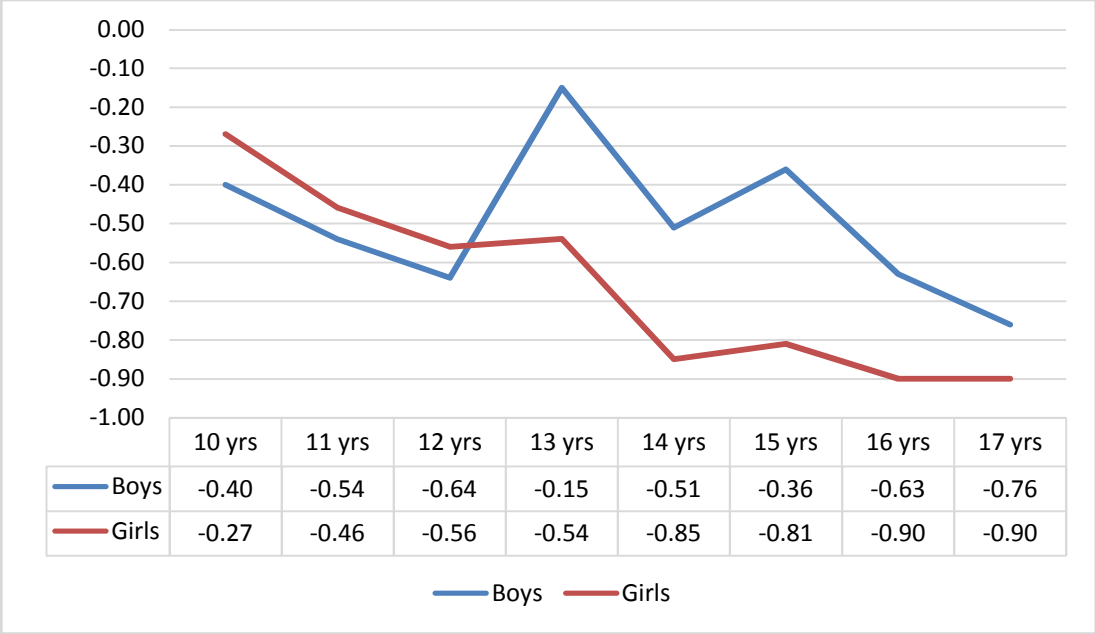


Fig. 4.11 : Z-scores of *Height - for - age* for non- stunted boys and girls across different age groups

The z-scores of the non-stunted categories of boys and girls at different age groups is depicted in Figure 4.11. The Z-score was observed from 13 to 16 years showed a wide difference among the boys and girls which reflect somewhat retarded growth of girls as compared to the boys in these age groups.

Table 4.7 :Prevalence of stunting in boys and girls across early (10-14 years) and late (15-17 years) adolescent groups

Gender	Adolescent Groups	Non-stunted N (%)	Moderate Stunted N (%)	Severe Stunted N (%)	χ^2	P value
Boys	Early (N= 420)	383 (91.2)	35 (8.3)	2 (0.5)	2.42	.30
	Late (N=298)	281 (94.3)	17 (5.7)	0 (0)		
Girls	Early (N= 460)	420 (91.3)	37 (8.0)	3 (0.7)	0.68	.71
	Late (N=289)	261 (90.3)	27 (9.3)	1 (0.3)		

The prevalence of stunting in boys and girls across early and late adolescent groups is presented in Table no 4.7. The relationship between the nutritional categories across the adolescent groups for both the boys and girls appeared to be non-significant.

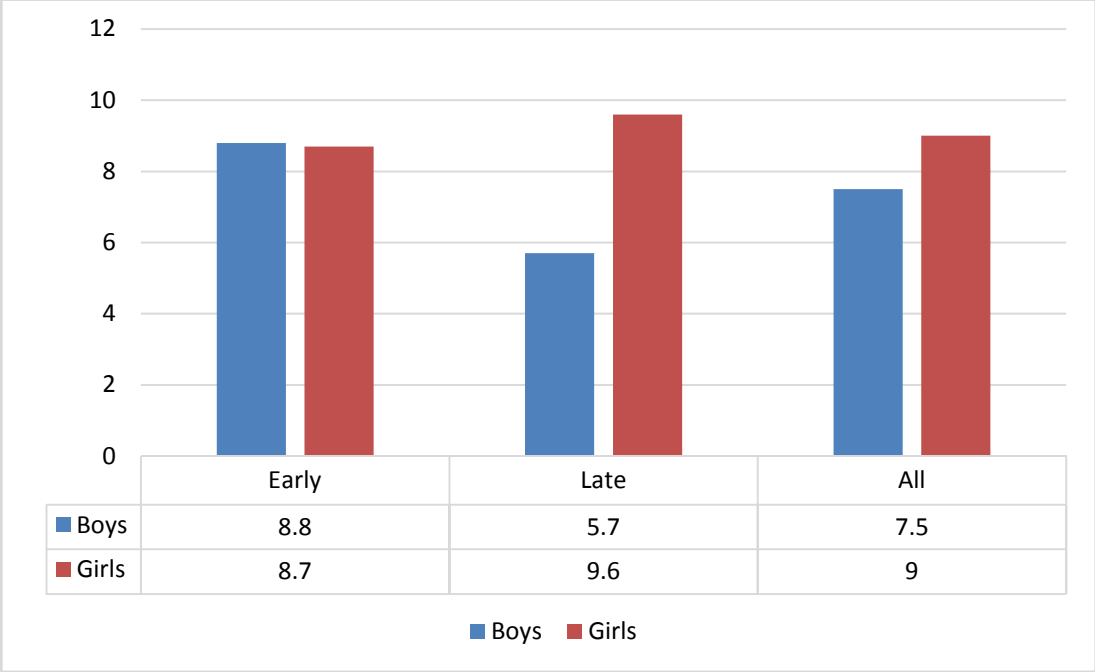


Fig. 4.12 :Prevalence of stunting among boys and girls across adolescent groups

The prevalence of total stunting in boys and girls across early and late adolescent groupsas represented in the Figure 4.12.The condition of being stunted among the boys and girls did not differ significantly by adolescent categories (χ^2 =1.215, df 1, p=.270).

Table 4.8 :Prevalence of thinness, overweight and obesity in boys and girls cross different age groups. Values are presented as N (%)

Age(yrs)	Boys					Girls				
	N	Moderate Thinness	Severe Thinness	Over Weight	Obese	N	Moderate Thinness	Severe Thinness	Over Weight	Obese
10	68	17(25)	3 (4.4)	3 (4.4)	2 (2.9)	79	16 (20.3)	5 (6.3)	1 (1.3)	0 (0)
11	75	10 (13.3)	4(5.3)	5 (6.7)	3 (4.0)	106	15 (14.2)	9 (8.5)	6 (5.7)	0 (0)
12	63	9 (14.3)	3 (4.8)	2 (3.2)	0 (0)	110	9 (8.5)	5 (4.5)	5 (4.5)	4 (3.6)

13	112	19 (17)	11 (9.8)	6 (5.4)	1 (0.9)	90	13 (14.4)	4 (4.4)	1 (1.1)	1 (1.1)
14	102	15 (14.7)	1 (1)	11 (10.8)	0 (0)	75	8 (10.7)	2 (2.7)	2 (2.7)	1 (1.3)
15	131	19 (14.5)	7(0.5)	9 (6.9)	4 (3.1)	89	8 (9.0)	3 (3.4)	2 (2.2)	0 (0)
16	100	15 (15.0)	1 (1.0)	5 (5.0)	1 (1.0)	112	13 (11.6)	6 (5.4)	8 (7.1)	1 (0.9)
17	67	5 (7.5)	0(0)	2 (3.0)	0 (0)	88	11 (12.5)	5 (5.7)	0 (0)	0 (0)
Total	718	139 (19)	30 (4.2)	44 (6)	11 (2)	749	93 (12)	39 (5)	25 (3)	7 (1)

The prevalence of thinness in boys and girls(Table 4.8) depicts a differential prevalence rate across the age groups with gender.Among the boy's moderate thinness was minimum at 17 years (7.5%) and maximum at 10 years (25%). Among the girls, moderate thinness was minimum at 12 years (8.5%) and maximum at 10 years (20.3 %).The overall prevalence of moderate thinness was more among the boys (19%) as compared to the girls (12%).

Rates of severe thinness among boys were more in the age groups of 10 to 14 years with maximum prevalence at 13 years group (9.8%). Severe thinness among girls was maximum in 11 years (8.5 %) and minimum in 14 years (2.7%). For the other age groups the rates of severe thinness varied from 3.4% to 6.3%.The overall rates of severe thinness were almost similar in boys (4.2%) and girls (5%).

In both boys and girls, the prevalence rates of overweight across all the age groups were more as compared to the prevalence rates of the obesity. Overweight was more among boys as compared to the girlsand varied from 3% at 12 and 17 years to a maximum of 10.8 % at 14 years. Among the girl'smaximum prevalence of overweight was observed at 16 years (7.1%). The overall prevalence rate of overweight was more in boys (6%) as compared to girls (5%).

More obese boyswere found at 10 years (2.9%), 11years (4%) and 15 years (3%) with an overall prevalence of 2%. While maximum obese girls were found at 12 years of age (3.6%).

Table4.9 :Mean and standard deviations of *BMI - for - age* Z-scores for different nutritional categories in boys and girls across different age groups

Age Groop	Nutritional Category	Boys				Girls			
		N	n	Mean	sd	N	n	Mean	sd
10 yrs	Normal	68	43	-0.75	0.85	79	57	-0.82	0.78
	Overweight	68	3	1.44	0.45	79	1	1.02	.
	Obese	68	2	2.03	0.00		0		
	Thin	68	17	-2.46	0.25	79	16	-2.42	0.31
	Severe Thin	68	3	-3.26	0.30	79	5	-3.36	0.14
11yrs	Normal	75	53	-0.65	0.78	106	76	-0.66	0.83
	Overweight	75	5	1.59	0.32	106	6	1.33	0.19
	Obese	75	3	2.17	0.21		0		
	Thin	75	10	-2.38	0.29	106	15	-2.47	0.28
	Severe Thin	75	4	-3.42	0.53	106	9	-4.24	1.78
12yrs	Normal	63	49	-0.66	0.81	110	87	-0.72	0.79
	Overweight	63	2	1.57	0.59	110	5	1.51	0.23
	Obese	63	0			110	4	2.03	0.41
	Thin	63	9	-2.38	0.17	110	9	-2.31	0.18
	Severe Thin	63	3	-3.28	0.07	110	5	-3.36	0.23
13yrs	Normal	112	75	-0.60	0.81	90	71	-0.59	0.83
	Overweight	112	6	1.42	0.27	90	1	1.16	.
	Obese	112	1	2.45	.	90	1	2.51	.
	Thin	112	19	-2.34	0.24	90	13	-2.39	0.20
	Severe Thin	112	11	-3.44	0.30	90	4	-3.49	0.44
14yrs	Normal	102	75	-0.77	0.83	75	62	-0.66	0.75
	Overweight	102	11	1.43	0.20	75	2	1.76	0.07
	Obese		0			75	1	2.20	.
	Thin	102	15	-2.39	0.28	75	8	-2.46	0.29
	Severe Thin	102	1	-3.76	.	75	2	-3.27	0.24
15yrs	Normal	92	92	-0.72	0.71	89	76	-0.82	0.66
	Overweight	92	9	1.42	0.28	89	2	1.42	0.05

Age Groop	Nutritional Category	Boys				Girls			
		N	n	Mean	sd	N	n	Mean	sd
	Obese	92	4	2.34	0.13		0		
	Thin	92	19	-2.44	0.29	89	8	-2.26	0.12
	Severe Thin	92	7	-3.34	0.34	89	3	-3.74	0.57
16yrs	Normal	100	78	-0.85	0.81	112	84	-0.82	0.71
	Overweight	100	5	1.41	0.27	112	8	1.57	0.40
	Obese	100	1	2.26	.	112	1	2.41	.
	Thin	100	15	-2.40	0.36	112	13	-2.42	0.28
	Severe Thin	100	1	-3.30	.	112	6	-3.19	0.11
17yrs	Normal	67	60	-0.65	0.59	88	72	-0.59	0.75
	Overweight	67	2	1.35	0.40		0		
	Obese		0				0		
	Thin	67	5	-2.18	0.20	88	11	-2.40	0.26
	Severe Thin		0			88	5	-3.68	0.43
Total	Normal	718	525	-0.71	0.77	749	585	-0.71	0.77
	Overweight	718	43	1.44	0.27	749	25	1.47	0.30
	Obese	718	11	2.24	0.18	749	7	2.18	0.36
	Thin	718	109	-2.39	0.27	749	93	-2.40	0.25
	Severe Thin	718	30	-3.38	0.32	749	39	-3.62	0.94

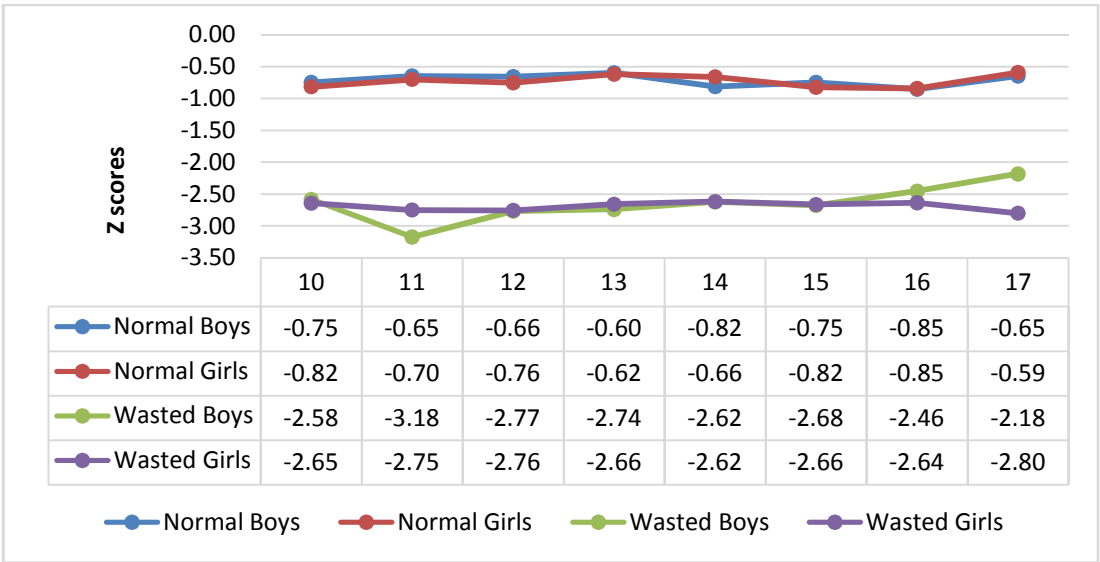
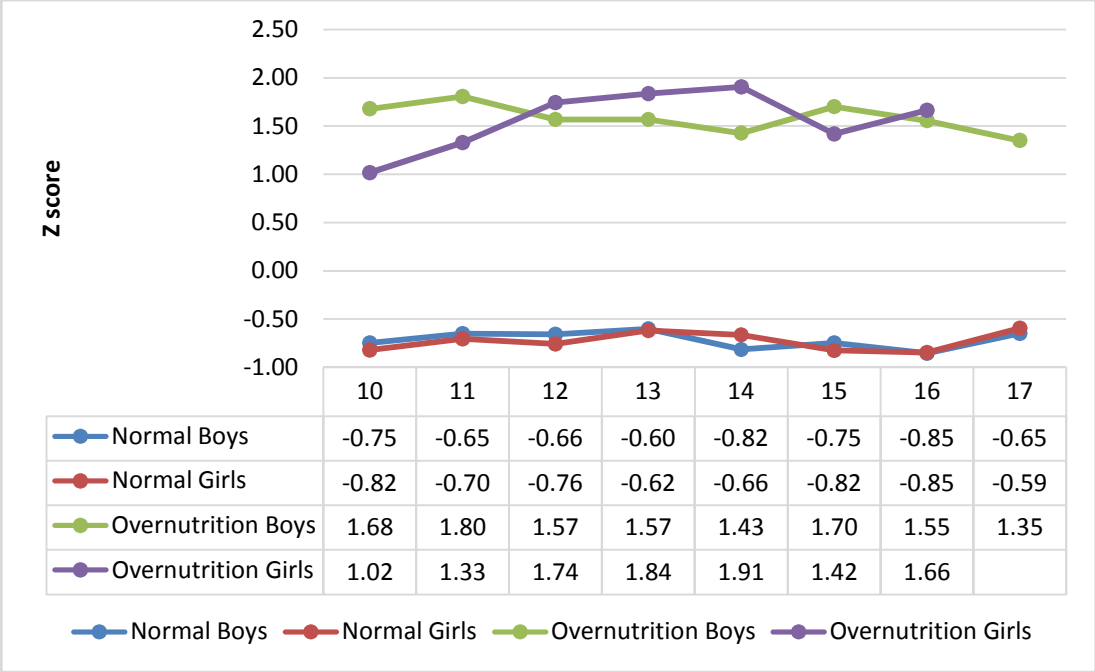


Fig. 4.13 : Z-scores of *BMI - for - age* for nomal and thin boys and girls across different age group



	10	11	12	13	14	15	16	17
Normal Boys	-0.75	-0.65	-0.66	-0.60	-0.82	-0.75	-0.85	-0.65
Normal Girls	-0.82	-0.70	-0.76	-0.62	-0.66	-0.82	-0.85	-0.59
Overnutrition Boys	1.68	1.80	1.57	1.57	1.43	1.70	1.55	1.35
Overnutrition Girls	1.02	1.33	1.74	1.84	1.91	1.42	1.66	

Fig. 4.14 : Z-scores of *BMI - for - age* for nomal and overnutrition boys and girls across different age group

The Z-score of normal, moderatethinness, severe thinness, overweight and obesity among boys and girls at different age group is summarized in Table no.4.9.

Thepaired representation of the Z-score for normal and thinness and normal and overnutrition between boys and girlsat different age groups is depicted in Figure 4.13 and Figure 4.14 respectively.

From the figure 4.13 it appeared that the mean Z-score for thinness were conspicuously different between boys and girls at 11 and 17 years. However, for the other age groups the mean Z-scores were almost similar. Major difference in mean Z scores for overnutrition was observed at 10, 11 and 14 years of age (Figure 4.14).

BMIAZ Z-scores for normal category of boys and girls at different age groups were obtained to be almost similar.

Table 4.10:Prevalence of thinness, overweight and obesity across early (10-14 years) and late (15-17 years) adolescent groups in boys and girls

Gender	Adolescent Groups	Normal N (%)	Thin N (%)	Severely Thin N (%)	Overweight	Obese	χ^2	P value
Boys	Early (N=420)	294 (70.0)	70 (16.7)	22(5.2)	28 (6.7)	6 (1.4)	5.17	.16
	Late (N=298)	230 (77.2)	39 (13.1)	8 (2.7)	16 (5.4)	5 (1.7)		
Girls	Early (N=460)	349 (75.9)	57 (12.4)	28 (6.1)	21 (4.6)	5 (1.1)	8.21	.08
	Late (N=289)	236 (81.7)	36 (12.5)	11 (3.8)	4 (1.4)	2 (0.7)		

The comparison of prevalence rates of different categories of malnutrition between early and late adolescent groups revealed no significant association in boys (χ^2 (3) = 5.17, p= .16), and girls (χ^2 (4) = 8.21, p= 0.08). (Table 4.10)

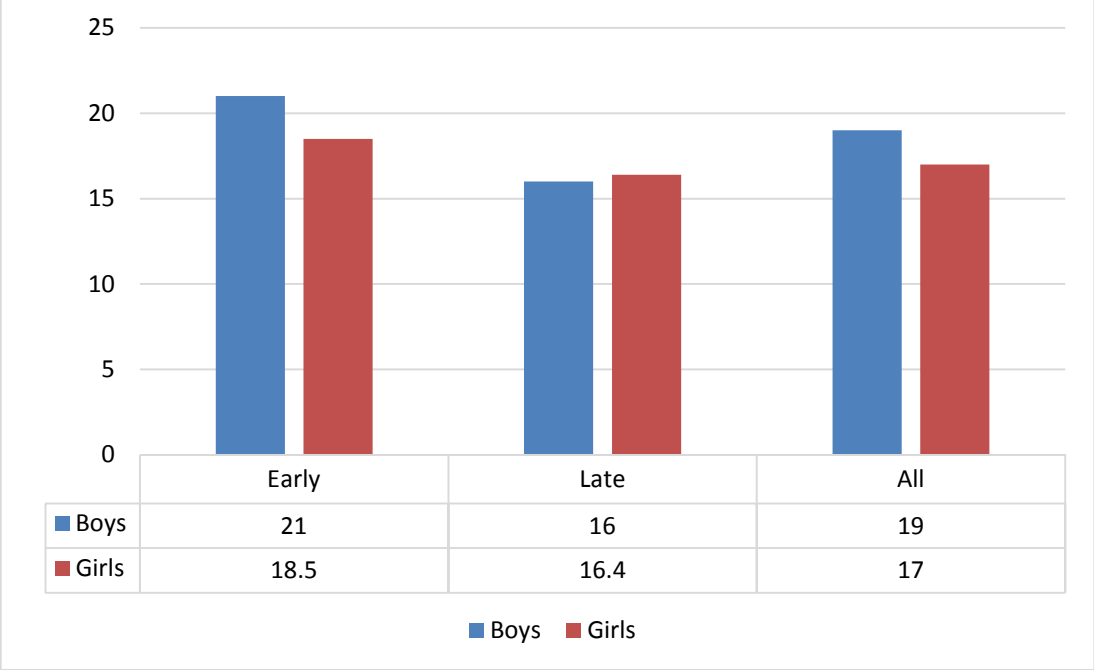


Fig.: 4.15. Prevalence of thinness among boys and girls across adolescent groups

The proportion of boys and girls who were reported to be thin across early and late adolescent categories is represented in the Figure 4.15.A chi-square test of independence showed that the condition of being thindid not differ significantly by adolescent categories,χ^2(1, N=271)= 0.0961, p=0.756 among boys and girls.

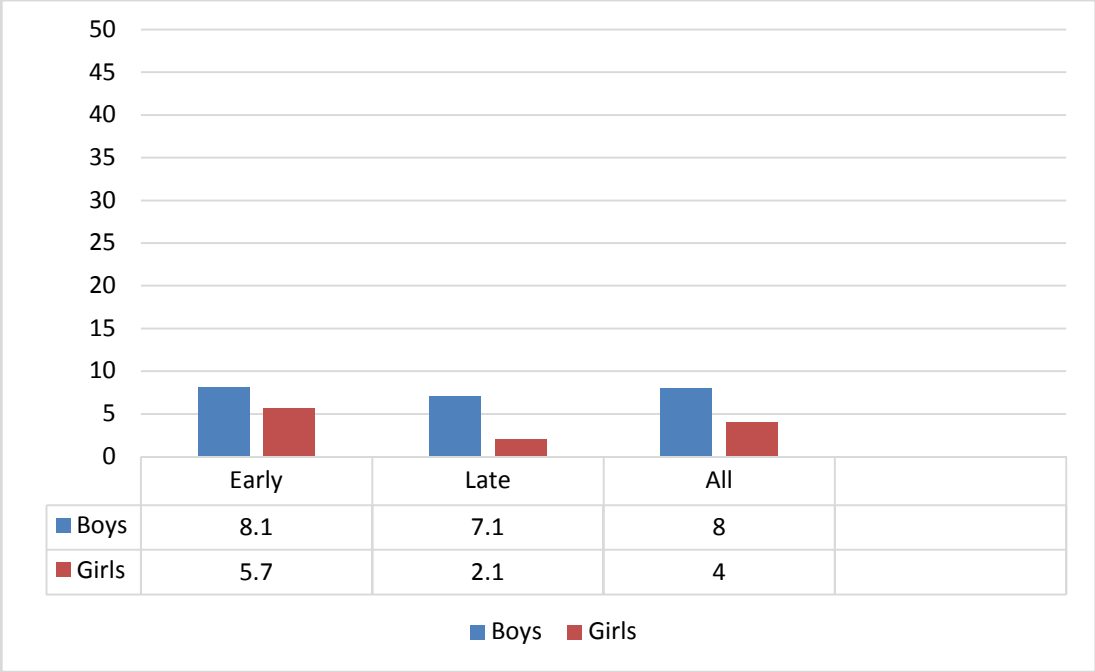


Fig. 4.16 :Prevalence of over-nutrition among boys and girls across different age groups

The proportion of boys and girls within the overnutrition category (combining overweight and obese) across early and late adolescent groups is represented in the Figure 4.16.A chi-square test of independence showed that overnutrition statusamong boys and girls did not show any statistically significant difference across adolescent groups (χ^2 are (1), N=87)= 3.569, p<0.06).

4.3.2 OVERALL PREVALENCE OF DIFFERENT CATEGORIES OF MALNUTRITION

Combining the nutritional categories obtained from height-for- age and BMI- for- age, four different categories of malnutrition were considered in the present study, viz, stunted, thinness, co-existence of stunted and thinness and overnutrition (by combining overweight and obese).

4.3.2.1 OVERALL PREVALENCE OF DIFFERENT CATEGORIES OF MALNUTRITION IN BOYS AND GIRLS AT DIFFERENT AGE GROUP.

The different categories of malnutrition in boys and girls at different age group is presented in Table no. 4.11

Table4.11 :Prevalence of different categories of malnutrition across the different age groups among boys and girls. Values are presented as N (%)

Age(yrs)	Boys					Girls				
	Nomal N (%)	Stunted N (%)	Thin N(%)	Stunted/ Thin N (%)	O/Ob N (%)	Normal N (%)	Stunted N (%)	Thin N (%)	Stunted/Thin N (%)	O/Ob N (%)
10	39 (57.4)	3 (4.4)	17 (25.0)	3 (4.4)	6 (8.8)	55 (69.6)	2 (2.5)	21 (26.6)	0 (0)	1 (1.3)
11	48 (64.0)	5 (6.7)	14 (18.7)	0 (0)	8 (10.7)	60 (56.6)	16 (15.1)	21 (19.8)	3 (2.8)	6 (5.7)
12	46 (73.0)	3 (4.8)	9 (14.3)	3 (4.8)	2 (3.2)	78 (70.9)	9 (8.2)	10 (9.1)	4 (3.6)	9 (8.2)
13	68 60.7)	7 (6.2)	26 (23.2)	4 (3.6)	7 (6.2)	65 (72.2)	6 (6.7)	16 (17.8)	1 (1.1)	2 (2.2)
14	67 (65.7)	8 (7.8)	15 (14.7)	1 (1.0)	11 (10.8)	55 (73.3)	7 (9.3)	10 (13.3)	0 (0)	3 (4.0)
15	86 65.6)	6 (4.6)	24 (18.3)	2 (1.5)	13 (9.9)	69 (77.5)	7 (7.9)	9 (10.1)	2 (2.2)	2 (2.2)
16	73 (73.0)	5 (5.0)	16 (16.0)	0 (0)	6 (6.0)	80 (71.4)	4 (3.6)	18 (16.1)	1 (0.9)	9 (8.0)
17	56 (83.6)	4 (6.0)	5 (7.5)	0 (0)	2 (3.0)	68 (77.3)	4 (4.5)	16 (18.2)	0 (0)	0 (0)

For the boys the rate of prevalence of stunting varied between 4.4% (at 10 years) to7.8% (at 14 years). For the girl's minimum rate of stunting (2.5%) was found at 10 years and maximum rate (15.1%) was obtained at 11 years. While intermediate values of prevalence were obtained at other age groups.

Like stunting the prevalence rates of thinness did not show any age-related pattern. Maximum rate of thinness (25%) was obtained at 10 years followed by (23.2%) at 13 years and minimum thinness (7.5%) was obtained among 17 years' boys.

For the girls the highest rate of thinness (26.6%) was also obtained at 10 years like the boys followed by (19.8%) at 11 years and minimum prevalence of thinness (9%) was seen in the age group 12 years. The prevalence of thinness from 13 to 17 years were obtained between 10 to 18%.

The coexistence of stunting and thinness was obtained at the age of 10,12,13,14 and 15 years for boys which varied between 1% at 14 years, 3.6% at 13 years, 4.4%at 10 years and 4.8% at 12 years. among the girls the stunting-thinness category of malnutrition was obtained at 11 years (2.8%), 12 years (3.6%), 13 years (1.1%), 15years (2.2%) and 16 years (0.9%).

Overnutrition was obtained at all age groups for boys which varied between 3 to 10.8%, and in all age groups except 17 years among the girls which varied between 1.3 to 8%.

4.3.2.2 :OVERALL PREVALENCE OF DIFFERENT CATEGORIES OF MALNUTRITION ACROSS THE ADOLESCENT CATEGORIES IN BOYS AND GIRLS

Prevalence of different categories of malnutrition and whole group of boys and is summarized in Table 4.12.

Table 4.12 :Prevalence of different categories of malnutrition across the different adolescent groups among boys and Girls. Values are presented as N (%)

Group (age)	Boys					Girls					χ^2	p
	N N (%)	S N (%)	W N (%)	S/W N (%)	O/Ob N (%)	N N (%)	S N (%)	W N (%)	S/W N (%)	O/Ob N (%)		
Early (10-14)	268 (63.8)	26 (6.2)	81 (19.3)	11 (2.6)	34 (8.1)	316 (68.7)	33 (7.2)	77 (16.7)	9 (2.0)	25 (5.4)	4.64	.33
Late (15-17)	215 (72.1)	15 (5.0)	45 (15.1)	2 (0.7)	21 (7.0)	214 (74.0)	22 (7.6)	44 (15.2)	2 (0.7)	7 (2.4)	8.20	.08
All	483 (67.3)	41 (5.7)	126 (17.5)	13 (1.8)	55 (7.7)	530 (70.8)	55 (7.3)	121 (16.2)	11 (1.5)	32 (4.3)	9.92	.04

Comparative prevalence of malnutrition among early and late adolescent boys showed higher prevalence of different malnutrition categories among the early adolescent boys as compared to their late counterpart. Similarly, findings were also obtained among early and late adolescent girls, except for the prevalence of stunting, which was almost similar in early and late adolescent girls.

Comparison of prevalence between early boys and girls showed that stunting was slightly higher among girls (6.2 % in boysvs 7.2 % in girls) and thinness is higher among boys (19.3 % in boys vs 16.7 % in girls). Prevalence of stunting – thinness is

almost similar in boys and girls. However, overnutrition was higher in boys (8.1 %) as compared to the girls (5.4 %). The difference in prevalence rates among early boys and girls appeared to be statistically non – significant, chi square (4, N= 1467) = 4.64, p=0.33.

Comparison of prevalence between late boys and girls showed that stunting was higher among girls (7.6 % in girlsvs 5.0 % in boys) and thinness and stunted – thinness is similar in both sexes. Overnutrition is higher among boys than girls (7.0 % in boysvs 2.4 % in girls). The difference in prevalence rates among late boys and girls appeared to be statistically non – significant, chi square (4, N= 1467) = 8.20, p=0.08.

Comparative prevalence of malnutrition among the whole group of boys and girls showed that stunting was higher in girls as compared to boys (7.3 % in girlsvs 5.7% in boys). Thinness was slightly higher among boys (17.5 % in boysvs 16.2 % in girls). The stunted- thinness was almost similar in both sexes. Overnutrition is higher among boys (7.7 %) than girls (4.3 %).The difference appeared to be statistically significant. Chi square (4, N= 1467) = 9.92, p=0.041.

Diagrammatic representation of the prevalence rates of different malnutrition categories in the whole groupof is presented in Figure 4.3.3.1.

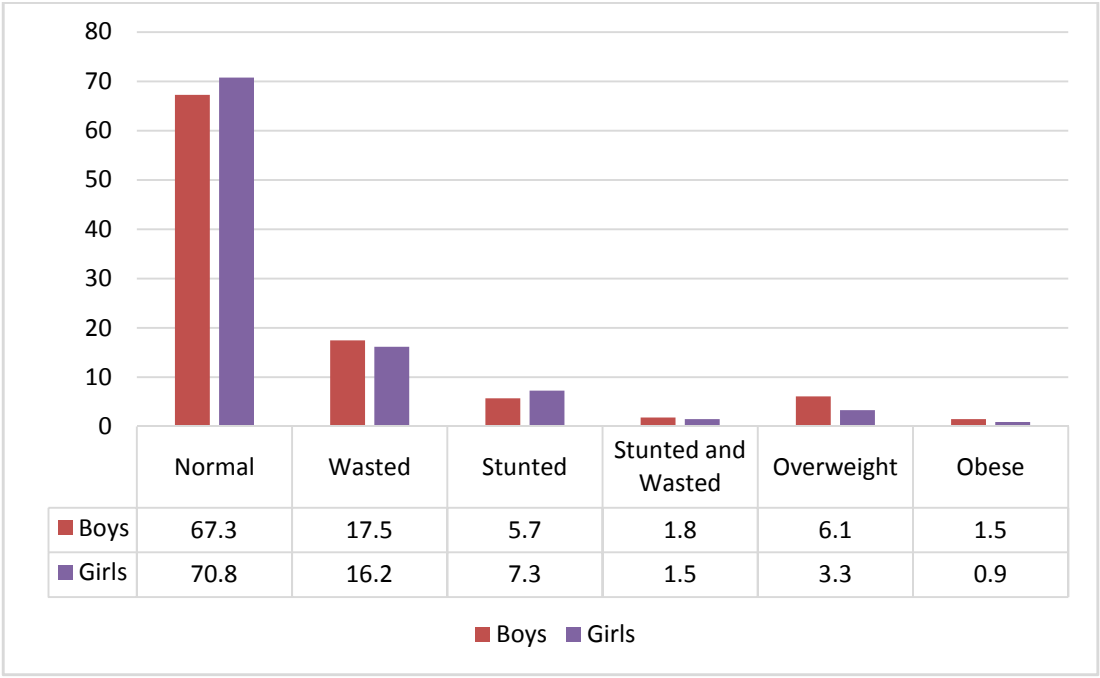


Fig. 4.17 : Prevalence of different categories of nutrition status for boys and girls

4.4 RESULTS ON DIETARY PATTERN

4.4.1 BREAKFAST HABIT OF THE HIMACHALI CHILDREN

Table4.13 :Breakfast habit among boys and girls

Gender	Adolescent category	N	Frequent consumption		Infrequent consumption		χ^2	p
			Daily	Most days a week	Few days a week	Never		
Boy	Early	420	420 (100)	0 (0)	1 (0)	0 (0)	14.41	.000
	Late	298	210 (70.5)	69 (23.2)	19 (6.4)	0 (0)		
	All	718	630 (87.7)	69 (9.6)	19 (2.6)	0 (0)		
Girl	Early	460	394 (85.7)	31 (6.7)	33 (7.2)	2 (0.4)	76.45	.000
	Late	289	167 (57.8)	74 (25.6)	45 (15.6)	3 (1.0)		
	All	749	561 (74.9)	105 (14.0)	78 (10.4)	5 (0.7)		

Analysis of breakfast habit of the Himachali childrenshowed that (88%) of the boys and (75%)to the girls had regular habit of breakfast.Having regular breakfast was more common in early adolescent period and decreased in late adolescent in both the sexes. 100 % of the early adolescent boys had regular breakfast as compared to 70% of the late adolescent boys, and 86% of the early adolescent girls had regular breakfast, as compared to 58% of late adolescent girls (Table 4.13). The relation between frequent and infrequent breakfast consumption patterns with adolescent groups in both sexes appear to be highly statistically significant.

4.4.2 CONSUMPTION PATTERN OF HEALTHY FOOD ITEMS

Table 4.14 : Consumption pattern of healthy foods by the boys and girls

Food	Gender	N	Daily		Most days a week		Few days a week		Never	
			F	%	F	%	F	%	F	%
Fruit	Boy	718	198	27.6	277	38.6	240	33.4	3	0.4
	Girl	749	217	29.0	303	40.5	229	30.6	0	0.0
	Total	1467	415	28.3	580	39.5	469	32.0	3	0.2
Milk	Boy	718	279	38.9	289	40.3	88	12.3	62	8.6
	Girl	749	337	45.0	301	40.2	20	2.7	91	12.1
	Total	1467	616	42.0	590	40.2	108	7.4	153	10.4
Dairy	Boy	718	76	10.6	99	13.8	517	72.0	26	3.6
	Girl	749	364	48.6	160	21.4	202	27.0	23	3.1
	Total	1467	440	30.0	259	17.7	719	49.0	49	3.3
Cooked Vegetable	Boy	718	347	48.3	242	33.7	125	17.4	4	0.6
	Girl	749	401	53.5	203	27.1	145	19.4	0	0.0
	Total	1467	748	51.0	445	30.3	270	18.4	4	0.3
Green Leafy vegetables	Boy	718	0	0.0	7	1.0	579	80.6	132	18.4
	Girl	749	0	0.0	46	6.1	662	88.4	41	5.5
	Total	1467	0	0.0	53	3.6	1241	84.6	173	11.8
Salad	Boy	718	260	36.2	189	26.3	197	27.4	72	10.0
	Girl	749	350	46.7	198	26.4	201	26.8	0	0.0
	Total	1467	610	41.6	387	26.4	398	27.1	72	4.9
Pulses	Boy	718	437	60.9	182	25.3	99	13.8	0	0.0
	Girl	749	513	68.5	135	18.0	101	13.5	0	0.0
	Total	1467	950	64.8	317	21.6	200	13.6	0	0.0

The pooled estimate (combining allthe age groups) of the consumption pattern of different healthy food items by the boys and girls is presented in Table 4.14. Majority of the boys and girls (almost 90 percent or more) mentioned that they had consumed the different food items “at least once a week”, and only a minor percentage of children reported that they had “never” consumed the item.

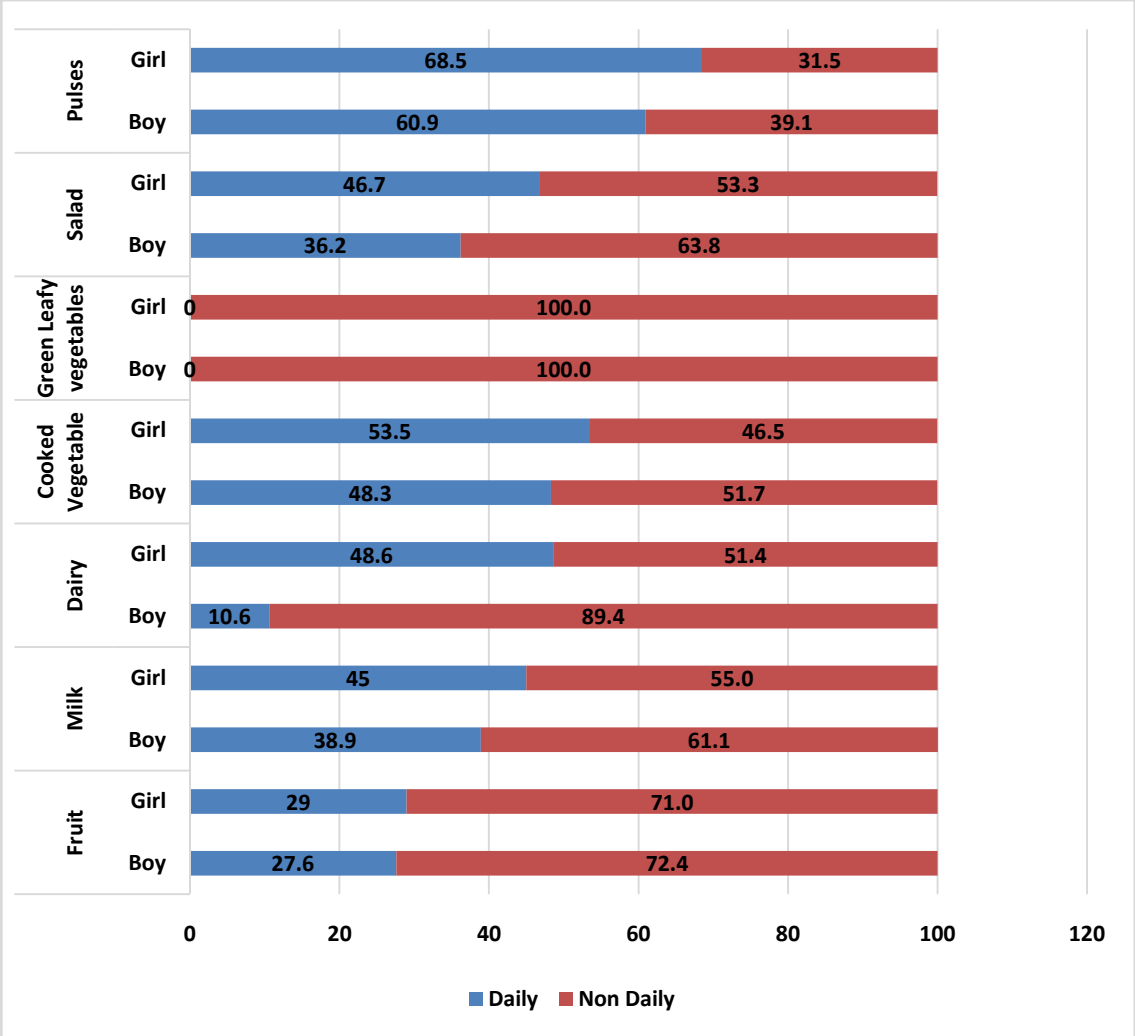


Fig.4.18 :Daily and non-daily consumption pattern of different healthy food items by the boys and girls

Percentages of boys and girls having daily and non-daily patterns of consumption for different healthy foods is represented in Figure 4.18. On a daily basis, none of the boys or girls consumed green leafy vegetables, while maximum number of boys and girls were found to consume pulses. All food items were consumed by higher percentages of girls daily as compared to the boys. The maximum difference in the percentages of boys and girls was observed in the consumption pattern of dairy products; 48.6% of girls reported consumption of dairy products as compared to only 10.6% of boys.

Table 4.15 :Dichotomized consumption pattern of healthy foods by boys and girls

Food	Group	Total	High Consumption		Low Consumption		χ^2	p
			Daily	Most days a week	Few days a week	Never		
Fruit	Boy	718	475	66.2	243	33.8	1.786	.18
	Girl	749	520	69.4	229	30.6		
	All	1467	995	67.8	472	32.2		
Milk	Boy	718	568	79.1	150	20.9	9.24	.002
	Girl	749	638	85.2	111	14.8		
	All	1467	1206	82.2	261	17.8		
Dairy	Boy	718	175	24.4	543	75.6	30.54	.000
	Girl	749	524	70.0	225	30.0		
	All	1467	699	47.6	768	52.4		
Cooked Vegetables	Boy	718	589	82.0	129	18.0	0.468	.494
	Girl	749	604	80.6	145	19.4		
	All	1467	1193	81.3	274	18.7		
Green leafy vegetables	Boy	718	7	1.0	711	99.0	28.1	.000
	Girl	749	46	6.1	703	93.9		
	All	1467	53	3.6	1414	96.4		
Salad	Boy	718	449	62.5	269	37.5	19.02	.000
	Girl	749	548	73.2	201	26.8		
	All	1467	997	68.0	470	32.0		
Pulses	Boy	718	619	86.2	99	13.8	0.029	.865
	Girl	749	648	86.5	101	13.5		
	All	1467	1267	86.4	200	13.6		

More number of boys and girls have higher or frequent intake of fruit (boys 66 %, girls 69 %), milk (boys 79 %, girls 85 %), cooked vegetables (boys 82 %, girls 81 %), salad (boys 63%, girls 73 %) and pulses (boys 86%, girls 87%). Green leafy vegetables were the least consumed item; about 99 % of the boys and 94 % of girls reported infrequent consumption of green leafy vegetables. A higher percentage of

girls (70%) and a comparatively much lower percentage of boys (24%) reported frequent consumption of dairy products.

The consumption patterns for milk, dairy products, green leafy vegetables and salads have statistically significant association with gender.The percentages of the boys and girls showed significant statistical variations in their consumption pattern for milk ($\chi^2$9.24, df = 1, p = 0.002), dairy products ($\chi^2$30.54, df = 1, p = 0.000), green leafy vegetables ($\chi^2$28.1, df = 1, p = 0.000) and salad ($\chi^2$19.02, df = 1, p = 0.000) (Table 4.15).

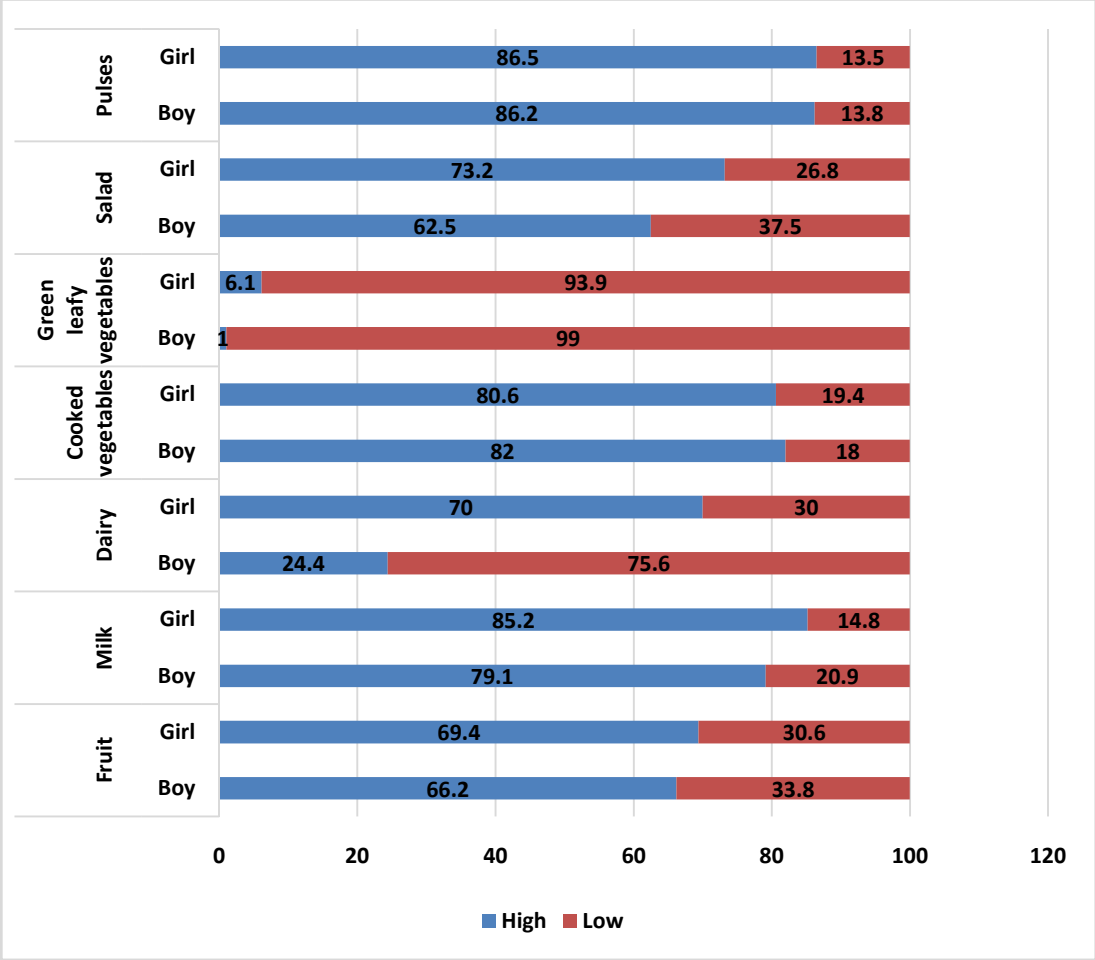


Fig.4.19 :Dichotomized consumption pattern of healthy foods by boys and girls.

Table 4.16 :Dichotomized consumption pattern of healthy foods by early and late adolescent boys

Food Groups	Adolescent category	Total	Frequent consumption		Infrequent consumption		χ^2	p
			N	%	N	%		
Fruit	Early	420	236	56.2	184	43.8	44.88	.000
	Late	298	239	80.2	59	19.8		
Milk	Early	420	346	82.4	74	17.6	6.56	.01
	Late	298	222	74.5	76	25.5		
Dairy	Early	420	65	15.5	355	84.5	43.45	.000
	Late	298	110	36.9	188	63.1		
Cooked vegetables	Early	420	352	83.8	68	16.2	2.167	.141
	Late	298	237	79.5	61	20.5		
Green leafy vegetables	Early	420	0	0.0	420	100.0	9.96	.002
	Late	298	7	2.3	291	97.7		
Salad	Early	420	206	49.0	214	51.0	78.57	.000
	Late	298	243	81.5	55	18.5		
Pulses	Early	420	367	87.4	53	12.6	1.16	.281
	Late	298	252	84.6	46	15.4		

The Table 4.16 showed that significantly higher percentages of boys in the late adolescent group consumed fruit, diary products, green leafy vegetables and salad as compared to the early adolescent boys. Frequent consumption of fruit was reported by 80 % of the late adolescent boys as compared to 56 % of the early adolescents and this difference was statistically significant (χ^2 = 44.88, df = 1, p = 0.000). Similar increase in consumption frequency from early to late adolescent period was observed for the consumption pattern of dairy products (15,5 % early adolescent's vs 37 % late adolescents) and this difference was also statistically significant (χ^2 = 43.45, df = 1, p = 0.000). Similar statistically significant increases were observed for the consumption patterns of green leafy vegetables (0 % early adolescent's vs 2.3% late adolescents, (χ^2 = 9.96, df = 1, p = 0.002) and salads (49 % early adolescent's vs 82% late adolescents, χ^2 = 78.6, df = 1, p = 0.000).

In contrast, the consumption of milk was reported by a significantly a greater number of early boys as compared to their late counterpart (82 % early adolescents vs 75% late adolescents, ($\chi^2 = 6.56$, df = 1, p = 0.01).

The percentages of boys having frequent consumption of cooked vegetables and pulses show a slight decline when early and late adolescents were compared; 84 % early adolescent vs 80 % late adolescent for cooked vegetables, and 87% early adolescent vs 84 % late adolescent for pulse consumption, however, these differences did not appear to be statistically significant.

Table 4.17 :Dichotomized consumption pattern of healthy foods by early and late adolescent girls

Food Groups	Adolescent category	N	High Consumption		Low Consumption		χ^2	p
			N	%	N	%		
Fruit	Early	460	282	61.3	178	38.7	37.05	.000
	Late	289	238	82.4	51	17.6		
Milk	Early	460	397	86.3	63	13.7	1.19	.275
	Late	289	241	83.4	48	16.6		
Dairy	Early	460	327	71.1	133	28.9	0.721	.396
	Late	289	197	68.2	92	31.8		
Cooked vegetables	Early	460	373	81.1	87	18.9	0.152	.697
	Late	289	231	79.9	58	20.1		
Green leafy vegetables	Early	460	0	0.0	460	100.0	78.01	.000
	Late	289	46	15.9	243	84.1		
Salad	Early	460	307	66.7	153	33.3	25.07	.000
	Late	289	241	83.4	48	16.6		
Pulses	Early	460	407	88.5	53	11.5	2.94	.05
	Late	289	241	83.4	48	16.6		

The dichotomized pattern of consumption frequency of different healthy food items by early and late adolescent girls is presented in Table 4.17.It was observed that significantlya greater number of late adolescent girls consumed fruit, green leafy vegetables and salad as compared to the early adolescent group; 61 % early

adolescent's vs 82% late adolescents for fruit, (χ^2 = 37.05, df = 1, p = 0.000), 0 % early adolescent's vs 16% late adolescents for green leafy vegetables, (χ^2 = 25.07, df = 1, p = 0.000) and by 67 % early adolescent vs 83 % late adolescent for salads (χ^2 = 25.07, df = 1, p = 0.000).

The frequencies of consumption of other food items like milk dairy product and cooked vegetables did not show any significant differences. These consumptions were slightly higher in early adolescent group. A higher percentage of early adolescent girls also reported frequent consumption of pulses, (88.5 % early vs 83.4% late) and this difference was statistically significant (χ^2 = 2.94, df = 1, p = 0.05).

4.4.3 :CONSUMPTION PATTERN OF UNHEALTHY FOOD ITEMS

Table 4.18 :Consumption pattern of unhealthy foods by boys and girls

Food	Gender	N	Daily		Most days a week		Few days a week		Never	
			F	%	F	%	F	%	F	%
SavorySnacks	Boys	718	14	1.9	79	11.0	625	87.0	0	0.0
	Girls	749	59	7.9	240	32.0	436	58.2	14	1.9
	All	1467	73	5.0	319	21.7	1061	72.3	14	1.0
Fast Foods	Boys	718	0	0.0	56	7.8	614	85.5	48	6.7
	Girls	749	0	0.0	87	11.6	588	78.5	74	9.9
	All	1467	0	0.0	143	9.7	1202	81.9	122	8/0
Sweet	Boys	718	33	4.6	96	13.4	513	71.4	76	10.6
	Girls	749	30	4.0	72	9.6	560	74.8	87	11.6
	All	1467	63	4.3	168	11.5	1073	73.1	163	11.1
Cake and Pastries	Boys	718	35	4.9	101	14.1	514	71.6	68	9.5
	Girls	749	45	6.0	99	13.2	529	70.6	76	10.1
	All	1467	80	5.5	200	13.6	1043	71.1	144	10.0
Candy and Chocolate	Boys	718	0	0.0	67	9.30	611	85.1	40	5.6
	Girls	749	7	0.9	186	24.8	541	72.2	15	2.0
	All	1467	7	0.5	253	17.2	1152	78.5	55	3.7
Soft Drink	Boys	718	13	1.8	121	16.9	454	63.2	130	18.1
	Girls	749	0	0.0	70	9.3	617	82.4	62	8.3
	All	1467	13	0.9	191	13.0	1071	73.0	192	13.1

The pooled estimate (combining all the age groups) of the consumption pattern of different unhealthy food items by the boys and girls is presented in table 4.18. Majority of the boys and girls (70.6 – 87.0%) reported to consume the different unhealthy food items "few days a week" only followed by most days a week (7.80 – 32.0%), and only a minor percentage(0 – 7.9) of children reported that they have not consumed the item "daily". Also, very small percentage of children (0- 18.1%) reported that they have "never" consumed the items.

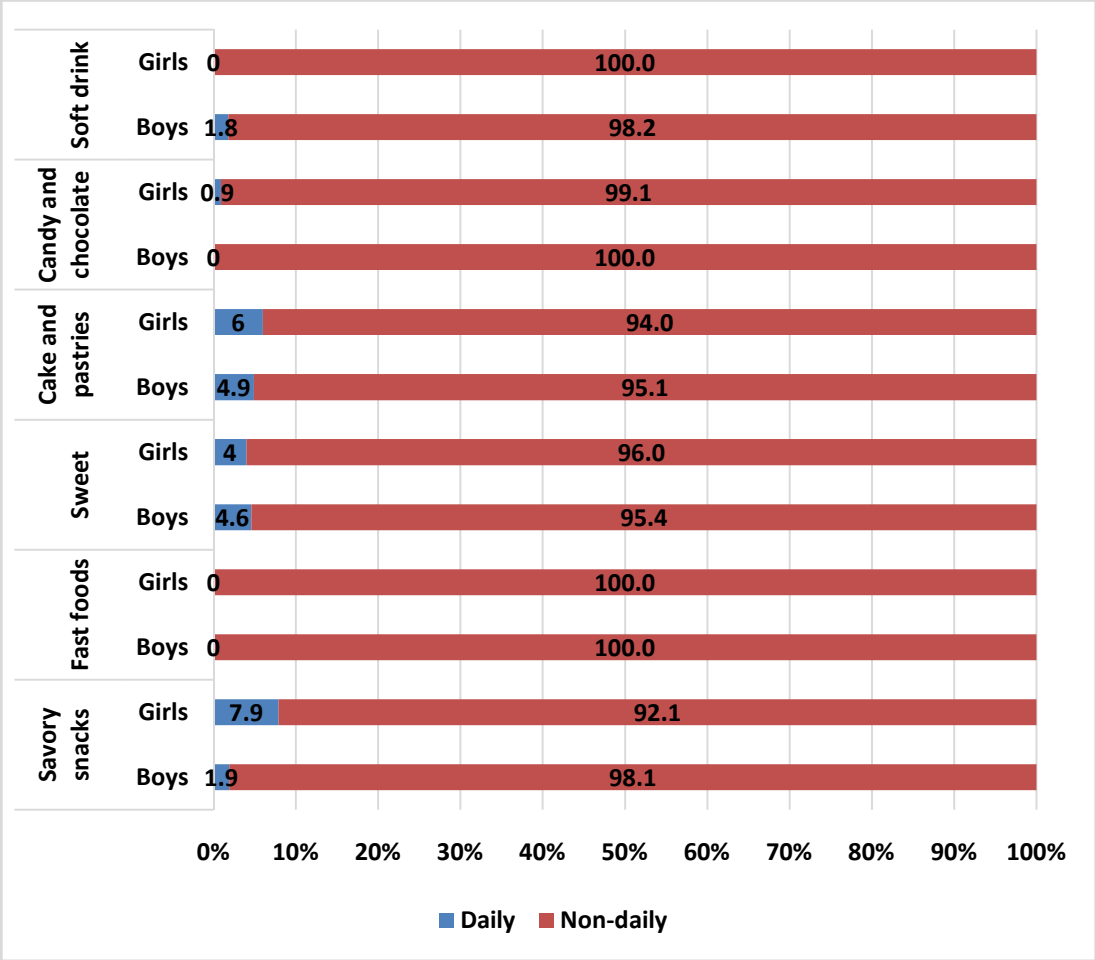


Fig. 4.20 :Daily and Non- daily consumption pattern of unhealthy foods by the boys and girls

Percentages of boys and girls having daily and non-daily patterns of consumption for different unhealthy foods is represented in Figure 4.20.Almost equal percentagesof girls and boys (30-33% respectively) consumed sweetsdaily.None of the boys or girls consumed fast food daily. None of the boys consumed candy and chocolate on daily basis, and none of the girls consumed soft drinks on daily basis. A much higher

percentage of girls (59%) consumed savory snacks dailyas compared to much lower percentage (14%) of boys.

Table 4.19 :Dichotomized consumption pattern of unhealthy foods by boys and girls

Food type	Gender	High Consumption		Low Consumption		χ^2	p
		N	%	N	%		
Savory Snacks	Boys	93	13.0	625	87.0	1.36	.000
	Girls	299	39.9	450	60.1		
	All	392	26.7	1075	73.3		
Fast foods	Boys	56	7.8	662	92.2	6.068	.014
	Girls	87	11.6	662	88.4		
	All	143	9.7	1324	90.3		
Sweet	Boys	129	18.0	589	82.0	37.94	.000
	Girls	102	13.6	647	86.4		
	All	231	15.7	1236	84.3		
Cake and pastries	Boys	136	18.9	582	81.1	0.019	.89
	Girls	144	19.2	605	80.8		
	All	280	19.1	1187	80.9		
Candy and chocolate	Boys	67	9.3	651	90.7	67.91	.0001
	Girls	193	25.8	556	74.2		
	All	260	17.7	1207	82.3		
Soft drink	Boys	134	18.7	584	81.3	26.58	.0000
	Girls	70	9.3	679	90.7		
	All	204	13.9	1263	86.1		

From the Table 4.19. it can be observed that most of the boys and girls had low consumption of all the unhealthy foods, viz.,savory snacks (boys 87 %, girls 60.1 %), fast foods (boys 92.2 %, girls 88.4 %), sweets (boys 82 %, girls 86.4 %), cake and pastries (boys 81.1%, girls 80.8 %), candy and chocolates (boys 90.7%, girls 74.2%) and soft drinks (boys 81.3%,girls90.7%).

A higher percentage of girls reported high consumption of savory snacks (39.9%), candy and chocolates (25.8%), and fast foods (11.6%), while more boys reported high consumption for sweets (18%), and soft drinks (18.7%) as compared to girls.

The consumption patterns for savory snacks, sweets, candy and chocolates and soft drinks have highly statistically significant association with gender. The percentages of

the boys and girls showed significant statistical variations in their consumption pattern for savory snacks (χ^2 = 1.36, df = 1, p = 0.000), sweets (χ^2 = 37.94, df = 1, p = 0.000), candy and chocolates (χ^2 = 67.91, df = 1, p = 0.0001) and soft drink (χ^2 = 26.58, df = 1, p = 0.000).

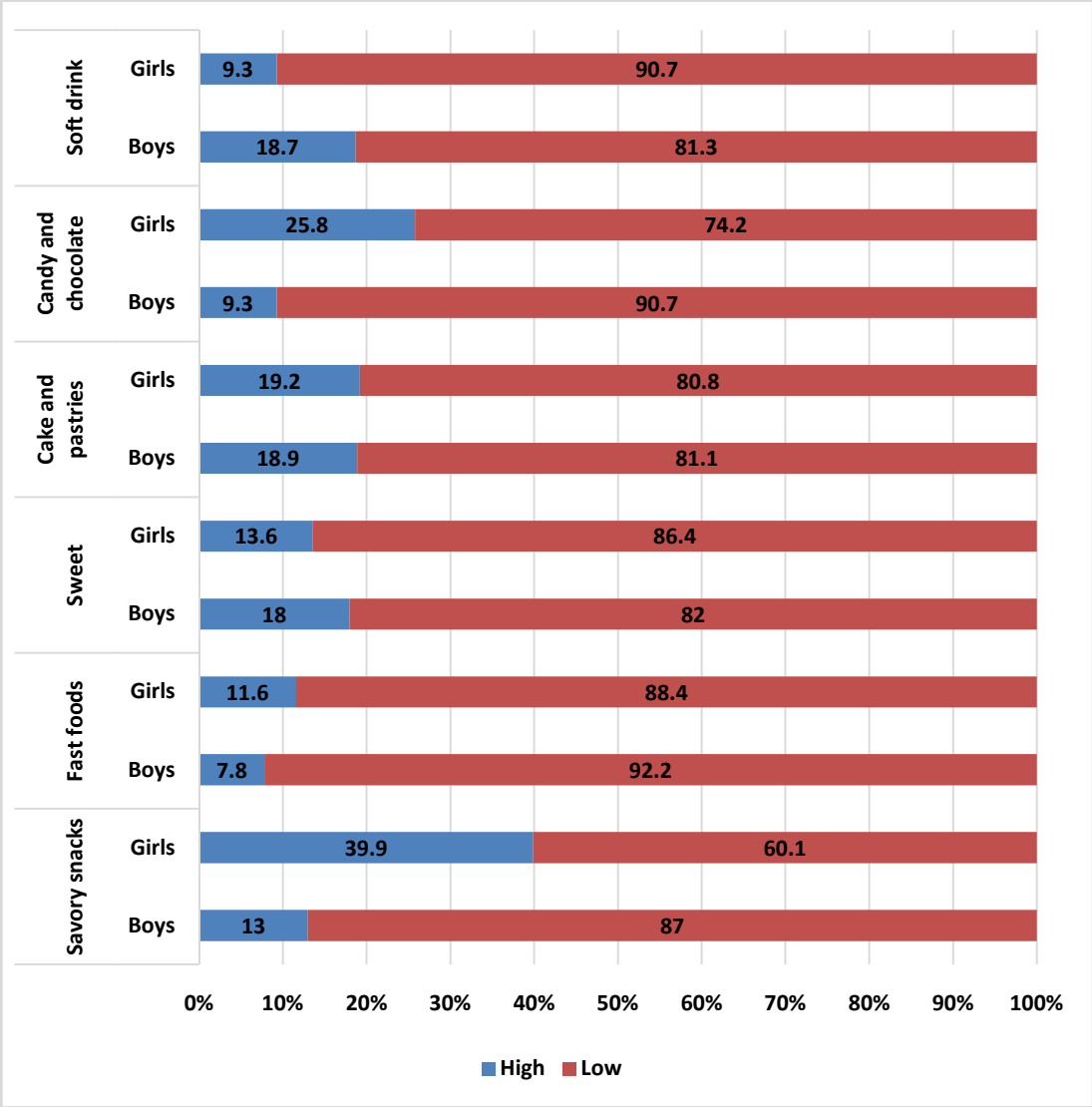


Fig.4.21 :Dichotomized consumption pattern of unhealthy foods by boys and girls

Table 4.20 :Dichotomized consumption pattern of unhealthy foods by the early and late adolescent boys

Food Items	Adolescent group	Total N	High Consumption		Low Consumption		χ^2	p
			N	%	N	%		
Savory snacks	Early	420	77	18.3	343	81.7	25.98	.00
	Late	298	16	5.4	282	94.6		
Fast foods	Early	420	27	6.4	393	93.6	2.64	.104
	Late	298	29	9.7	269	90.3		
Sweet	Early	420	234	55.7	186	44.3	59.03	.000
	Late	298	80	26.8	218	73.2		
Cake and pastries	Early	420	93	22.1	327	77.9	6.755	.009
	Late	298	43	14.4	255	85.6		
Candy and chocolate	Early	420	40	9.5	380	90.5	0.044	.833
	Late	298	27	9.1	271	90.9		
Soft drink	Early	420	45	10.7	375	89.3	42.11	.000
	Late	298	89	29.9	209	70.1		

The Table 4.20 showed that the consumption pattern decreases from early to late adolescent for majority of the food items (savory snacks, sweets, cake/ pastries and candy / chocolates) except for the fast food and the soft drinks.

Significantly higher percentage of early adolescent boys as compared to their late counterpart, reported frequent consumption of savoury snacks (18.3 %) vs 5.4%, χ^2 = 25.98, p = .000), sweets (55.7 % vs 26.8 %, χ^2 = 59.03, p = 0.000), and cake and pastries (22.1 % vs 14.4%, χ^2 = 6.75, p = 0.009).

Significantly higher percentage of late adolescent boys as compared to their early counterpart, reported frequent consumption of soft drinks (29.9% vs 10.7%, χ^2 = 42.11,p = .000)

Table 4.21 :Dichotomized consumption pattern of unhealthy foods by the early and late adolescent girls

Food items	Adolescent group	Total N	High Consumption		Low Consumption		χ^2	p
			N	%	N	%		
SavorySnacks	Early	460	202	43.9	258	56.1	7.93	.005
	Late	289	97	33.6	192	66.4		
Fast foods	Early	460	58	12.6	402	87.4	1.15	.284
	Late	289	29	10.0	260	90.0		
Sweet	Early	460	159	34.6	301	65.4	23.03	.000
	Late	289	53	18.3	236	81.7		
Cake and pastries	Early	460	89	19.3	371	80.7	0.011	.915
	Late	289	55	19.0	234	81.0		
Candy andchocolate	Early	460	118	25.7	342	74.3	0.008	.927
	Late	289	75	26.0	214	74.0		
Soft Drink	Early	460	13	2.8	447	97.2	59.81	.000
	Late	289	57	19.7	232	80.3		

Analysis of dichotomized consumption pattern of unhealthy foods by early and late adolescent girls (Table 4.21), showed that significantly higher percentage of early adolescent girls as compared to their late counterpart, had frequent consumption of savoury snacks (43.9% vs 33.6%, $\chi^2 = 7.93$, p = .005), and sweets (34.6 % vs 18.3 %, $\chi^2 = 23.03$, p = .000).)

A significantly higher percentages of late adolescent girls as compared to their early counterpart reported frequent consumption of soft drinks (19.7% vs 2.8%, $\chi^2 = 59.81$, p = .000).

4.4.4 VEG AND NON- VEG FOOD CONSUMPTION BY THE HIMACHALI ADOLESCENT POPULATION

The distribution of vegetarian and non-vegetarian meal pattern revealed that among the boys (N = 718) half of the boys are vegetarian (n = 361, 50.3 %) and the remaining half are non-vegetarian (N = 357, 49.7%).

Girls, in contrast were mostly vegetarian. Among the girls (N = 749), a total of 492 girls (65.7%) were vegetarian and 257 girls (34.3 %) were non-vegetarian. The

distribution of meal pattern among the boys and girls appeared to be highly statistically significant (χ^2 (1) = 35.17, p < .001)

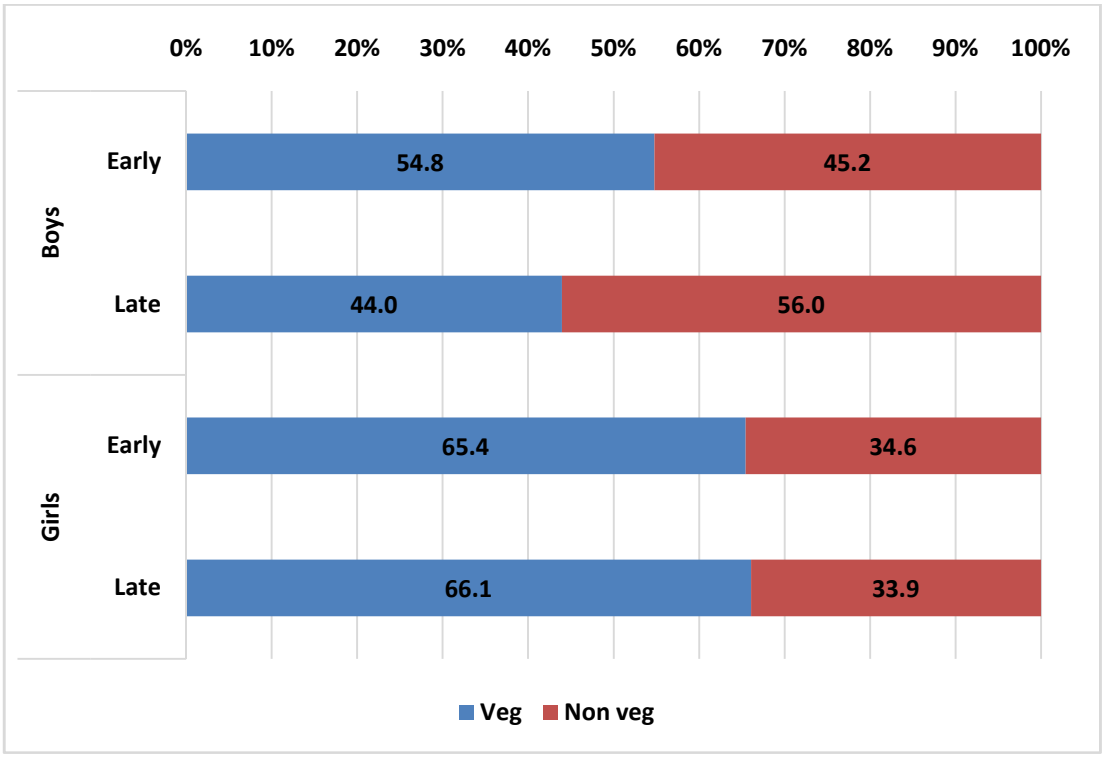
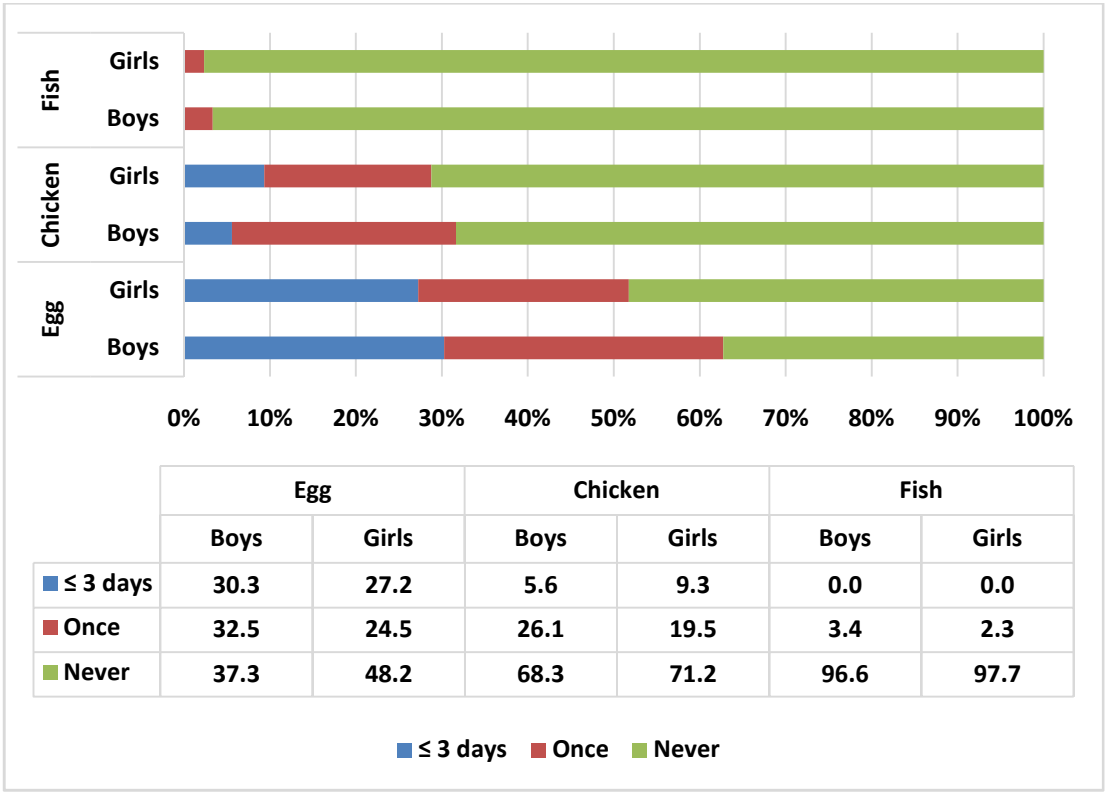


Fig. 4.22 :Vegetarian and non-vegetarian diet pattern of the boys and girls in relation to adolescent category



	Egg		Chicken		Fish	
	Boys	Girls	Boys	Girls	Boys	Girls
≤ 3 days	30.3	27.2	5.6	9.3	0.0	0.0
Once	32.5	24.5	26.1	19.5	3.4	2.3
Never	37.3	48.2	68.3	71.2	96.6	97.7

Fig.4.23 :Consumption frequencies of non-vegetarian items by boys and girls

Egg, chicken and meat and fish were the non-vegetarian items consumed. All the items were reported to be consumed less frequently, i.e, either ≤ 3 days a week, or once or never over the last two weeks prior to the study. Figure 4.23 depicts the frequency of consumption of different non-vegetarian foods. Fish was the least consumed item and consumed only by 3.4 % of boys (n =12) and 2.3 % (n =6) girls. Overall consumption of chicken was reported by 31.7 % of the boys (n = 113) and 28.8 % of the girls (N = 74). Percentages of boys and girls reporting the consumption of eggs were highest. 224 boys (62.7) and 133 girls (51.8%) reported egg consumption.

4.5 RESULTS ON ASSOCIATION BETWEEN DIETARY PATTERN AND NUTRITIONAL STATUS

4.5.1 DIETARY PATTERN AND STUNTING

Diet and Stunting status in Boys

Table 4.22 :Dietary pattern and stunting status in boys

Dietary Variables	Pattern	Stunting Status		χ^2	p
		Yes (N=54) F (%)	No (N=664) F (%)		
Breakfast	Regular (617)	32(5.2)	585(94.8)	34.369	.000
	Irregular (101)	22(21.8)	79(78.2)		
Fruit	High (475)	35(7.4)	440(92.6)	0.047	.829
	Low (243)	19(7.8)	224(92.2)		
Milk	High (568)	44(7.8)	524(92.2)	0.199	.656
	Low (150)	10(6.7)	140(93.3)		
Diary	High (175)	13(7.4)	162(92.6)	0.003	.958
	Low (543)	41(7.6)	502(92.4)		
Cooked Veg.	High (589)	43(7.3)	546(92.7)	0.229	.632
	Low (129)	11(8.6)	118(91.4)		
Green leafy	High (7)	1(14.3)	6(85.7)	0.465	.495
	Low (711)	53(7.4)	658(92.6)		
Salad	High (449)	32(7.1)	417(92.9)	0.267	.605
	Low (269)	22(8.1)	247(91.9)		

Dietary Variables	Pattern	Stunting Status		χ^2	p
		Yes (N=54) F (%)	No (N=664) F (%)		
Pulses	High (619)	45(7.3)	574(92.7)	0.407	.524
	Low (99)	9(9)	90(91)		
Savory snack	High (93)	20(21.5)	73(78.5)	30.041	.000
	Low (625)	34(5.4)	591(94.6)		
Fast food	High (56)	10(17.9)	46(82.1)	9.330	.002
	Low (662)	44(6.6)	618(93.4)		
Sweet	High (314)	17(5.4)	297(94.6)	3.562	.059
	Low (404)	37(9.1)	367(90.9)		
Cake/pastries	High (136)	12(8.8)	124(91.2)	0.409	.522
	Low (582)	42(7.2)	540(92.8)		
Candy / Chocolate	High (67)	6(9)	61(91)	0.219	.640
	Low (651)	48(7.4)	603(92.6)		
Soft Drinks	High (134)	18(13.4)	116(86.6)	8.279	.004
	Low (584)	36(6.2)	548(93.8)		

Analysis of dietary pattern and stunting in boys (Table 4.22)showed significant association of stunting with irregular breakfast pattern (22% stunted in irregular group vs 5% stunted in regular group), χ^2 =34.37, p < .001.

Stunting in boys is also significantly associated with high consumption of savory snacks (22% stunted in high consumption group vs 5% stunted in low consumption group), χ^2 30.04, df 1, p < 0.001, and soft drinks consumption (13.4% stunted in high consumption group vs 6% stunted in low consumption group), χ^2 8.28, df 1, p < 0.01.

Diet and Stunting status in Girls

Table 4.23 :Dietary pattern and stunting status in girls

Dietary Variables	Pattern	Stunting Status		χ^2	p
		Yes (N=66) N (%)	No (N=683) N (%)		
Breakfast	Regular (559)	31 (5.5)	528 (94.5)	29.25	.000
	Irregular (190)	35 (18.4)	155 (81.6)		
Fruit	High (520)	9 (1.7)	511 (98.3)	1.06	.000

Dietary Variables	Pattern	Stunting Status		χ^2	p
		Yes (N=66) N (%)	No (N=683) N (%)		
	Low (229)	57 (24.9)	172 (75.1)		
Milk	High (638)	52 (8.1)	586 (91.9)	2.34	.126
	Low (111)	14 (12.6)	97 (87.4)		
Diary	High (542)	45 (8.3)	497 (91.7)	0.109	.741
	Low (225)	21 (9.3)	204 (90.7)		
Cooked Veg.	High (604)	34 (5.6)	570 (94.4)	46.94	.000
	Low (144)	31 (21.5)	113 (78.5)		
Green leafy	High (46)	1 (2.2)	45 (97.8)	2.68	.101
	Low (703)	65 (9.2)	638 (90.8)		
Salad	High (548)	47 (8.6)	501 (91.4)	0.140	.708
	Low (201)	19 (9.5)	182 (90.5)		
Pulses	High (648)	56 (8.6)	592 (91.4)	0.172	.678
	Low (101)	10 (9.9)	91 (90.1)		
Savory snack	High (299)	22 (7.4)	277 (92.6)	1.309	.253
	Low (450)	44 (9.8)	406 (90.2)		
Fast food	High (87)	8 (9.2)	79 (90.8)	0.018	.893
	Low (662)	58(8.8)	604 (91.2)		
Sweet	High (112)	15 (13.4)	97(86.6)	1.109	.292
	Low (537)	51 (9.5)	486 (90.5)		
Cake/pastries	High (144)	17 (11.8)	127 (88.2)	1.989	.158
	Low (605)	49 (8.1)	556 (91.9)		
Candy / Chocolate	High (193)	15 (7.8)	178 (92.2)	0.350	.554
	Low (556)	51 (9.2)	505 (90.8)		
Soft Drinks	High (70)	4 (5.7)	66 (94.3)	0.922	.337
	Low (679)	62 (9.1)	617 (90.9)		

Stunting in girls was associated with breakfast frequency and consumption patterns of fruit and cooked vegetables. Self-reported intake of unhealthy foods did not reveal any relation with stunting status.

Among the irregular breakfast group statistically significant higher percentage of girls (18%) were stunted as compared to 6% of the girls in the regular breakfast group, (χ^2 29.25, df 1, $p < 0.001$).

Stunting was reported by 25% of the girls with low consumption of fruit as compared to only 1.7% of the girls with high fruit consumption (χ^2 10.06, df 1, $p < 0.01$). Again, stunting was reported by 22% of girls with low cooked vegetable consumption as compared to 6% of the girls with low consumption (χ^2 46.94, df 1, $p < 0.01$).

4.5.2 DIETARY PATTERN AND THINNESS

Diet and Thinness status in Boys

Table 4.24 :Dietary pattern and thinnessin Boys

Dietary Variables	Pattern	Stunting Status		χ^2	p
		Yes (N=139) F (%)	No (N=579) F (%)		
Breakfast	Regular (617)	98 (15.9)	519 (84.1)	33.95	.000
	Irregular (101)	41 (40.6)	60 (59.4)		
Fruit	High (475)	79(16.6)	396(83.4)	6.689	.010
	Low (243)	60(24.7)	183(75.3)		
Milk	High (568)	114(20.1)	454(79.9)	0.881	.348
	Low (150)	25(16.7)	125(83.3)		
Diary	High (175)	33(18.9)	142(81.1)	0.037	.847
	Low (543)	106(19.6)	437(80.47)		
Cooked Veg.	High (589)	111(18.9)	478(81.2)	0.554	.457
	Low (129)	28(20.7)	101(78.29)		
Green leafy	High (7)	1(14.2)	6(85.7)	0.117	.733
	Low (711)	138(19.4)	573(80.59)		
Salad	High (449)	79(17.6)	370(82.4)	2.391	.122
	Low (269)	60(22.3)	209(77.7)		
Pulses	High (619)	125(20.1)	494(79.9)	2.003	.157
	Low (99)	14(14.1)	85(85.9)		
Savory snack	High (93)	26(27.9)	67(72.0)	5.06	.025
	Low (625)	113(18.08)	512(81.9)		
Fast food	High (56)	20(35.71)	36(64.3)	10.407	.0001

Dietary Variables	Pattern	Stunting Status		χ^2	p
		Yes (N=139) F (%)	No (N=579) F (%)		
	Low (662)	119(17.9)	543(82)		
Sweet	High (314)	57(18.1)	257(81.9)	0.520	.471
	Low (404)	82(20.2)	322(79.7)		
Cake/pastries	High (136)	26(19.1)	110(80.9)	0.006	.937
	Low (582)	113(19.4)	469(80.5)		
Candy / Chocolate	High (67)	12(17.9)	55(82)	0.099	.753
	Low (651)	127(19.5)	524(80.4)		
Soft Drinks	High (584	132(22.6)	452(77.3)	21.086	.000
	Low) (134)	7(5.2)	127(94.7)		

Analysis of dietary pattern and thinness in boys (Table 4.24)showed significant association of thinness with irregular breakfast pattern (41% stunted in irregular group vs16% stunted in regular group), χ^2 =33.95, p < .000.

Significantly higher prevalence of thinness was also reported among the boys who had low consumption of fruit, (25 % thin) as compared to17% of the thin boys with high consumption (χ^2 =6.69, df 1, p = .010).

Thinness in boys was also significantly associated with high consumption of savory snacks (28% thin in high consumption group vs 18% thin in low consumption group),χ^2 5.06, df 1, p < .025,fast food consumption (36% thin in high consumption group vs 18% stunted in low consumption group), χ^2 10.41, df 1, p < .000, and soft drinks (23% thin in high consumption group vs 5%thin in low consumption group) χ^2 =21.09, df 1, p < .001).

Diet and Thinness status in Girls

Table 4.25 :Dietary pattern and thinness status in girls

Dietary Variables	Pattern	Wasting Status		χ^2	p
		Yes (N=132) N (%)	No (N=617) N (%)		
Breakfast	Regular (559)	72 (12.9)	487 (87.1)	34.15	.000
	Irregular (190)	60 (31.6)	130 (68.4)		
Fruit	High (520)	40 (7.7)	480 (92.3)	11.55	.000
	Low (229)	92 (40.2)	137 (59.8)		
Milk	High (638)	114 (17.9)	524 (82.1)	0.178	.673

Dietary Variables	Pattern	Wasting Status		χ^2	p
		Yes (N=132) N (%)	No (N=617) N (%)		
	Low (111)	18 (16.2)	93(83.8)		
Diary	High (524)	80 (15.3)	444 (84.7)	6.671	.010
	Low (225)	52 (23.1)	173 (76.9)		
Cooked Veg.	High (604)	83 (13.7)	521 (86.3)	33.17	.000
	Low (144)	49 (34)	95 (66)		
Green leafy	High (46)	6 (13)	40 (87)	0.708	.400
	Low (703)	126 (17.9)	577 (82.1)		
Salad	High (548)	97 (17.7)	451 (82.3)	0.008	.927
	Low (201)	35 (17.4)	166 (82.6)		
Pulses	High (648)	107 (16.5)	541 (83.5)	4.087	.043
	Low (101)	25 (24.8)	76 (75.2)		
Savory snack	High (299)	53 (17.7)	246 (82.3)	0.004	.952
	Low (450)	79 (17.6)	371 (82.4)		
Fast food	High (87)	16 (18.4)	71 (81.6)	0.040	.842
	Low (662)	116 (17.5)	546 (82.5)		
Sweet	High (212)	32 (15.1)	180 (84.9)	1.303	.254
	Low (537)	100 (18.6)	437 (81.4)		
Cake/pastries	High (144)	25 (17.4)	119 (82.6)	0.0080	.927
	Low (605)	107 (17.7)	498 (82.3)		
Candy / Chocolate	High (193)	29 (15)	164 (85)	1.208	.272
	Low (556)	103 (18.5)	453 (81.5)		
Soft Drinks	High (70)	8 (11.4)	62 (88.6)	2.041	.153
	Low (679)	124 (18.3)	555 (81.7)		

Dietary pattern and thinness among girls (Table4.25**)** revealed that breakfast habit has a significant effect on thinness. The data revealed that a higher percentage (32%) of the girls in the irregular breakfast group were thin as compared to only 13% of the girls who took regular breakfast, and this difference appeared to be significant (χ^2 34.15, df 1, p <0.001).

Analysis of healthy food consumption pattern showed statistically significant association between thinness and fruit consumption (40 % in low consumption group

vs 8% in high consumption group, χ^2 1.15, df 1, p <0.001), diary product consumption (23 % in low consumption group vs 15% in high consumption group, χ^2 6.67, df 1, p =0.01), cooked vegetable (34% % in low consumption group vs 14% in high consumption group, chi square 33.17, df 1, p < 0.001) and pulses (25% in low consumption group vs 17% in high consumption group, chi square 4.09, df 1, p =0.05). However, snacking pattern or consumption of unhealthy type of foods did not reveal any significant association with the thinness.

4.5.3 DIETARY PATTERN AND OVER-NUTRITION (OVERWEIGHT AND OBESITY)

DIET AND OVER-NUTRITION AMONG BOYS

Table 4.26 :Dietary pattern and over-nutrition status in boys

Dietary Variables	Pattern	Over-nutrition Status		χ^2	p
		Yes (N=55) F (%)	No (N=663) F (%)		
Breakfast	Regular (617)	39(6.3)	578(93.7)	11.122	.001
	Irregular (101)	16(15.8)	85(84.2)		
Fruit	High (475)	38(8)	437(92)	0.229	.632
	Low (243)	17(7)	226(93)		
Milk	High (568)	45(7.9)	523(92.1)	0.265	.607
	Low (150)	10(6.7)	140(93.3)		
Diary	High (175)	9(5.1)	166(94.9)	2.073	.150
	Low (543)	46(8.5)	497(91.5)		
Cooked Veg.	High (589)	47(8)	542(92)	0.473	.492
	Low (129)	8(6.2)	121(93.8)		
Green leafy	High (7)	0(0)	7(100)	0.586	.444
	Low (711)	55(7.7)	656(92.3)		
Salad	High (449)	38(8.5)	411(91.5)	1.093	.296
	Low (269)	17(6.3)	252(93.7)		
Pulses	High (619)	48(7.8)	571(92.2)	0.056	.812
	Low (99)	7(7)	92(93)		
Savory snack	High (93)	22(23.7)	71(76.3)	38.646	.000
	Low (625)	33(5.3)	592(94.7)		
Fast food	High (56)	20(35.7)	36(64.3)	67.580	.000
	Low (662)	35(5.3)	627(94.7)		

Dietary Variables	Pattern	Over-nutrition Status		χ^2	p
		Yes (N=55) F (%)	No (N=663) F (%)		
Sweet	High (314)	35(11.1)	279(88.9)	9.589	.002
	Low (404)	20(5)	384(95)		
Cake/pastries	High (136)	10(7.3)	126(92.7)	0.022	.881
	Low (582)	45(7.7)	537(92.3)		
Candy / Chocolate	High (67)	7(10.4)	60(89.6)	0.812	.368
	Low (651)	48(7.3)	603(92.7)		
Soft Drinks	High (134)	18(13.4)	116(86.6)	7.761	.005
	Low (584)	37(6.3)	547(93.7)		

Analysis of dietary pattern and over nutritional status in boys (Table 4.26) showed statistically significant association of over-nutrition with irregular breakfast consumption pattern (16% overweight in irregular group vs 6%overweight in regular group),$\chi^2$11.12, df 1, $p < 0.001$.

Overweight in boys is significantly associated with high consumption of savory snacks (24% overweight in high consumption group vs 5% overweight in low consumption group), χ^2 38.65, df 1, $p < 0.001$, fast food (36% overweight in high consumption group vs 5% overweight in low consumption group) χ^2 67.58, df 1, $p < 0.001$, sweets (11% overweight in high consumption group vs 5% overweight in low consumption group) χ^2 9.58, df 1, $p < 0.002$, and soft drinks consumption (13% overweight in high consumption group vs 6% overweight in low consumption group) χ^2 7.76, df 1, $p < 0.005$.

Diet and Over-nutrition among girls

Table 4.27 :Dietary pattern and over-nutrition status in girls

Dietary Variables	Pattern	Over-nutrition Status		χ^2	p
		Yes (N=32) F (%)	No N=717) F (%)		
Breakfast	Regular (559)	16 (2.9)	543 (97.1)	10.71	.001
	Irregular (190)	16 (8.4)	174 (91.6)		
Fruit	High (520)	2 (0.4)	518 (99.6)	62.86	.000
	Low (229)	30 (13.1)	199 (86.9)		

Dietary Variables	Pattern	Over-nutrition Status		χ^2	p
		Yes (N=32) F (%)	No N=717) F (%)		
Milk	High (638)	27 (4.2)	611 (95.8)	0.017	.90
	Low (111)	5 (4.5)	106 (95.5)		
Diary	High (524)	24 (4.6)	500 (95.4)	0.404	.525
	Low (225)	8 (3.6)	217 (96.4)		
Cooked Veg.	High (604)	26 (4.3)	578 (95.7)	0.050	.975
	Low (144)	6 (4.2)	138 (95.8)		
Green leafy	High (49)	3 (6.5)	43 (93.5)	0.606	.436
	Low (703)	29 (4.1)	674 (95.9)		
Salad	High (548)	25 (4.6)	523 95.4)	0.419	.517
	Low (201)	7 (3.5)	194 (96.5)		
Pulses	High (648)	30 (4.6)	618 (95.4)	1.50	.221
	Low (101)	2 (2.0)	99 (98.0)		
Savory snack	High (299)	17 (5.7)	282 (94.3)	2.43	.119
	Low (450)	15 (3.3)	435 (96.7)		
Fast food	High (87)	9 (10.3)	78 (89.7)	8.87	.003
	Low (662)	23 (3.5)	639 (96.5)		
Sweet	High (212)	11 (5.2)	201 (94.8)	0.607	.436
	Low (537)	21 (3.9)	516 (96.1)		
Cake/pastries	High (144)	3 (2.1)	141 (97.9)	2.089	.148
	Low (605)	29 (4.8)	576 (95.2)		
Candy / Chocolate	High (193)	7(3.6)	186 (96.4)	0.265	.607
	Low (556)	25 (4.5)	531(95.5)		
Soft Drinks	High (70)	6(8.6)	64(91.4)	3.49	.062
	Low (679)	26(3.8)	653(96.2)		

Analysis of over nutritional status and dietary pattern in girls (Table 4.27)showed statistically significant association of breakfast consumption pattern with over-nutrition. Among the irregular breakfast group 8% girls were overweight as compared to 3% of the girls having regular breakfast consumption (χ^2 10.71, df 1, $p < 0.001$).

Statistically significant association was observed between low fruit consumption and over-nutrition, 13% of the girls with low fruit consumption were overweight as compared to only 0.4% of the girls with high fruit consumption. (χ^2 62.86, df 1, $p < .001$).

Similar highly significant statistical relations were obtained with the consumption of fast food.10% of the girls with high fastfood consumption were found to be in overweight and obese as compared to only 4% girls with low consumption (χ^2 8.87, df 1, $p < 0.01$).

REFERENCES OF RESULTS

1. Khadilkar V., Khadilkar A.V. and Kajale N. (2019). Indian growth references from 0-18-year-old children and adolescents - A comparison of two methods. *Indian Journal of Endocrinology and Metabolism*, **23**, 635-44.

CHAPTER – V

DISCUSSION

5.1 DISCUSSION ON PHYSICAL GROWTH

The present study has determined the growth standards of the school going adolescent boys and girls of Himachal Pradesh within the age group of 10 to 17 years. The growth standards were assessed principally from height and weight which are considered as the two most sensitive anthropometric indicators of physical growth. The study has also attempted to evaluate the growth deficiencies in this population from two growth indices namely height - for - age and BMI-for-age.

Attempt has been made to compare the height and weight of the present Himachali boys and girls with similar Indian population as reported in some earlier studies.

5.1.1 DISCUSSION ON HEIGHT

5.1.1.1 COMPARISON OF MEAN HEIGHT OF HIMACHALI BOYS WITH OTHER INDIAN POPULATION

The pooled mean height of Himachali boys of 10-17 years was 155.7 cm. As compared to four studies reported in other Indian population of same age group Himachali boys were found to be taller(Fig.5.1), than rural adolescents from nine different Indian states[1](Mean difference=10.4 cm), the tribal adolescents from Orissa[2](Mean difference=10.2 cm), rural adolescent boys from West Bengal[3](Mean difference=9.9 cm),urban school children from north India[4](Mean Difference= 1.9 cm) and rural boys from Haryana[5](Mean Difference= 1.9 cm).

However, the mean height of Himachali boys were 2.5 cmlower than the mean height reported for Indian school boys belonging to the upper socio-economic strata[6].

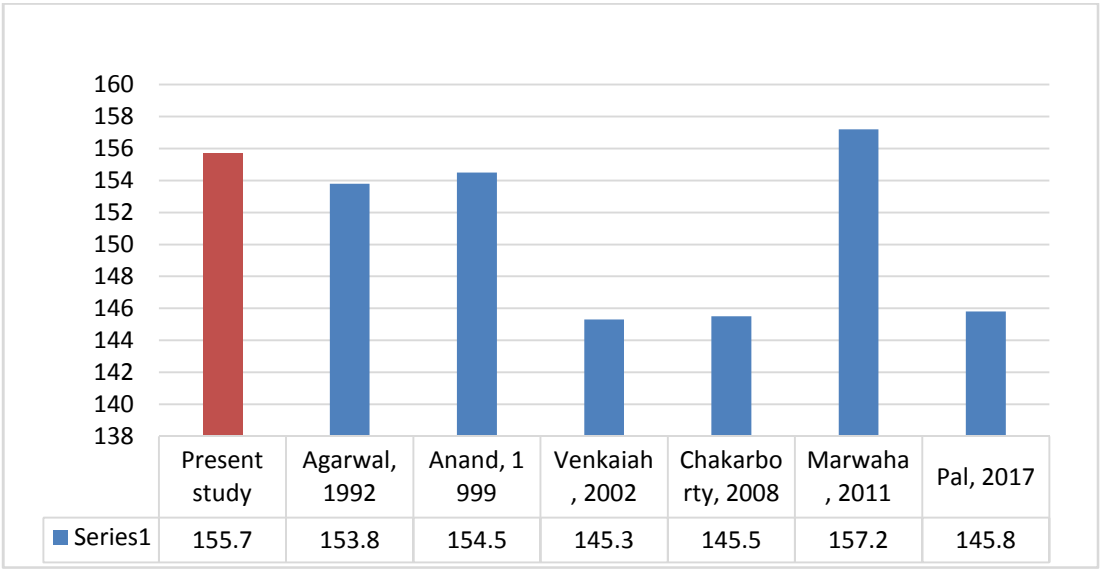


Fig.5.1 :Comparison of height of the Himachali boys with other Indian studies

1. Agarwal etal.,1992. Affluent school children from urban population of north India.
2. Anand K, 1999. Rural school children from Haryana, North India
3. Venkaiahetal., 2002. Rural adolescents from nine Indian states.
4. Chakraborty&Bharti, 2008. Shabar tribal children from Orissa.
5. Marwahaetal., 2011. Urban school children from different Indian cities of upper socio-economic strata.
6. Pal etal., 2017. Rural children from West Bengal of lower socioeconomic strata.

5.1.1.2 COMPARISON OF MEAN HEIGHT OF EARLY ADOLESCENT HIMACHALI BOYS WITH OTHER STUDIES

The mean height of early adolescent (10-14years) Himachaliboys was 148.3 cm.This was found to be higher thanthe early adolescent Indian boys as reported in five different studies. In decreasing order, the mean differences were19 cm, 10.9 cm, 6.1 cm, 5.1 cm and 3.3 cm, as compared to the rural boys of West Bengal[7],boys oflower socioeconomic class from Assam[8], urban school children from Kolkata[9], urban school boys of Ahmedabad[10] and rural school children from Jammu and Kashmir[11]respectively (Figure 5.2).

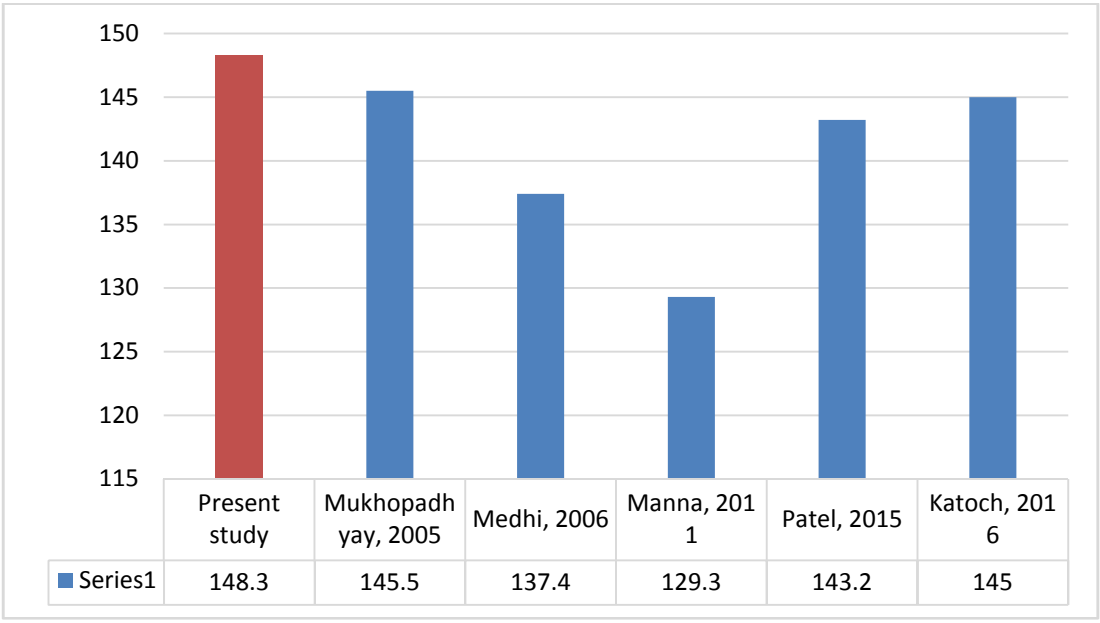


Fig.5.2 :Comparison of height of the early adolescent Himachali boys with other Indian studies

1. Mukhopadhyayetal., 2005. Urban school children from North 24 Parganas, West Bengal.
2. Medhietal., 2006. Children of tea garden workers, from lower socioeconomic class of Assam.
3. Manna et al., 2011. Rural school children from Darjeeling and Jalpaiguri districts of West Bengal.
4. Patel etal., 2015. Urban school children from Ahmedabad, Gujrat.
5. Katoch and Sharma. 2016. Rural school children from Doda district, Jammu and Kashmir.

5.1.1.3 COMPARISON OF MEAN HEIGHT OF LATE ADOLESCENT HIMACHALI BOYS WITH OTHER STUDIES

The pooled mean height of late adolescent Himachali boys (15-17 years) was 168.1 cm. This was higher than the mean heights of different population of late adolescent Indian boys. In decreasing order, the mean differences were found to be 11.4 cm, 10.7 cm, 1.1 cm,10.9 cm as compared to tribal adolescents from Orissa[2], rural adolescents from different Indian states[1],rural adolescent boys from West Bengal[3] and urban affluent Indian school children[4]respectively. However, themean height was found to be slightly lower by 0.9 cm when compared withthe Indian school children[6]. This comparison is presented in Figure 5.3

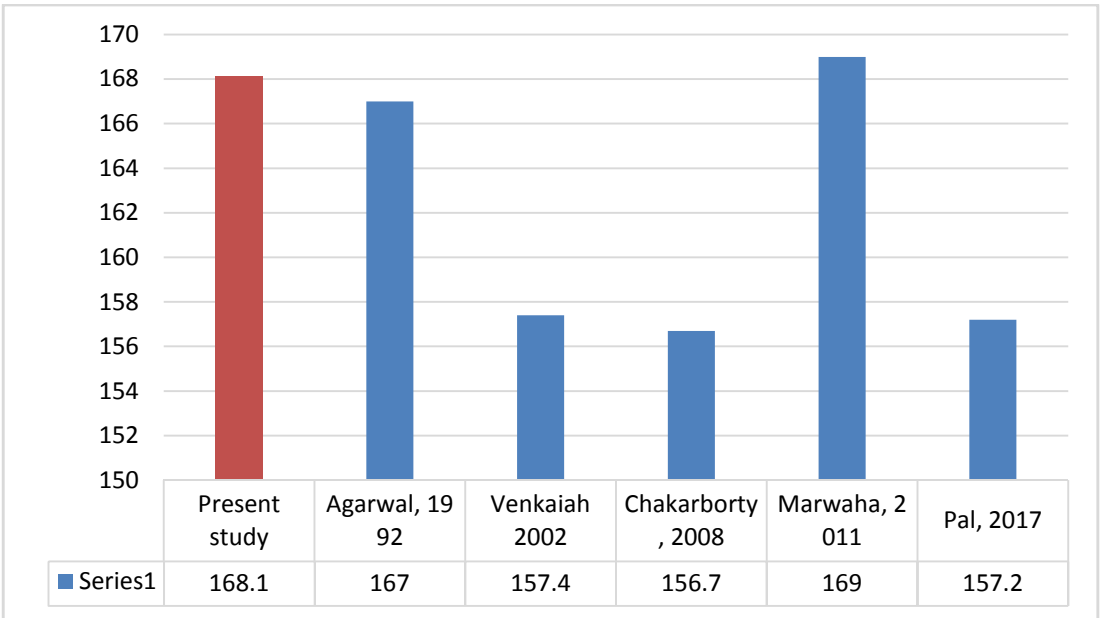


Fig.5.3 :Comparison of height of the late adolescent Himachali boys with other Indian studies

1. Agarwaletal., 1992. Affluent school children from urban population of north India.
2. Venkaiahetal., 2002. Rural adolescents from nine Indian states.
3. Chakraborty&Bharti, 2008. Shabar tribal children from Orissa.
4. Marwahaetal., 2011. Urban school children from different Indian cities of upper socio-economic strata.
5. Pal etal., 2017. Rural children from West Bengal of lower socioeconomic strata.

5.1.1.4 COMPARISON OF HEIGHT OF HIMACHALI GIRLS WITH OTHER INDIAN POPULATION

The height of Himachali girls was (mean=150.7 cm) shorter by 1.3 cm and 1.6 cm as compared to Indian school children[6]and Rajput females from Shimla district of Himachal Pradesh[12]respectively, and taller by 0.7 cm, 7.2 cm, 7.6 cm, and 8.5 cm as compared to urban girls of north India[4], rural girls from West Bengal[3] and rural adolescent girls from different Indian states[1], and Shabar tribal adolescent girls from Odissa[2] respectively. (Fig.5.4)

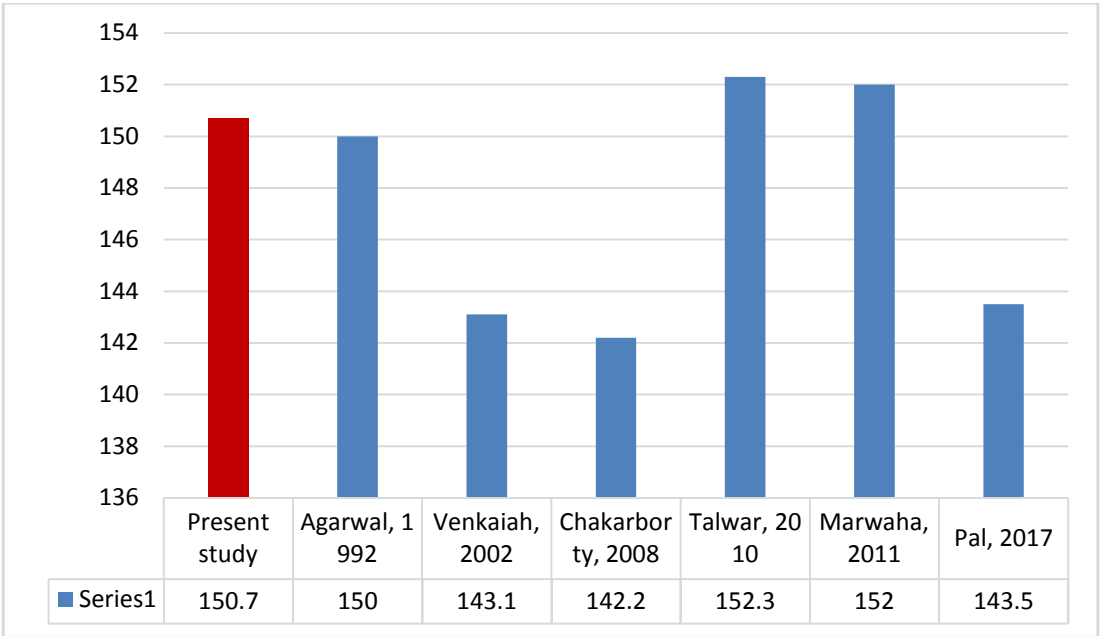


Fig.5.4 :Comparison of height of the Himachali girls with other Indian studies

1. Agarwaletal., 1992. Affluent school children from urban population of 19 cities of north, south, east and west of India.
2. Venkaiahetal., 2002. Rural adolescents from nine Indian states.
3. Chakraborty&Bharti, 2008. Shabar tribal children from Orissa.

4. Talwar,2010. Adolescent Rajput females from Shimla district of Himachal Pradesh.
5. Marwaha et al., 2011. Urban school children from different Indian cities of upper socio-economic strata.
6. Pal etal., 2017. Rural lower social class children from West Bengal.

5.1.1.5 COMPARISON OF MEAN HEIGHT OF EARLY ADOLESCENT HIMACHALI GIRLS WITH OTHER STUDIES

The mean height of early adolescent (10-14years) Himachali girls was 147.4 cm. This was found to be higher than the mean height reported for five different Indian population of early adolescent girls. In decreasing order, the mean differences ofheight between Himachali girls and these population were 15.8 cm, 9.8 cm, 8.2 cm, 6.2 cm and 4.2 cm,when compared with rural school children of North Bengal[7], girls of lower socioeconomic class from Assam[8], rural girls from PaschimMedinipur district of West Bengal[13], girls from urban areas of Ahmedabad[10], and urban girls from north 24 Pargana of West Bengal[9]respectively. This comparison is presented in Figure 5.5

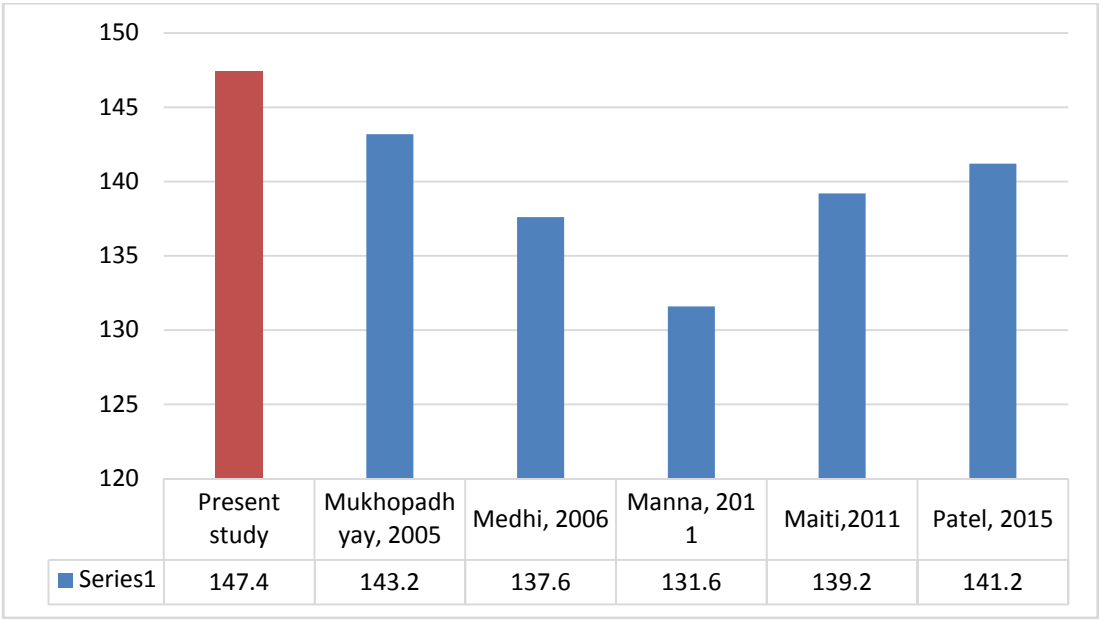


Fig.5.5 :Comparison of height of the early adolescent Himachaligirls with other Indian studies

1. Mukhopadhyayetal., 2005. Urban school children from North 24 Parganas, West Bengal.

2. Medhietal., 2006. Children of tea garden workers, from lower socioeconomic class of Assam.
3. Manna et al., 2011. Rural school children from Darjeeling and Jalpaiguri districts of West Bengal.
4. Maitietal., 2011. Early adolescent school girls in PaschimMedinipur district of West Bengal.
5. Patel etal., 2015. Urban school children from Ahmedabad, Gujrat.

5.1.1.6 COMPARISON OF MEAN HEIGHT OF LATE ADOLESCENT HIMACHALI GIRLS WITH OTHER STUDIES

The pooled mean height of late adolescent (15-17 years) girls was 156.0 cm. This was found to be higher than the mean heights of different Indian studies reported for late adolescent girls. In decreasing order,the mean differences of height between the late adolescent Himachali girls and other studies were 9.1 cm, 5.6 cm, 5.5 cm, 5 cm and 1.2 cm as compared to tribal adolescents from Orissa[2], school going adolescent girls from Tamilnadu[14], rural adolescent girls from West Bengal[4], rural adolescents from different Indian states[1], and adolescent Rajput females of Shimla district of Himachal Pradesh respectively. However, this reported height was found to be slightly lower by 1.5 cm as compared to the Indian school children[6]andalmost similar to the affluent class adolescents from eight different states of India[5] and rural school children from Haryana[5] (mean value=155.4 cm). This comparison is presented in Figure 5.6

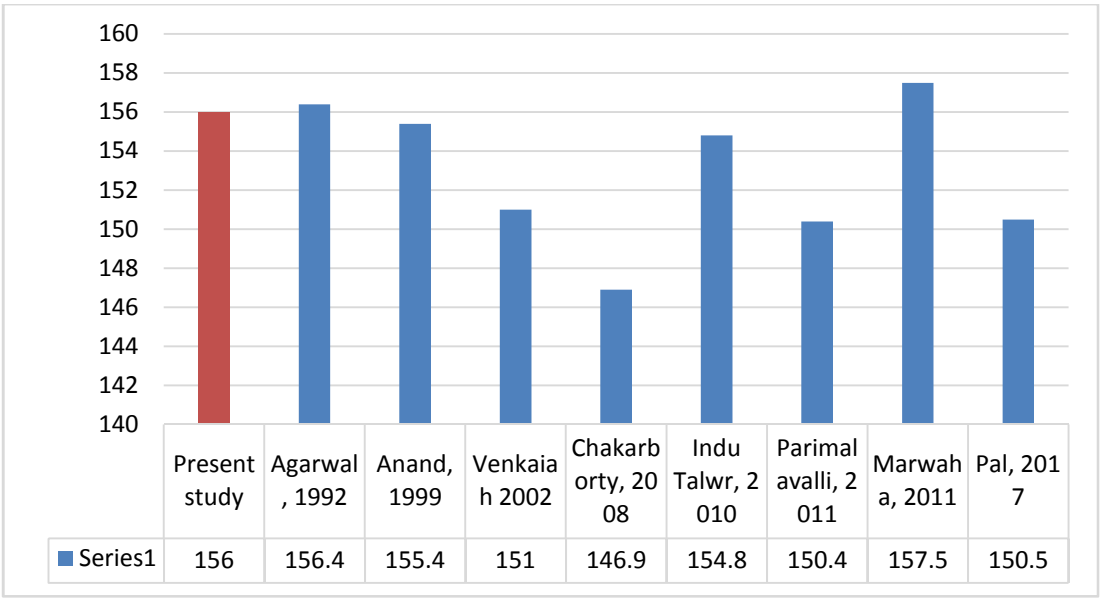


Fig. 5.6 :Comparison of height of late adolescent Himachali girls with other Indian studies

1. Agarwaletal., 1992. Affluent school children from urban population of 19 cities of north, south, east and west of India.
2. Anand K, 1999. Rural school children from Haryana, North India.
3. Venkaiahetal., 2002. Rural adolescents from nine Indian states.
4. Chakraborty&Bharti, 2008. Shabar tribal children from Orissa.
5. Indu Talwar,2010. Adolescent Rajput females from Shimla district of Himachal Pradesh.
6. Parimalavalli& Sangeetha,2011. School going adolescent girls from Tamilnadu.
7. Marwahaetal., 2011. Govt and Private school children from 19 cities from north, south, east and west zones of India.
8. Pal etal., 2017. Rural lower social class children from West Bengal.

5.1.2 DISCUSSION ON WEIGHT

5.1.2.1 COMPARISON OF MEAN WEIGHT OF HIMACHALI BOYS WITH OTHER INDIAN POPULATION

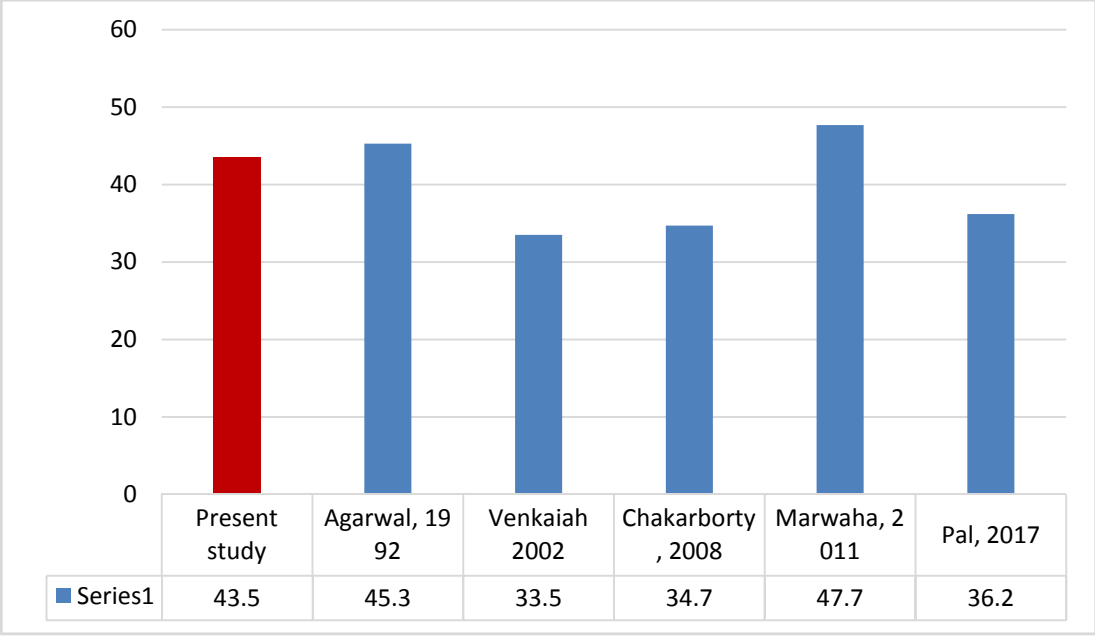


Fig.5.7 :Comparison of weight of the Himachali boys with other Indian populations

1. Agarwaletal., 1992. Affluent school children from urban population of north India.
2. Venkaiahetal., 2002. Rural adolescents from nine Indian states.

3. Chakraborty&Bharti, 2008. Shabar tribal children from Orissa.
4. Marwahaetal., 2011. Urban school children from different Indian cities of upper socio-economic strata.
5. Pal etal., 2017. Rural children from West Bengal of lower socioeconomic strata.

The mean weight of Himachali boys (10-17 years) was 43.5 kg. This was higher by 10 kg as compared torural adolescents from nine different Indian states[1]by 8.8 kg from tribal adolescent boys from Orissa[2] and 7.3 kg from rural adolescent boys from West Bengal[3].However, the weight ofHimachali boys werefound to be less by 4.4 kgand 1.8 kg as compared to the Indian school boys belonging to the upper socio-economic strata[6], and urban school children from north India[4]. (Fig. 5.7).

5.1.2.2 COMPARISON OF WEIGHT OF EARLY ADOLESCENT HIMACHALI BOYS WITH OTHER STUDIES

The mean weight of early adolescent (10-14years) Himachali boys was 37.1 kg. Only one study conducted on the urban school children from Karad, Maharastra[18] reported a higher weight (Mean=39 kg). However, when compared with six different population of early adolescent Indian boys, the Himachali boys appear to be heavier with mean differences ranging between 2.8 kg to 9 kg[8-11,15-16]. This comparison is summarised in Figure 5.8.

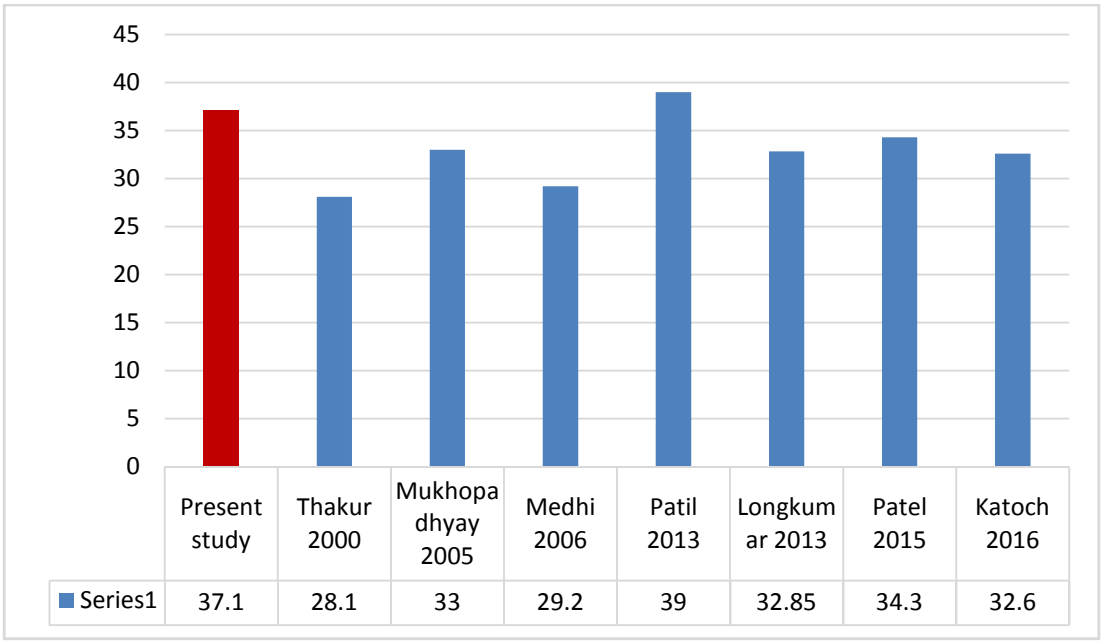


Fig.5.8 :Comparison of weight of the early adolescent Himachali boys with other Indian populations

1. Thakur et al., 2000. Lower middle to lower class Urban adolescents from South Gujrat.
2. Mukhopadhyayetal., 2005. Urban school children from North 24 Parganas, West Bengal.
3. Medhietal., 2006. Children of tea garden workers, from lower socioeconomic class of Assam.
4. Patil et al., 2013. Urban-well to-do class school children from Karad, Maharastra.
5. Longkumar, 2013. Urban Naga school children from Nagaland.
6. Patel etal., 2015. Urban school children from Ahmedabad, Gujrat.
7. Katoch and Sharma, 2016. Rural school children from Doda district, Jammu and Kashmir.

5.1.2.3 COMPARISON OF MEAN WEIGHT OF LATE ADOLESCENT HIMACHALI BOYS WITH OTHER STUDIES

A mean weight of 54 kg was obtained for late adolescent (15-17 years) Himachali boys. This was higher than the mean weights of reported for rural adolescents Indian boys[1](Mean difference= 11.7 kg),tribal adolescents from Orissa[2]((Mean difference=9.9 kg), rural adolescent boys from West Bengal[3](Mean difference=9.3 kg).However, this reported weight was lower by4.5 kg and 2.9 kgwhen compared tothe Indian school children[6]and urban affluent Indian school children[4]. This comparison is presented in Figure 5.9.

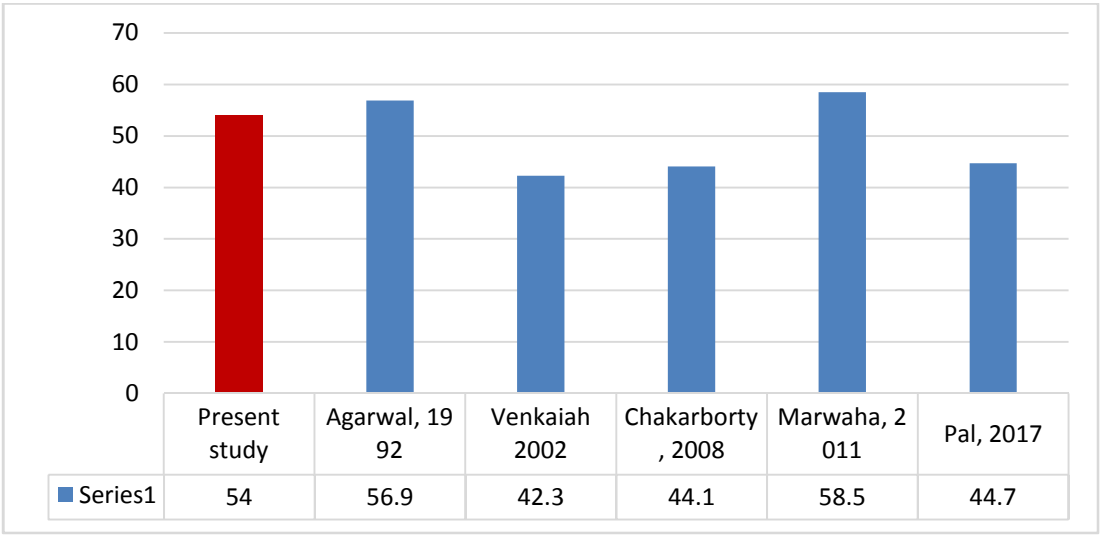


Fig.5.9 :Comparison of weight of the late adolescent Himachali boys with other Indian populations

1. Agarwaletal., 1992. Affluent school children from urban population of north India.
2. Venkaiahetal., 2002. Rural adolescents from nine Indian states.
3. Chakraborty&Bharti, 2008. Shabar tribal children from Orissa.
4. Marwahaetal., 2011. Urban school children from different Indian cities of upper socio-economic strata.
5. Pal etal., 2017. Rural children from West Bengal of lower socioeconomic strata.

5.1.2.4 COMPARISON OF WEIGHT OF HIMACHALI GIRLS WITH OTHER INDIAN POPULATION

The mean weight of Himachali girls (40. 1 kg) was similar to the mean weight of Rajput females from Shimla district of Himachal Pradesh[12]. Himachali girls were found to be heavier by 6.4 kg as compared to rural adolescent girls of different Indian states[1]by 6 kg and 5.9 kg as compared to tribal adolescent girls of Orissa[2] and rural adolescent girls of West Bengal[3] respectively.

However, the mean weight was less by 5.5 kg and 1.3 kg as compared to the Indian school boys belonging to the upper socio-economic strata[6] and urban school children from north India[4]. (Fig.5.10).

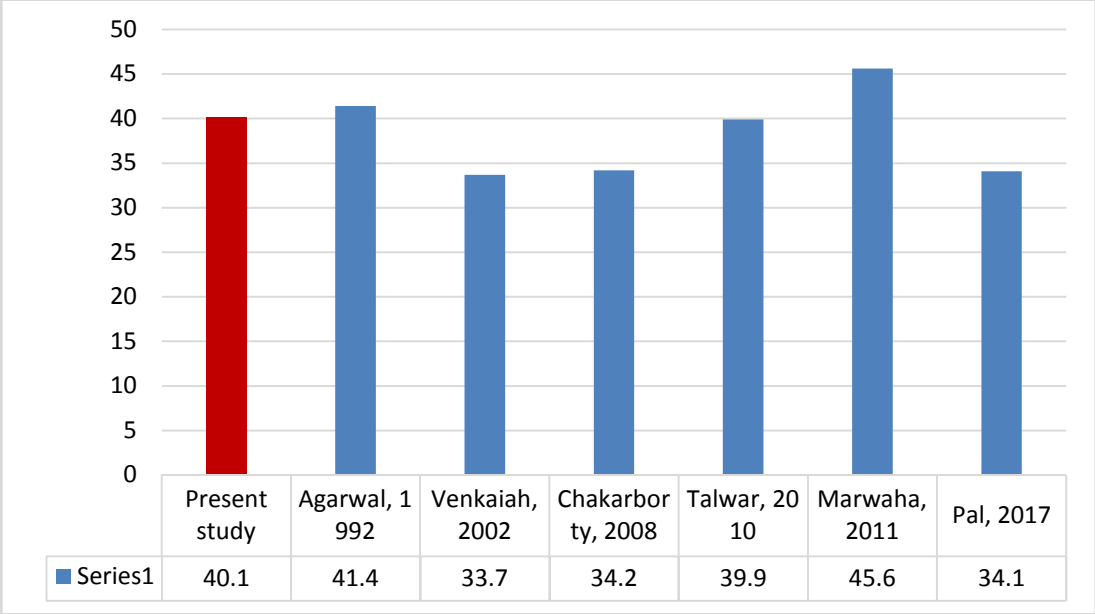


Fig.5.10 :Comparison of weight of the Himachali girls with other Indian studies

1. Agarwaletal., 1992. Affluent school children from urban population of 19 cities of north, south, east and west of India.

2. Venkaiahetal., 2002. Rural adolescents from nine Indian states.
3. Chakraborty&Bharti, 2008. Shabar tribal children from Orissa.
4. Talwar, 2010. Adolescent Rajput females from Shimla district of Himachal Pradesh.
5. Marwaha et al., 2011. Urban school children from different Indian cities of upper socio-economic strata.
6. Pal etal., 2017. Rural children from West Bengal of lower socioeconomic strata.

5.1.2.5 COMPARISON OF WEIGHT OF EARLY ADOLESCENT HIMACHALI GIRLS WITH OTHER STUDIES

The mean weight of early adolescent (10-14years) Himachaligirls was 36.8 kg. This was higher than the mean weight reported for seven different Indian populationof early adolescent girls. The mean differences between the weight of Himachali girls with these population varied between 1.3 kg to 7.6 kg[8-10,13,15-17], as presented in figure **5.1.2.5.**However, the mean weight of Himachali girls was found to be less by 4.3 kg as compared to urban school girls from Maharastra[18]. (Fig 5.11)

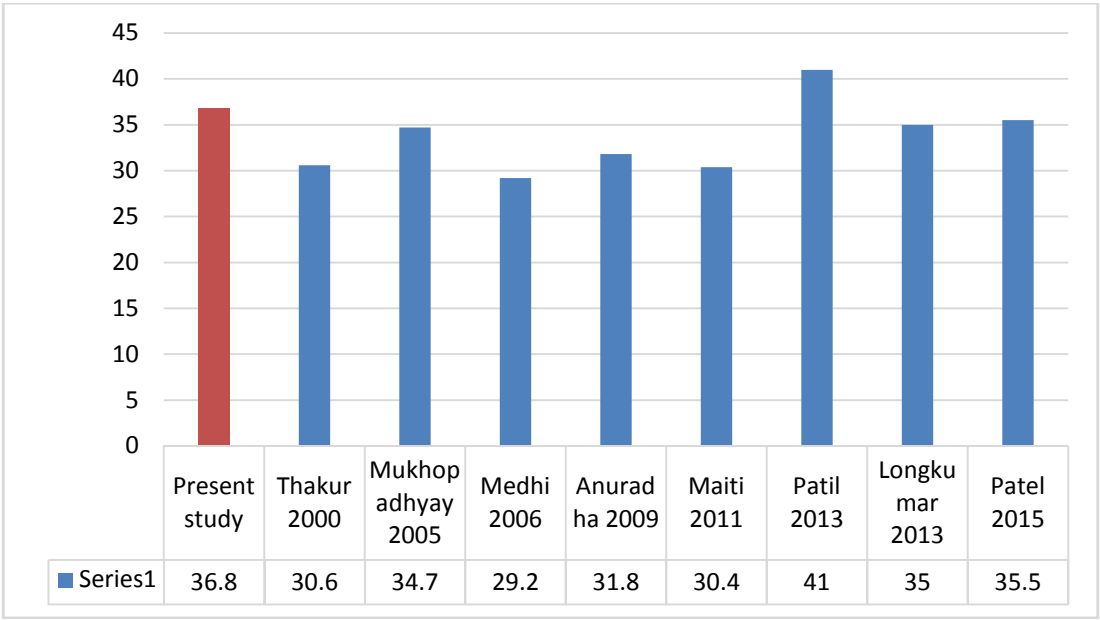


Fig.5.11 :Comparison of weight of the early adolescent Himachali girls with other Indian studies

1. Thakur et al., 2000. Lower middle to lower class Urban adolescents from South Gujrat.

2. Mukhopadhyayetal., 2005. Urban school children from North 24 Parganas, West Bengal.
3. Medhietal., 2006. Children of tea garden workers, from lower socioeconomic class of Assam.
4. AnuradhaGoyle, 2009. Girls of government school from Jaipur city.
5. Maiti et al., 2011. Adolescent girls from PaschimMedinipur district of West Bengal.
6. Patil et al., 2013. Urban-well to-do class school children from Karad, Maharastra.
7. Longkumar, 2013. Urban Naga school children from Nagaland.
8. Patel et al., 2015. Urban school children from Ahmedabad, Gujrat.

5.1.2.6 COMPARISON OF WEIGHT OF LATE ADOLESCENT HIMACHALI GIRLS WITH OTHER STUDIES

The mean weight of late adolescent (15-17 years) girls was 45.5 kg. like the early adolescent group, this was higher as compared to mean weight reported for most of the Indian population of late adolescent girls. With the mean differences ofweight varied between 0.6 kg to 6.3 kg.[1-3,12,14].However, theweight was lower by 7 kgand 4.8 kg as compared to the Indian school children[6]and affluent class adolescents from different Indian states[4].(Fig5.12)

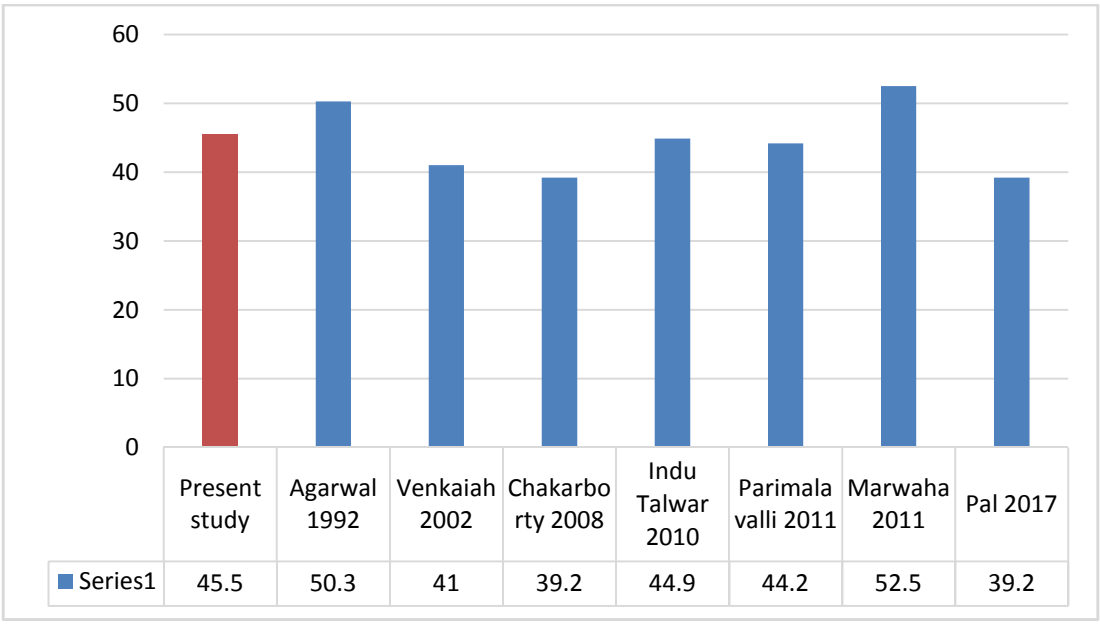


Fig. 5.12 :Comparison of weight of the late adolescent Himachali girls with other Indian studies

1. Agarwal et al.,1992. Affluent school children from urban population of north India.
2. Venkaiahetal., 2002. Rural adolescents from nine Indian states.
3. Chakraborty&Bharti, 2008. Shabar tribal children from Orissa.
4. InduTalwr. 2010. Adolescent Rajput females from Shimla district of Himachal Pradesh.
5. Parimalavalli, 2011. School-going adolescent girls from Tamilnadu.
6. Marwahaetal., 2011. Urban school children from different Indian cities of upper socio-economic strata.
7. Pal etal., 2017. Rural children from West Bengal of lower socioeconomic strata.

5.2 COMPARATIVE DISCUSSION ON MALNUTRITION

The subjects considered in the present study represents a mixed urban and rural population from the non-hilly regions (average altitude 950 meters) of Mandi District of Himachal Pradesh. The states geographical conditions are unique as compared to other states of India because Himachal Pradesh is a hilly state of northern India. As it is a well-known fact that there is a wide range of variation in socio-cultural parameters among the hilly and non-hilly states[13]. It is likely that the lifestyle factors will influence the dietary pattern and food habits which along with the economic factors affect the nutritional status[14-15].

Therefore, for a rational and meaningful description of the prevalence of different categories of malnutrition attempt has been made to compare the prevalence rate of the present study with those reported from different zones of India (East, West, North, South and North-east) and also with the urban and rural population of comparable age group.

5.2.1 PREVALENCE OF STUNTING AMONG HIMACHALI BOYS

In the present, study the rate of stunting among boys was 7.5%. This rate is much lower as reported in different Indian studies covering both urban and rural population from different zones of India. The rate of stunting reported in these studies ranges between 12 to 55%[3,7-8,11,19-23,25-27] as presented in Figure 5.13. However, a study conducted on the rural adolescent boys (11-15 years) from Kullu district of Himachal Pradesh reported a slightly lower rate of stunting (6.9%)[24].

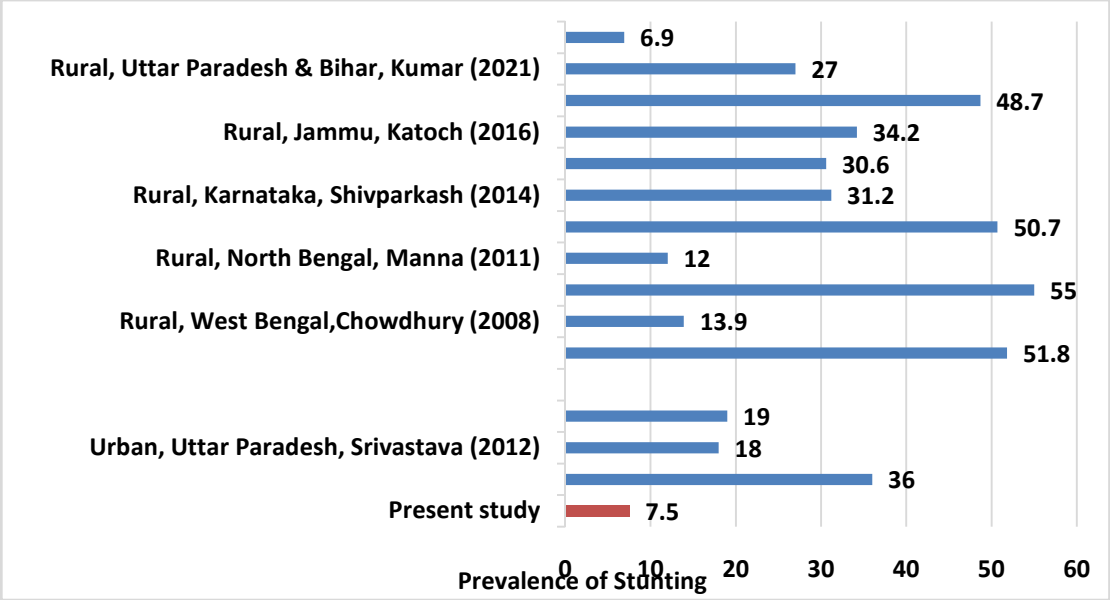


Fig.5.13 :Prevalence of Stunting of Himachali boys as compared to other Indian studies

5.2.2 PREVALENCE OF STUNTING AMONG HIMACHALI GIRLS

The rate of stunting among girls obtained in this studywas 9%. Several Indian studies have reported higher prevalence of stunting among girls with the rate of stunting varied between 12 to 58%[3,11,21-23,25-27,30]. In four studies the rate of stunting among girls were found to be lower as compared to stunting rate of Himachali girls that varied between 2 to 7.6%[7,13,28-29]. This comparison is presented in Figure 5.14.

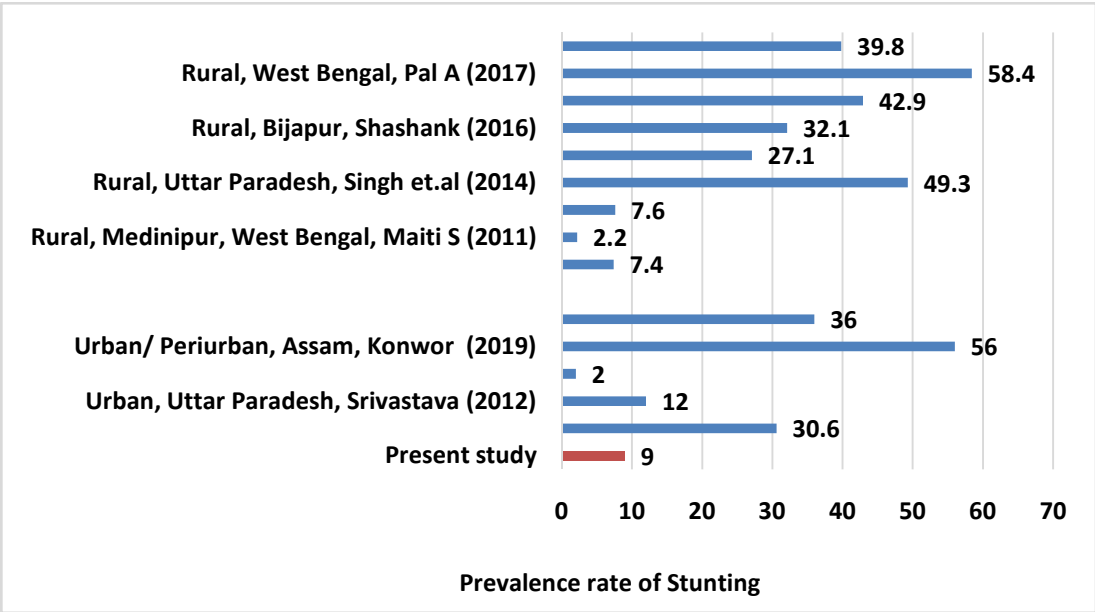


Fig.5.14 :Prevalence of Stunting of Himachali girls as compared to other Indian studies

5.2.3 PREVALENCE OF THINNESS AMONG HIMACHALI BOYS

The rate ofthinness among Himachaliboys was 19.4%, which was lower than the rates reported in most of the Indian studies (prevalence of thinness varied between 20.4% to 54.4%[2,3,8,10,16,20-21,23-25]). Only one study conducted among the rural boys of Jammu[11] reported a lower rate of thinness (2.5%), as compared to the Himachali boys. This comparison is presented in Figure 5.15

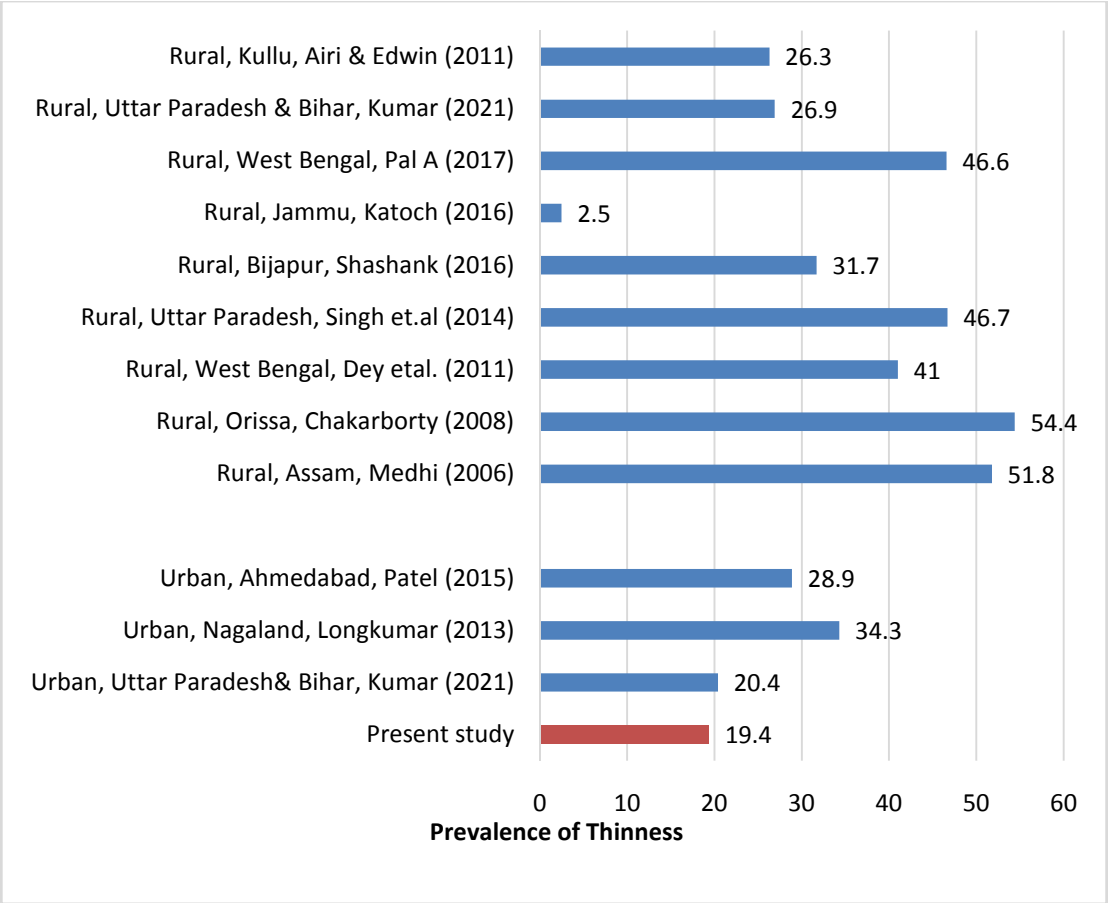


Fig.5.15 :Prevalence of thinness of Himachali boys as compared to other Indian studies

5.2.4 :PREVALENCE OF THINNESS AMONG HIMACHALI GIRLS

Prevalence of thinness in Himachali girls was 17.6%. Almost similar prevalence of 19% was reported among the rural adolescent girls (11-15 years) of Kullu district of Himachal Pradesh[24]and West Bengal[20]. And somewhat lower prevalence rate was obtained for the rural (13.2%), and urban (12.5%) girls Uttar Pradesh and Bihar[25].

Reported prevalence of thinness from other rural and urban population of Indian adolescent girls were much higher than the present findings and varied between 19% to 57%[3,14,20-21,23,28,30-33]. (Fig 5.16).

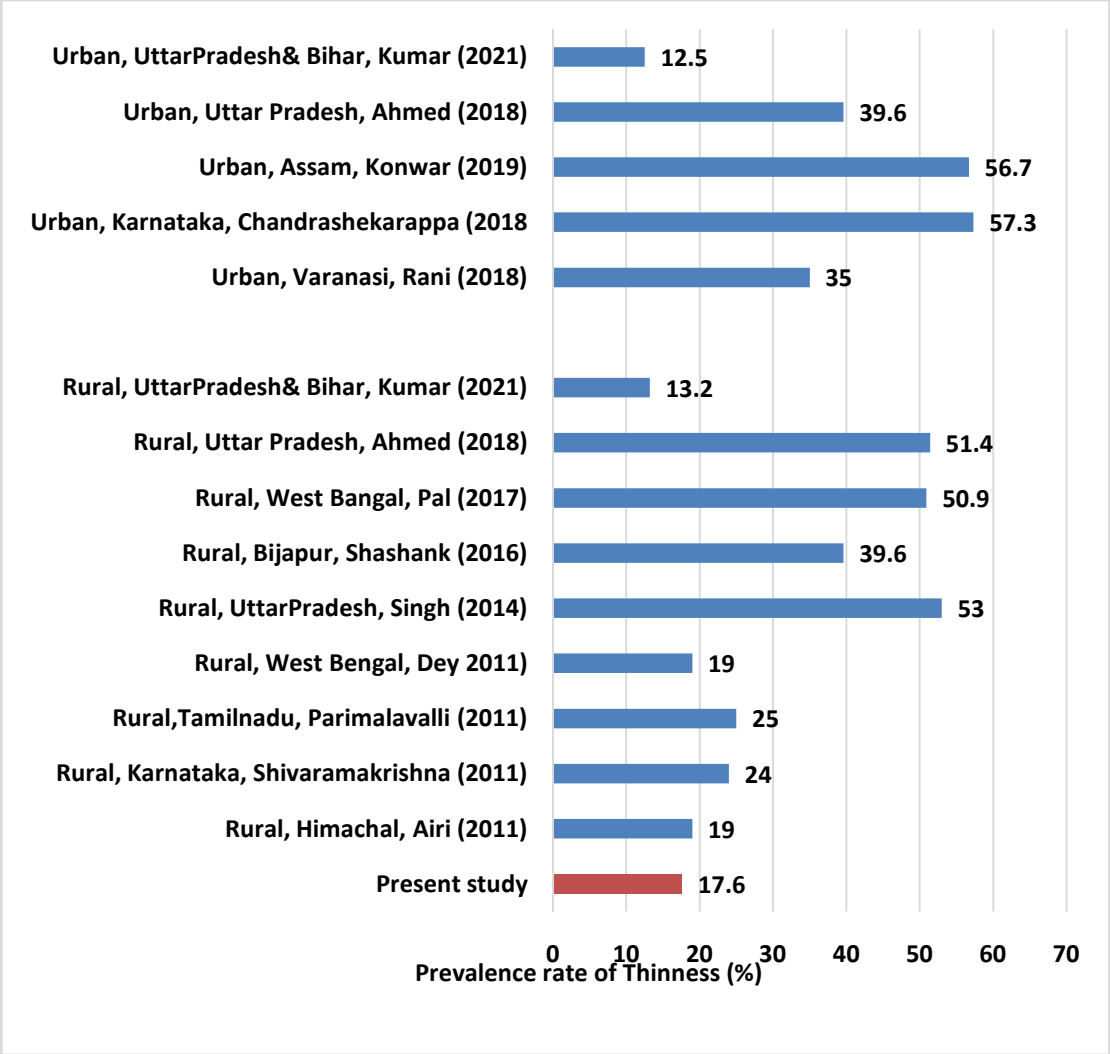


Fig.5.16 :Prevalence of thinness of Himachali girls as compared to other Indian studies

5.2.5 PREVALENCE OF OVER NUTRITION AMONG HIMACHALI BOYS

The prevalence rate of overweight among Himachaliboys was6.1%, this was higher than the rates reported from rural Himachal boys (1.5%)[24], and rural boys of West Bengal (4%)[20], urban boys of Nagaland (2.1%)[16] and urban boys of Gujrat (0.8%)[10], but lower as compared to rates reported for rural boys of West Bengal(6.8%)[3]and 14.9% [34].

The rate of obesity among Himachali boys was 1.5%, which was lower as compared to rural boys of West Bengal (3.8%)[34]. (Fig 5.17)

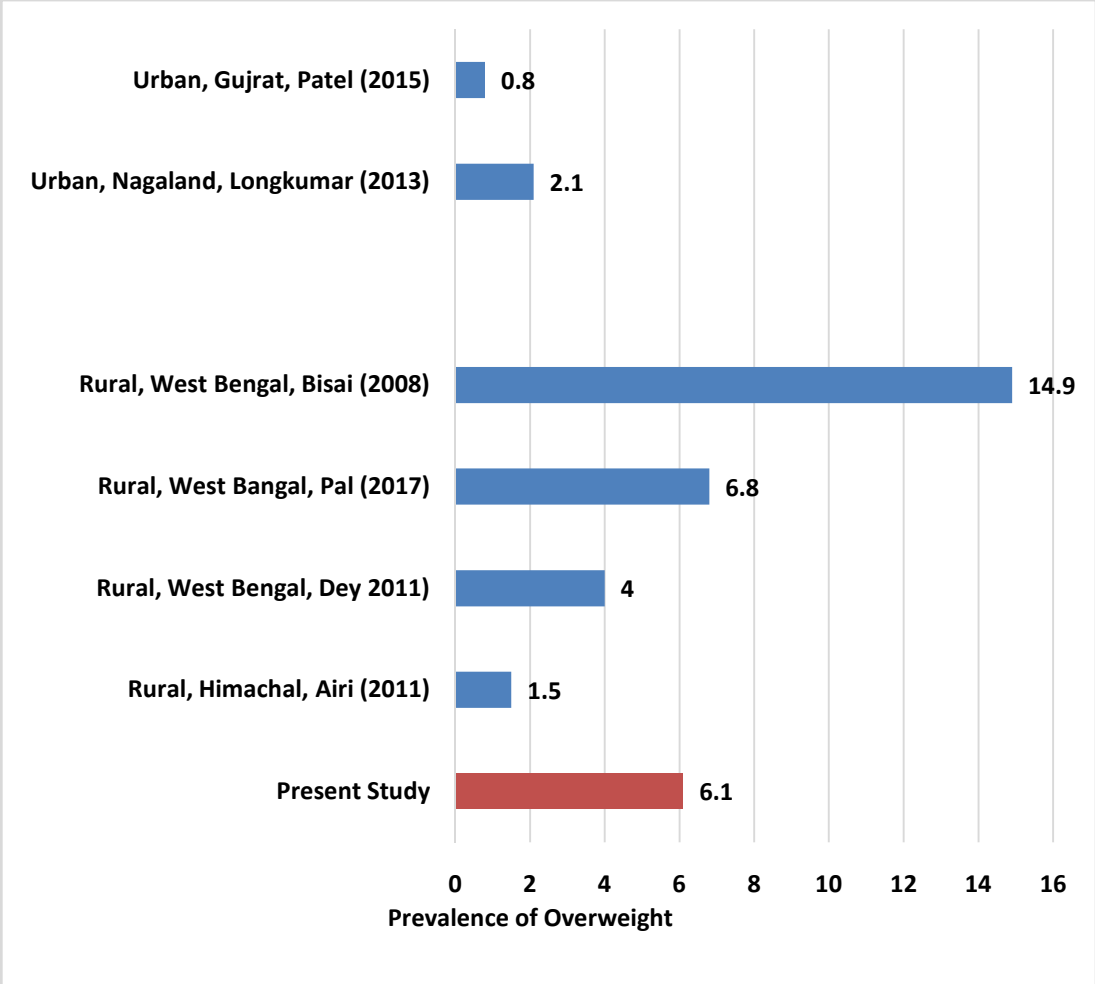


Fig.5.17 :Prevalence of overweight of Himachali boys as compared to other Indian studies

5.2.6 PREVALENCE OF OVER NUTRITION AMONG HIMACHALI GIRLS

The prevalence rate of overweight in Himachali girls was 3.3%. This was higher as compared to most of the studies reported from different Indian population. Higher prevalence rates of overweight were obtained for rural (3.8%) and urban (9.3%) girls of Uttar Pradesh[31]. While all other studies[3,10,16,20,24,32]reported lower prevalence rate of overweight girls as compared to present study findings.(Fig 5.18)

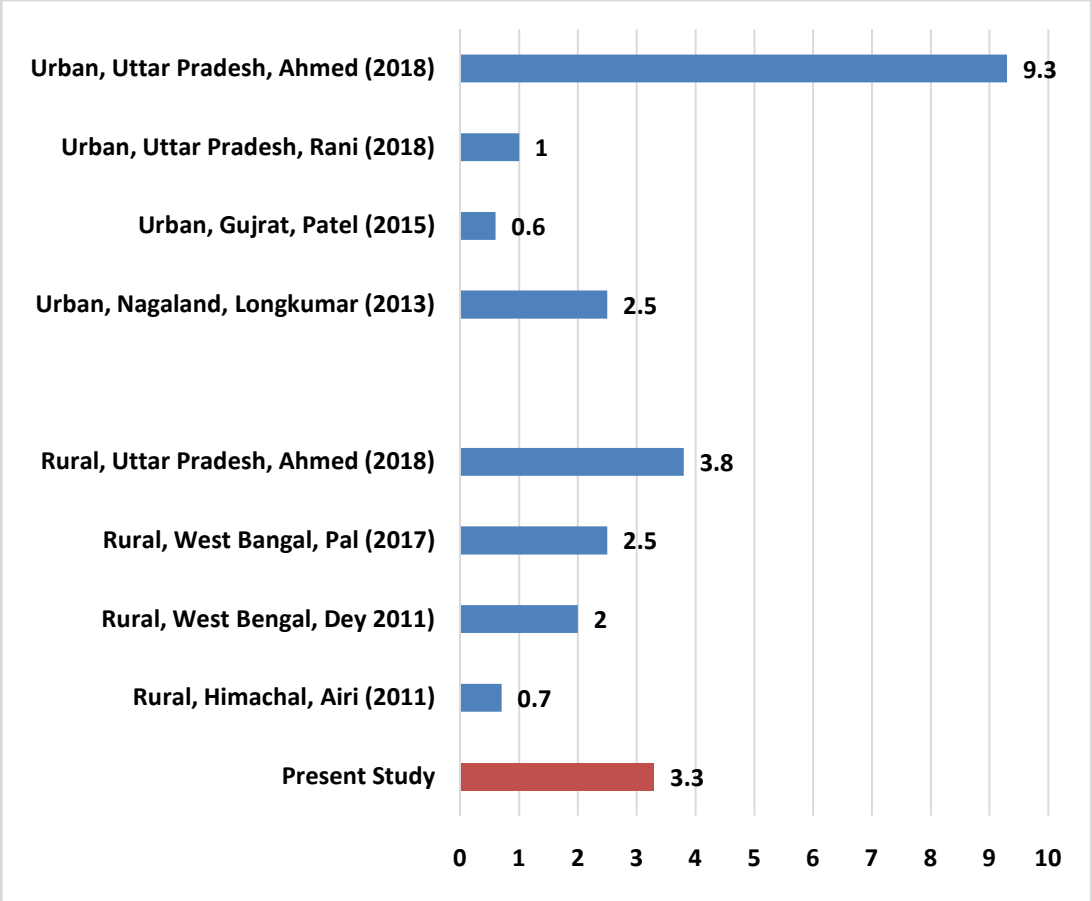


Fig.5.18 :Prevalence of overweight of Himachali girls as compared to other Indian studies

5.2.7 DISCUSSION OF GROWTH VELOCITY

Studies related to physical growth of Indian children found that the growth spurts in girls occur between 8-14 years and that in boys occur between 9-15 years. During this period the height gain can be 24 cm - 26 cm in girls and 27 cm - 29 cm in boys[35].Similar findings were obtained in this present study particularly for the boys where height gain for boys from 10 -15 years was found to be 30.4 cm with the corresponding weight gain of 23.6 kg.

The maximum height gain for Himachaliboys (9.8 cm) was observed between 12 to 13 years. This corroborates with some other studies conducted among a large group of north Indian school children[36] and urban Naga school children[16]which also reported a maximum height gain for boys between 12 to 13 years.

A number of studies reported that adolescents' physical growth metrics accelerate more quickly during puberty[1-6,37-40]. Studies on physical growth status of children reported that age-specific greater growth spurts in anthropometric variables such as

height and weight were seen among adolescent boys as they approached to puberty (13 years)[39-40]. The results in the present study were consistent with these earlier findings.

Among Himachali boys, a larger acceleration in height (24.1 cm) and weight (18 kg) was observed between 10 to 14 years, as compared to later ages (15-17) where this increase in height and weight was 1.6 cm and 3.7 kg respectively. The highest weight gain (6.5 kg) among boys in present study was observed between 12 to13 years. A similar gain in weight was reported for boys from Assam[8].

For the Himachaligirls, maximum gain in height (6 cm) and weight (5.6 kg) was observed between the age group of 11 to 12 years.Maximum gain in height in this age group was also reported among north Indian urban affluent school children (6 cm)[4],urban Naga school children (8.3 cm)[16], and adolescent Rajput females of Shimla district of Himachal Pradesh (5.7 cm)[12]. The maximum weight gain in this age group was reported for north Indian urban affluent school children (5.1 kg)[4] and girls from government school of Jaipur city (3.6 kg)[17]respectively.

5.3 DISCUSSION ON DIETARY PATTERN

5.3.1 BREAKFAST PATTERN OF HIMACHALI CHILDREN

Regular breakfast is essential for the nutritional well-being of children. It is considered as a healthy dietary habit, which not only increases the overall quality of daily diet but also improves the adequacy of nutritional intake[41-42].

Skipping breakfast is associated with health-compromising behaviours in adults and adolescents[43]. Studies related to breakfast pattern reported that among a population of adolescent girls of Mumbai[44], 35.9% skipped breakfast thrice a week, and 14 % of urban adolescents from Kolkatta[45] reported breakfast skipping habits.

In the present study a regular breakfast pattern was observed by most of the subjects with a somewhat lower percentage of girls (75%) reporting regular breakfast pattern as compared to the boys (87%). A study conducted on dietary habit of the adolescent population of Ghana[46] reported that more boys (87.8%) consumed breakfast compared to the girls (83.1%), whichis similar with the gender trend in breakfast habit observed in this study.

In both the sexes the regularity in in breakfast was more in the early adolescent group as compared to theirlate counterpart. A similar trend ofdecrease in regularity of daily

breakfast with increasing age has also been reported in some earlier studies[47-48].A similar finding indicating more regularity in breakfast pattern in younger children (89.3%) as compared to the older (82.8%) has also been reported among the Jordonian school children[48].Breakfast pattern among adolescent and children have been reported in several other studies from India and abroad. A comparative discussion is presented herewith. The percentages of Himachali adolescents with regular breakfast pattern was higher as compared to Kashmiri population (51%)[49], adolescent of Baroda (58%)[50] and overweight adolescent girls of Haryana (59%)[51], and lower as compared tosouth Indian girls (87%)[52] and girls from Bihar (100%)[53].

5.3.2 COMPARATIVE DISCUSSION ON FOOD CONSUMPTION PATTERN

The present study has evaluated two different types of dietary patterns,the habitual diet taken with major meal of the day and the snacking pattern of the children. Food items consumed during meals were nutrient dense,and therefore considered as healthy food items.The food items taken in snacks were energy dense and less in nutrients, so they were considered as unhealthy food items.

A study on Indian dietary pattern suggested that Indian diets are based on fruit, vegetable, pulses and cereals, mostly rice with added dairy products and are mostly vegetarian[54].

5.3.3 COMPARATIVE DISCUSSION ON HEALTHY FOOD CONSUMPTION

Healthy food consumption pattern of Himachali children has been discussed under three headings-

a) Consumption of fruit and vegetable,
b) Consumption of milk and dairy products,
c) Consumption of cereals and pulses.

a. Consumption of fruit and vegetable

The percentage of Himachali boys having vegetables daily is much higher as compared to the Pune, Maharashtrian boys[55] but lower as compared to adolescent boys of Assam and Bihar[56].

The fruit consumption of Himachali boys is almost similar as compared the adolescent boys of Pune, Maharastra[55], but much higher as compared to adolescent boys of Assam and Bihar[56]. (Fig 5.19).

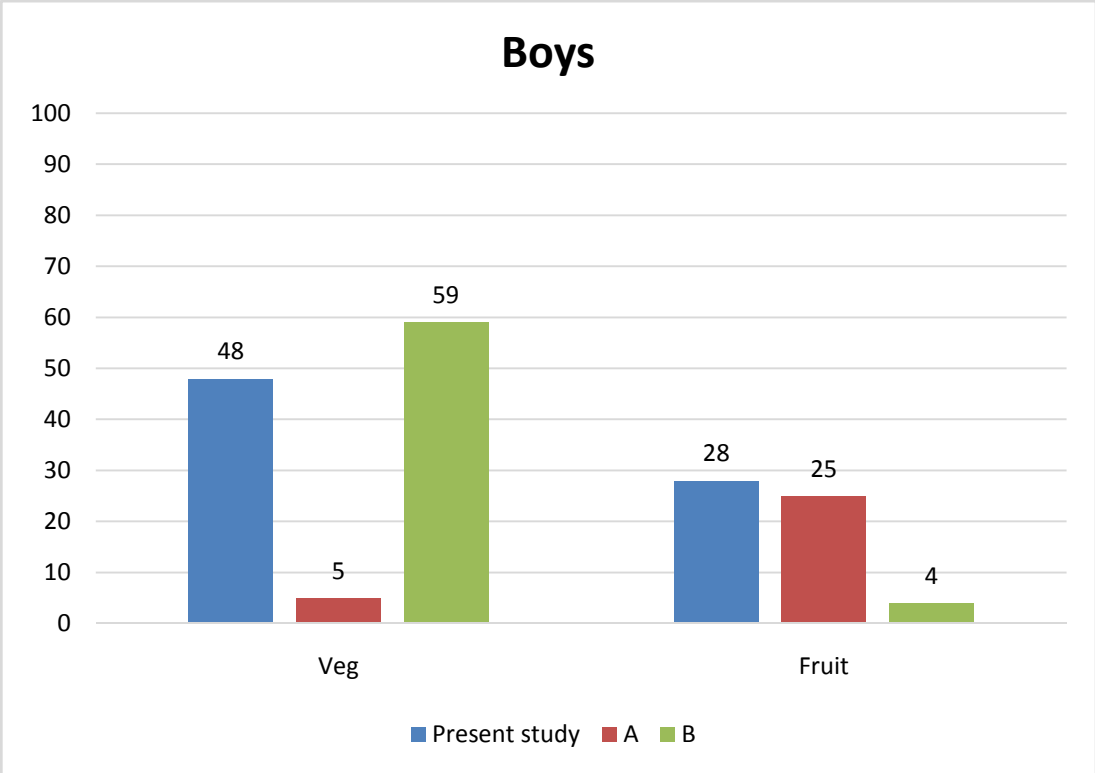


Fig. 5.19 :Percentages of Himachali boys having daily fruit and vegetables consumption as compared to the other studies

A-Adolescent boys (7-11 years) of Pune Maharashtra, India ((Reema Mukherjee,2017)[55].

I- Adolescent boys (10-19 years) of Assam and Bihar (Shantanu Sharma et al,2021)[56].

The percentage of Himachali girls consuming vegetable daily was higher as compared to the adolescent girls from Pune[55] and Varanasi[57-58],but lower as compared to adolescent girls of Bihar[53,56], Agra[59] and Kerala[60].

The percentage of Himachali girls who reported daily fruit consumption was almost similar to the adolescent girls of Pune, Maharstra[55] and Bihar[53], higher as compared to the girls of Varanasi[57], and girls from Assam and Bihar[56] and lower as compared to the girls from Varanasi[58], Agra[59], and Kerala[60]. (Fig 5.20)

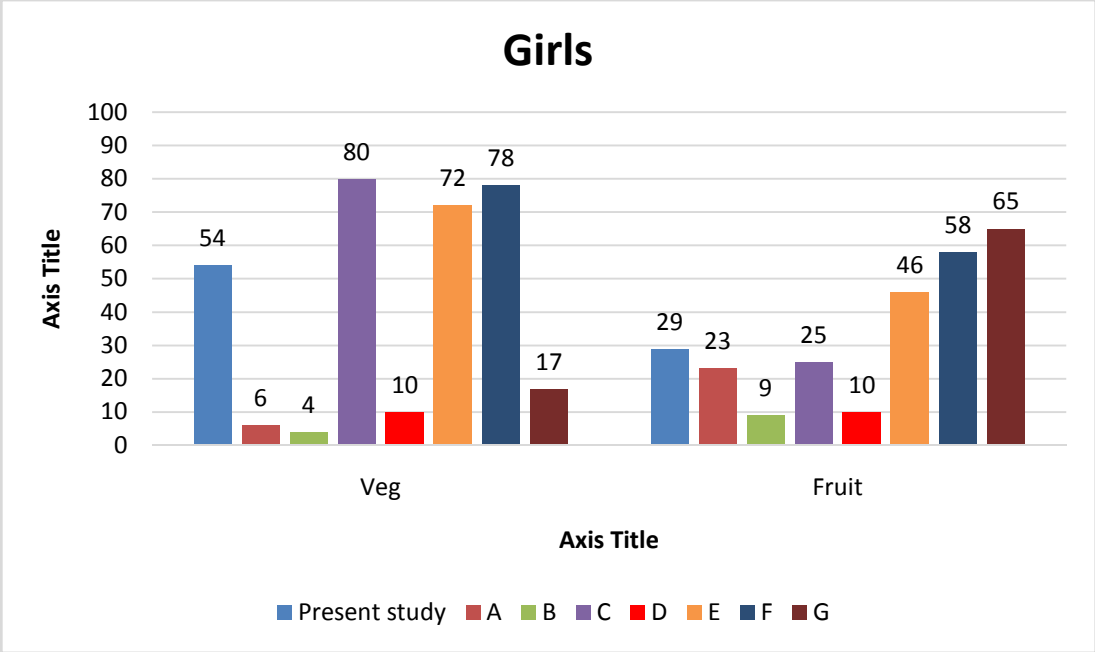


Fig. 5.20 :Percentages of Himachali girls having daily fruit and vegetables consumption as compared to the other studies

1. Adolescent boys and girls (7-11 years) of Pune Maharashtra, India ((Reema Mukherjee,2017)[55]
2. Adolescent boys and girls (10-19 years) of Assam and Bihar (Shantanu Sharma et al.,2021)[56].
3. Adolescent girls (13-18 years) of Motihari town Bihar, India(Twara T et al.,2015)[53]
4. Urban adolescent girls of Varanasi, India (Krishna J et al.,2012)[57]
5. Adolescent Girls (10-19 years) Urban slum Agra (Sarvesh Kumar, Neha Mishra,2019)[59].
6. Adolescent and adult girls (10-28 years) of Mysore urban area (Omidvar S and Begum K, 2014)[60].
7. Teenage adolescent girls (13-19 years) from urban slums of Varanasi (Jitender Kumar et al.,2021)[58].

CONSUMPTION OF MILK AND DAIRY PRODUCTS

The percentage of the Himachali boys (25%) consuming milk and dairy products daily, was lower as compared to boys from Pune, Maharastra (71%)[55]and Assam and Bihar (32%)[56].

The percentage of the Himachali girls (47%) with daily milk and dairy products consumption was lower as compared to adolescents' girls from Pune (70%)[55], and

higher as compared to adolescent girls from Assam and Bihar (29%)[56], and Agra (42%)[59].

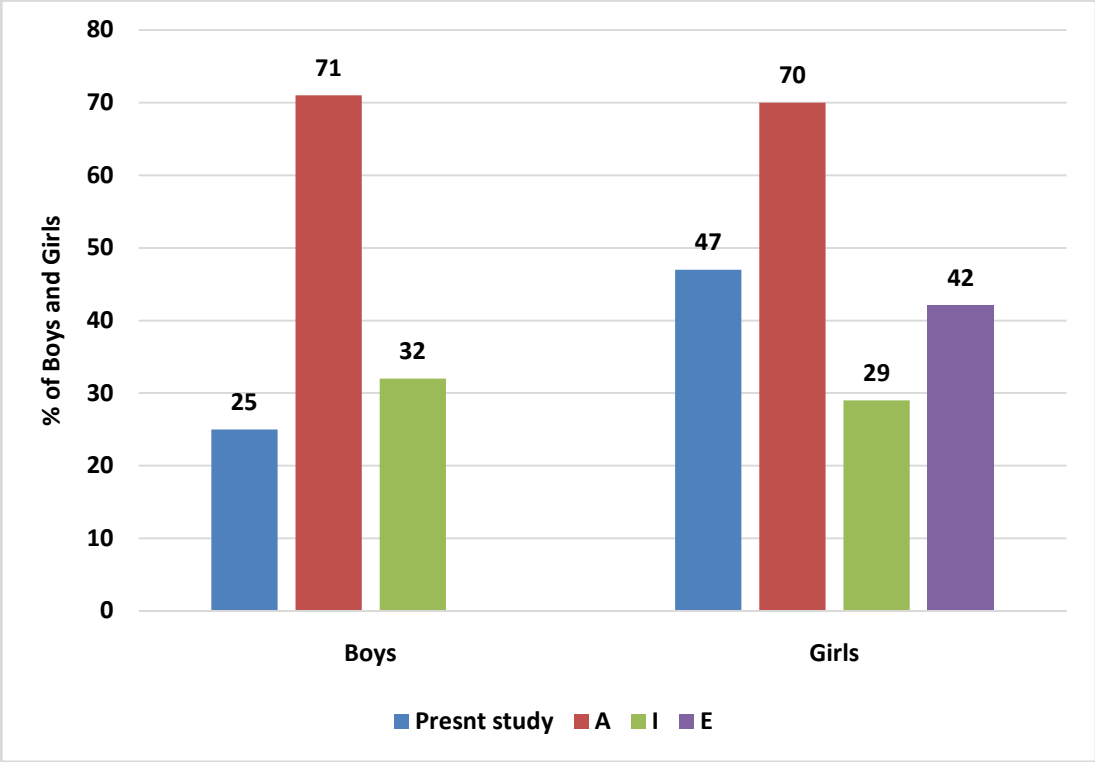


Fig. 5.21 :Consumption Frequency of milk and dairy by Himachali boys and girls as compared to the other studies

1. Adolescent boys and girls (7-11 years) of Pune Maharashtra, India ((Reema Mukherjee,2017)[55]
2. Adolescent Girls (10-19 years) Urban slum Agra (Sarvesh Kumar, Neha Mishra,2019)[59].
3. Adolescent boys and girls (10-19 years) of Assam and Bihar (Shantanu Sharma et al,2021)[56].

CONSUMPTION OF PULSE AND CEREALS

The combined percentage of Himachali boys and girls (86%) having daily consumption of pulses was found to be highest as compared to the five different Indian studies[50,52,56,58,61]as presented in Figure 5.22.

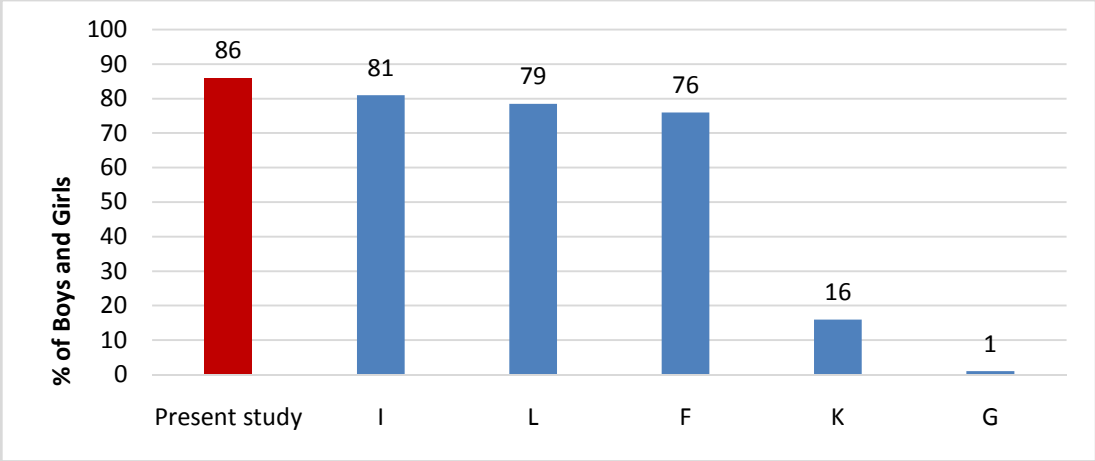


Fig. 5.22 :Consumption Frequency of Pulses by Himachali children (both boys and girls) as compared to the other studies

1. School-going adolescents (10-19 years) of urban Baroda, India (Kotecha et al.,2013)[50].
2. School children (10-12 years) of rural community Kerala (Blossom KL, 2018)[52].
3. Adolescent boys and girls (10-19 years) of Assam and Bihar (Shantanu Sharma et al,2021)[56]
4. School children (7-9 years) in Lucknow (Saxena and Mishra,2014)[61].
5. Teenage adolescent girls (13-19 years) from urban slums of Varanasi (JitenderKumar et al.,2021)[58].

5.3.4 COMPARATIVE DISCUSSION ON UNHEALTHY FOOD CONSUMPTION

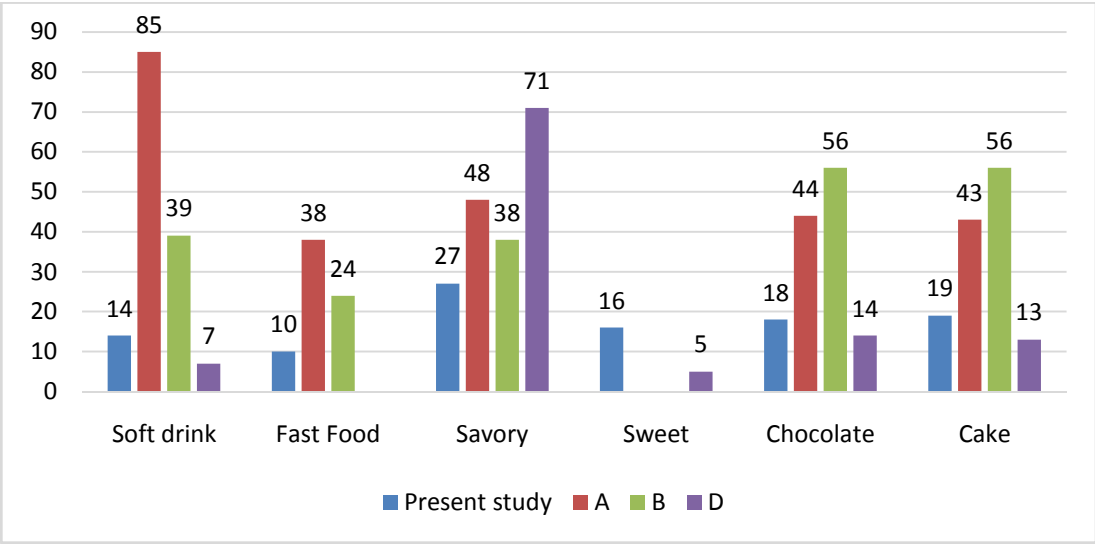


Fig. 5.23 :Overall percentage of Himachali children with high consumption of unhealthy food as compared to the other studies

1. Urban Indian adolescents (14-16 years) of Kolkatta, India(Rathi et al.,2017)[45].
2. School-going adolescents (10-19 years) of urban Baroda, India (Kotecha et al.,2013)[50].
3. School-aged children (12-18 years) in Rural Himachal Pradesh, India (Gupta et al.,2018)[62].

The percentages of Himachali boys and girls having daily consumption of different snacking items have been compared with three different populations, urban adolescents of Kolkata[45], Baroda[50] and rural adolescents from Kullu district of Himachali Pradesh[62] (Figure 5.23). as compared to the reports available from other states namely West Bengal and Gujrat the present Himachali children has lower consumption of all the snack items. However, when compared with the study of Kullu district of Himachal Pradesh a little variation is obtained between the present Himachali children and rural boys of Kullu district; 14% vs 7% for soft drink, 16%vs 5% for sweets, 18% vs 14% for chocolates and candy and 19% vs 13% for cake and pastries. Savory snacks consumption was reported by much higher %age of Kullu adolescents (71%)[62].

Snacking as become a part of the adolescent food habit[57]. A cross country study reporting on the daily snacking pattern of within 9-13 years of age group from Australia, China, Mexico and the US reported that in different countries two to three smacking occasions per day was most common[63].

An Egyptian study has reported that around 70% of the boys and girls are having regular fast food consumption[64].

In a study carried out in Baroda City of India's school children in the age group of 10 to 19 years reported that 30 % of the children consumed fast food and snacks in the preceding 24 hours[50]. An Indian study conducted on adolescence school children of Maharashtra Pune reported that snacks and fast food was preferred by around 80% of the children[55].

In the present study we found that 8 to 19% of the boys and 9 to 40% of the girls had high consumption or frequent consumption of different type of food junk food which is comparatively lower than the earlier studies reported from different parts of India. Present study also showed that percentage of girls having frequent consumption of snacking items was higher as compared to the boys. In a study conducted among the

adolescent boys and girls of Kullu district of Himachal Pradesh the different percentage of boys and girls consuming different fast food and junk food items vary from 4 - 40% in boys and 42-68% in girls which also indicates that girls are more addicted to the junk food which is persistent with the present findings[62]. Other studieshave reported frequent consumption of junk food (daily or thrice a week) by 33% of the girls of the Kurukshetra district of Haryana[51]and 50%[60] of the girls from Kerala. These percentages were comparable with the percentages of Himachali girls having daily consumption of snacking items.

5.3.5 DISCUSSION ON VEG AND NON-VEG PATTERN

The meal pattern of the Himachali adolescents has been assessed in terms of vegetarian and non-vegetarian diet, and attempt has been made to compare this pattern with other Indian studies. The meal pattern of the Himachali boys and girls showed somewhat higher percentages of vegetarian diet (50.3 % boys and 65.7 % girls) as compared to the non-vegetarian diets, with more girls reporting vegetarian meals as compared to the boys.

The present report is inconsistent with one of the other findings from Himachal Pradesh; i.e the report available on the adolescents of the Kullu district[65]reported a veg meal pattern among 20 % of the subjects, which is lower than the present findings. However,one another study reported a 39 % and 63% of veg pattern for adolescent boys and girls respectively from Kangra district[66] of Himachal Pradesh, which is similar for veg- meal pattern of girls reported in present study.

When compared with different states of India, it has been found that vegetarian meal pattern was higher among Himachali adolescents.A higher prevalence of non-vegetarian meal pattern (100%, 77%) was reported among south Indian adolescent populations (Blossom[52] andOmdivar[60]), and among adolescent populations of Pune (93 %) from western part of India[55]. Kashmiri adolescents also reported a much higher percentage (61%) of non-vegetarian meal pattern[49]. Higher percentages of non-vegetarian pattern (76%) were also observed among the adolescent girls of Agra[59].

Lower percentages of non-vegetarian pattern comparable with the present study was reported by the adolescent girls (35%) of Baroda[50]and adolescent girls (59%) of Haryana[51].

5.4 DISCUSSION ON ASSOCIATION OF DIETARY PATTERN WITH MALNUTRITION

Nutritional studies focus on two major areas of diet in the etiology of malnutrition; firstly, the total amount of daily intake of different nutrients which can be obtained through diet survey and secondly, from the consumption pattern of different dietary sources. The second approach was undertaken in this study. The study has obtained self-reported intake pattern on categorized dietary sources (food groups) consumed over a period of two weeks prior to the study.

The dietary pattern of the Himachali children has provided information on the nutritional etiology of different categories of malnutrition. The study found a combined effect of healthy and unhealthy food consumption on different categories of malnutrition.Furthermore, agender difference in dietary pattern for both healthy and unhealthy diet patters was also noticed. This has influenced the nutritional status of the boys and girls differently.These findings were consistent with some earlier studies[67-69].

Studies focussing on daily intake of nutrients had different finding on their role in stunting. While some studies have identified lower daily intake of proteins and calcium as a factor responsible for stunting[70-71],other studies fail to establishsuch relation [72]. However, the later study found significant relation between consumption pattern of food groups (dietary sources) with stunting, particularly the intake pattern of fruit, cooked vegetables and dairy products.

In the present study girls with lower fruit consumption were reported to be more stunted which corroborates this earlier report. However, this is not obtained among the boys. Again, the present Himachali boys who were stunted had significantly lower intake of dairy products and the Himachali girls who were stunted had lower intake of cooked vegetables. This also corroborates with the previous study.

It has been postulated that dairy products and vegetables contains necessary nutrients like calcium that is necessary for promoting height. The present study also found that vegetarian diet pattern was more among the girls and more girls were found to stunted as compared to boys. This point towards the importance of the proteinaceous diet (more in animal protein) in the prevention of stunting which was also reported in previous studies[72-73].

Multiple studies have reported a positive association between the unhealthy dietary pattern and risk of different categories of malnutrition including stunting, overweight and obesity, and an inverse association between healthy dietary pattern with malnutrition. These studies have confirmed the low nutrient content for different fast-food items in terms of different vitamins and mineral content and high sugar content[74] and higher consumption of such items resulted in lower intake of macro and micronutrients. In this study, higher consumption of unhealthy food particularly savory snacks, fast food and soft drinks were associated with higher prevalence of stunting among the boys. This is in agreement with some earlier reports[75-78].

It was also reported that individuals with malnutrition show trends of higher consumption of fast-foods and lower consumption of fruit, vegetables and milk[79-80]. The results of present study are consistent with these findings.

Thinness was prevalent among boys and girls who had lower consumption of fruits, dairy products, cooked vegetables and higher consumption of savory snacks, fast food and soft drinks.Similarly, girls with lower fruit and high fast-food consumption and boys with higher consumption of savory snacks, fast food, sweet and soft drinks have significantly higher proportion of overnutrition.

From the comparative discussion of height and weight and prevalence rates of different categories of malnutrition presented in the earlier section (5.1 and 5.2) it appeared that the nutritional status of Himachali adolescent boys and girls was better than majority of the similar Indian population from different zones of India covering both urban and rural population. Only few urban populations reported similar or slightly better nutritional status as compared to the present Himachali population.

The Himachali adolescent children assessed in this study were selected mainly from the non-hilly regions of Mandi district of Himachal Pradesh that includes mostly urban and peri-urban areas. These subjects mostly represent upper middle and higher socioeconomic class.

Reports are available that opined socioeconomic status had a significant impact on physical health and nutrition[81-82], and boys and girls from higher socioeconomic group were taller, heavier and even fatter than their peers from average and low socioeconomic group[81]. The results were obtained in the present study corroborates

with these findings as boys and girls selected in this study belongs to higher socioeconomic strata as mentioned earlier.

As with urbanization and changes in socio-economic structure of the society we are moving through a stage of nutritional transition[83], snacking habit has become a part of the adolescent food habit30 (Agarwal, 2008)[84]. Reema Mukherjee)[55].

In the present study we found that 10 to 27% of the boys had frequent snacking habits which is much lower whencompared with the snacking pattern of different adolescent population of India as discussed in the previous sections.

Himachal Pradesh is a state in Northern India and as per the 2011 Census it is the least urbanized state in the country. It is one of the few states that has remained untouched by other customs external to the state majorly due to geographical location. This has contributed a lot in preserving the traditional dietary pattern of the state.

A typical daily meal pattern of almost every household of Himachal Pradesh is a vegetarian diet comprising of dal-chawal-subzi-roti' which includes intake of mostly seasonal vegetables.The most striking feature in Himachalidiet, is that a specific kind of pulse is not repeated on a daily basis, instead, the weekly menu consists of different varieties of pulses. A combination of pulses in diet has been proved to be beneficial to meet up the demand for most of the amino acids and provide a balanced intake of carbohydrates proteins and fat[85]. Studies have also reported that as compared to other Indian states the average intake of proteins is highest and average fats intake is also much higher in Himachal Pradesh[86].

Various factors emanating from socio cultural perspective influence children and adolescent behaviour that remain with them throughout their lives[86]. The food behaviour is also not an exception. Factors which strongly influence children food habit include family structure, family food preferences, parental support in developing children food habit. It was also found that consumption of home-cooked meals is a frequent practice among the Himachali children as compared to dining out[87]. Home cooked meals have many proven benefits, such as reduction of excess energy, sugar, and fat intakes and increased vegetable and fruit ingestion[88]

Therefore, it can be opined that the traditional food habits prevalent in Himachali households have definitely influenced the food habits of the children in a positive way which is reflected in a higher consumption of different healthy food items by majority

of the boys and girls. This definitely indicated towards a balanced diet. Additionally, the present study has also revealed that almost 80% or more boys and girls has a lower consumption of different unhealthy food items. This has contributedfor better nutritional status of adolescent Himachalichildren as compared to other states of India.

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SUMMARY AND CONCLUSION

6.1 SUMMARY

PHYSICAL GROWTH

The mean height of the boys is 157.5 ± 13.3 cm and mean height of the girls is 150.6 ± 8.8 cm. The mean weight of the boys was 44.7 ± 12.2 kg and mean weight of the girls was 40.1 ± 9.20 kg. Both height and weight showed a progressive increase with age from 10 to 17 years.

The highest gain in height among boys (9.8cm) was reported at 12 to 13 years of age groups and among girls (6cm) at 11 to 12 years of the age groups. Up to 12 years girls were taller than boys and after the 13 years age boys were found to be significantly taller than girls. Major gain in weight for the boys was 6.5 kg from 12 to 13 years, and for the girls it was 5.8 kg between 11-12 years. At 10- or 12-years girls were significantly heavier than boys and after 13 years boy's weight was significantly more than the girls.

The mean height of the boys and girls differ differently when compared to the 50^{th} percentile values of the Indian growth reference height of children.

The mean weight of Himachali boys and girls at all age groups were lower than the 50^{th} percentile of Indian growth reference standard.

MALNUTRITION

Majority of the boys and girls at all age groups were normal. The overall prevalence of stunting among boys was 7.5% (Percent) and among girls 9%.

The prevalence of thinness was more than among the boys (19%) as compared to the girls (12%). The overall rates of severe thinness were almost similar in boys (4.2%) and girls (5%).

Overweight was slightly more among boys (6%) as compared to the girls (5%). While overall prevalence of obesity among boys was 2% and among girls 3%.

Comparative prevalence of malnutrition among the whole group of boys and girls showed that stunting was higher in girls as compared to boys (7.3 % in girlsvs 5.7% in boys). Thinness was slightly higher among boys (17.5 % in boysvs 16.2 % in girls). The stunted- thinness was minimum and almost similar in both sexes. Overnutrition is statistically significantly higher among boys (7.7 %) than girls (4.3 %).

6.2 DIETARY PATTERN

BREAKFAST PATTERN

Most of the children, 88% of boys and 75% of girls and more early adolescent children of both sexes showed regular breakfast as compared to their late counterpart.

HEALTHY FOOD CONSUMPTION

Almost 90 percent or more boys and girls reported that they have consumed the different healthy food items “at least once a week”.

Higher consumption of green leafy vegetables, dairy products, milk and salad was reported by a significantly more number of girls than boys.

In both gender, fruit, green leafy vegetable and salad consumption was more in the late group while milk consumption was more in the early group.

UNHEALTHY FOOD CONSUMPTION

Majority of the boys and girls in different age groups (70.6 – 87.0%) reported that they consumed the different unhealthy food items “few days a week”.

A significantly higher percentages of boys reported high consumption of sweet and soft drinks while significantly higher percentages of girls reported high consumption of savory snacks, fast foods and candies and chocolates.

MEAL PATTERN

Vegetarian pattern was more among girls, 65.7 % girls, while distribution of veg and non-vegetarian meal pattern was almost equal among boys (50.3 % vegetarian vs 49.7 % non-vegetarian).

6.3 DIET AND MALNUTRITION

BREAKFAST PATTERN AND MALNUTRITION

Irregular breakfast pattern significantly associated with stunting, thinness and overnutrition in both boys and girls.

HEALTHY FOOD CONSUMPTION AND MALNUTRITION

Among the healthy foods, lower consumption of fruit and cooked vegetables were associated with stunting among girls, however, lower consumption of none of the healthy food items were associated with stunting in boys.

Lower consumption of fruit was associated with thinness among boys. Lower consumption of fruit, dairy products and cooked vegetables were associated with thinness and girls.

Lower consumption of fruit was associated with overnutrition among the girls, while consumption of none of the healthy foods were associated with overnutrition in boys.

UNHEALTHY FOOD CONSUMPTION AND MALNUTRITION

High consumption of savory snacks, fast foods and soft drinks were significantly associated with stunting and thinness and overweight among boys. Higher sweet consumption is also associated with overnutrition among the boys. Only fast food consumption was associated with overnutrition among the girls.

6.4 CONCLUSION

Problems relating to food intake and malnutrition have been identified as widespread concern for public health worldwide. Therefore, emphasis has been placed to identify the extent of malnutrition as a consequence of dietary habit in different population group. The present study is an endeavour in this effort. This study has sought to focus on the nutritional status and dietary pattern of school going children in the urban and peri-urban areas of Himachal Pradesh for specific reasons. Firstly, they represent the most advantaged and as well as the most vulnerable group of the society and secondly, their nutritional health status will determine the well-being of next generation. Any interventions design to have a long-term impact on the health of the country must take into consideration the health status of adolescent. This reflects the importance of the present study.

The present study has generated a substantial amount of information on the nutritional and dietary pattern of the Himachali children which can be used as a reference while developing suitable population specific health and nutritional policies. As compared to different parts of India, the results obtained in the present study were quite impressive and revealed a positive deviance in the lifestyle approach of the Himachali children that are mainly dictated by cultural preservation of the communities coupled to minimum infiltration of urbanization. These facets can also be implemented as a strength-based approach to bring positive behavioural and social change to improve the health and nutritional condition in other population setting.

6.5 RECOMMENDATIONS

The present study makes the following recommendations towards the development of healthy food choice and practices among children and adolescents of Himachal Pradesh.

Implementation of Nutrition Education Programs:

In the present study, it has been reported that majority of the boys and girls (70-87%) consumed different unhealthy food items. So these children can be educated by providing nutrition education programs in schools to raise awareness about healthy eating habits and side-effects of unhealthy foods and its related problems in the future. These, programs could include workshops, seminars, and interactive sessions to educate both; students and parents on the importance of a balanced diet, healthy food choices and regular meal practices.

Integration of Nutritional Modules in School Curriculum:

The study proposes integration of nutrition-related modules into the school curriculum to ensure that students receive consistent and structured education on nutrition, helping them develop informed dietary choices from an early age.

The nutritional module may also include a regular monitoring and assessment system to track changes in nutritional status and eating habits over time. This will help to evaluate the effectiveness of implemented interventions.

School Meal Improvement Initiatives:

The study advocates for improvements in the nutritional content of school meals by collaborating with relevant authorities to enhance the quality and diversity of the meals provided, ensuring they meet the nutritional requirements of growing adolescents. Secondly, it has been seen in the present study that fast food items are easily available to the students outside the school campus. So initiative should be taken by the school authorities, not to allow easy accessibility of such food-items to the children during school hours.

Parental Nutritional Education:

The study recommends workshops or seminars on nutritional education for parents so that they can become aware of different barriers and possibilities of healthy nutritional practices. These programmes can also equip parents with the knowledge and skills needed to support their children's nutritional needs at home.

Promotion of Physical Activities:

The study strongly recommends the development of extracurricular programs that will encourage regular physical exercise among school children, in conjunction with a balanced diet to promote overall health and well-being. Study results showed the prevalence of undernutrition among both sexes, which can be improved with the government supported systems such as fortification programs. So, this study strongly recommends the government of Himachal Pradesh to take initiatives or to develop strategies to meet the nutritional requirements of the school-going children of Himachal Pradesh.

ANNEXURES

ANNEXURE – I

The Principal

……..…. School

Dated: ….....…

Subject: Regarding permission to conduct a survey on students of your institute.

Sir/Madam

Most humbly, I **Neetu Saini**, research scholar, Pacific Academy of Higher Education and Research University, Udaipur, want to state that I need certain data of school going children from class VI to XII regarding my research work titled **"Evaluation of Physical Growth Standards, Nutritional Status and Dietary Patterns among the School Age-Children of Himachal Pradesh: A Cross Sectional Study".** The survey includes measuring of height and weight of the students and a questionnaire seeking information on their personal details and the dietary pattern. The survey does not involve any invasive procedure. Moreover, the teachers may also be present during the survey. I therefore request to kindly grant me permission to conduct the abovementioned survey.

I shall be highly indebted to you.

Thanking you

Yours faithfully

Neetu Saini

ANNEXURE – II

INFORMED CONSENT DOCUMENT
PART I

Information to be provided to participants / legally acceptable representative of participants in case they are minor or likely to be deemed incompetent to consent on their own.

Title of the study: "Evaluation of Physical Growth Standards, Nutritional Status and Dietary Patterns among the School Age-Children of Himachal Pradesh: A Cross Sectional Study".

What is the purpose of this study?

The purpose of the study is to access the physical growth status, nutritional status, dietary pattern and its association with nutritional status among school-going children of Himachal Pradesh.

Who are the participants and how many participants are likely to be there?

The participants included in the study are students from class VI to class XII. The study intends to have number of participants up to 1000.

Why have I been chosen?

You are the student of desired age group for the proposed research.

Do I necessarily have to take part?

Taking part in this study is voluntary, however, your participation will be a great help to the researcher and will be highly appreciated.

What happens during the study / What do I have to do? (the procedures, such as answering a questionnaire, which the participant will have to undergo)

Students are requested:

1. To go through their measurement of height and weight with the help of anthropometric rod and weighing machine in the presence of researcher and teacher.
2. To answer a questionnaire based on personal details and dietary patterns of the subjects.

What are the possible benefits of taking part?

Your participation may help to determine the health status of school aged children as well as the nutritional status and dietary pattern of Himachali children which may further create a health awareness among the students in general.

Are there any possible disadvantages of taking part?

No, not at all as the study does not involve any invasive procedure.

Are there are any monetary costs involved in participation?

No, there are no monetary costs involved in participation.

Will my taking part in this study be kept confidential?

Yes.

What will happen to the results of the study?

With the help of results, we may. prepare a report on nutritional status of school-going Himachali children and compare it with children of other states. We may even recommend its implications to the government and health authorities.

Any other information relevant to participation in the study such as sponsorship:

No.

A statement thanking the participant for going through the informed consent document.

I would like to express my deepest appreciation and thanks to the dear subjects for their wholehearted cooperation and participation during the research.

Contact for further information (the name designation and contact numbers of Principal Investigator)

Neetu Saini, (Assistant Professor, Govt. Degree College Mandi Himachal Pradesh). Ph.D. Scholar, Pacific Academy of Higher Education and Research University, Udaipur.

PART 2

INFORMED CONSENT FORM

I. EVALUATION OF PHYSICAL GROWTH STANDARDS, NUTRITIONAL STATUS AND DIETARY PATTERNS AMONG THE SCHOOL AGE-CHILDREN OF HIMACHAL PRADESH: A CROSS SECTIONAL STUDY.

Informed Consent Document Version No. and Date

Subject's: Name: _____ ID No. _____ Age _____ Sex _____

Please tick if you agree

1. I confirm that I have read and understood the information sheet for the above study dated _____ and have had the opportunity to ask questions. ❒
2. I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without having to give a reason, and without my rights and privileges being affected. ❒
3. I understand that my data would be kept confidential but individuals authorized by the Principal Investigator, the ethics committee of the institute where the study will be conducted and government regulatory authority will have access to my records both in respect of the current study and further research that may be conducted in relation to it. Even if I withdraw, I agree to this access. However, I understand that my identity will not be revealed and confidentiality of information will be maintained. ❒
4. I agree not to restrict the use of any data or results that arise from this study for academic purpose. ❒
5. I agree to voluntarily take part in the above study. ❒

Signature / Thumb impression of the subject or a legally acceptable representative (LAR):

_____ **Date:** _____ **Signatory's name**: _____

Study investigator's signature: _____ **Date:** _____

Study investigator's name: _____

QUESTIONNAIRE

ANNEXURE – III

Questionnaire

1. Reference Number:

Date and Place

Date of survey: Place:

Name of school:

Address of the school:

Location of the school:

Type of school: (Pvt) / govt

Personal Information

Name of student:

Date of birth:

Class:

Address:

Contact Number:

Physical Parameters

Age:

Height:

Weight:

BMI:

z-score for Height for age:

z-score for BMI for age:

Nutritional Category:

DIETARY PATTERN

How often do you have the following food items during the last 15 days

Food item	Daily	Most days a week (≥4 days)	Few days a week (≤ few days)	Once in a week and Never
Fruits				
Milk				
Dairy				
Green and Leafy vegetable				
Cooked vegetable				
Salad				
Pulses				
Savory snacks				
Fast foods				
Sweet				
Cake and pastries				
Candy and chocolate				
Soft drink				

What is diet Pattern: Veg Non-Veg

How frequently you had your breakfast in last 15 days.

Daily Most days a week Few days a week Never

प्रश्नावली

1 संदर्भ संख्या :	
दिनांक और स्थान	
सर्वेक्षण की तिथिः	स्थानः
पाठशाला का नामः	
पाठशाला का पताः	
पाठशाला का स्थान निर्धारणः	
पाठशाला का प्रकारः	गैर सरकारी / सरकारी
व्यक्तिगत सूचना	
विद्यार्थियों का नामः	
जन्म तिथि :	
कक्षा :	
पता :	
संपर्क संख्याः	
शारीरिक माप :	
आयुः	
लंबाईः	
वजनः	
शरीर विद्यमान सूचकांकः	
आयु की ऊंचाई के लिए जेड–स्कोरः	
उम्र की बीएमआई के लिए जेड–स्कोरः	
पोषक श्रेणीः	

आहार प्रतिरूप

पिछले 15 दिनों के दौरान आपने कितनी बार निम्नलिखित खाद्य पदार्थ खाए

खाद्य – सामग्री	प्रतिदिन सप्ताह में अधिकांश दिन > =4 दिन	सप्ताह में कुछ दिन < 4 दिन	सप्ताह में एक बार और कभी नहीं
फल			
दूध			
दुग्धालय			
हरि और पत्तेदार सब्जियां			
पकी हुई सब्जियाँ			
सलाद			
दाल			
स्वादिष्ट स्नैक्स (अल्पाहार)			
फास्ट फूड (शीघ्र तैयार किया जाने वाला भोजन)			
मिठाई			
केक और पेस्ट्री			
कैंडी और चॉकलेट			
शीतल पेय (ठंडा)			

आहार प्रतिरूप क्या हैः शाकाहारी मांसाहारी

पिछले 15 दिनों में आपने कितनी बार नाश्ता किया :

प्रतिदिन सप्ताह में अधिकांश दिन सप्ताह में कुछ दिन कभी नहीं

PUBLICATIONS

International Journal of Community Medicine and Public Health
Pathania NS et al. Int J Community Med Public Health. 2021 Oct;8(10):4960-4966
http://www.ijcmph.com
pISSN2394-6032 | eISSN2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20213802

Original Research Article

Assessment of nutritional status of adolescent school going boys of Himachal Pradesh

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Received: 21 July 2021
Accepted: 20 August 2021

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ABSTRACT

Background: Given the paucity of data on the nutritional standard of the Himachali children, the present study was conducted to assess the physical growth and malnutrition of adolescent school-going boys of Himachal Pradesh within the age group of 15-17 years.
Methods: Boys were selected from both government and private schools of the non- hilly regions of Mandi district of Himachal Pradesh. Height, weight, and BMI were determined. Stunting was evaluated from height-for-age Z-score, and thinness, overweight, and obesity were estimated from BMI-for-age Z-score using the WHO recommended cut-off values.
Results: Mean height varied between 167.2 to 168.7 cm. Weight varied between 52.4 to 56.1 kg with a corresponding BMI between 18.7 to 19.7 kg/m^2.The overall prevalence of stunting and wasting were 5.7% and 15.8% respectively. The coexistence of stunting and wasting was not found in any of the age groups. The overall prevalence of overweight and obesity was 5.4% and 1.7% respectively.
Conclusions: Himachali boys appeared to be taller than most of the Indian population of boys of similar age groups. Prevalence of the different categories of over nutrition and undernutrition were also lower as compared to that obtained for other Indian studies on adolescent boys. The existence of overweight and obese individuals points towards the double burden of malnutrition.

Keywords: Physical growth, Malnutrition, Stunting, Thinness, Adolescent, India

INTRODUCTION

Growth is the most fundamental survival mechanism. Physical growth is a complex and continuous process of physical development by which an infant develops into an adult. It involves a progressive development in terms of physical size and morphology which commences through different phases and can be described as growth during infancy, childhood, and adolescence. Height and weight are considered the two most fundamental and sensitive anthropometric indicators of physical growth. In each phase of development the height and weight increase at a particular pace. Therefore, growth monitoring for infants, children, and adolescents, is fundamentally based on the measurement of these two parameters. Growth monitoring can assess the physical growth profile for a group of population in terms of presence and extent of growth problem and thereby reveals conditions of malnutrition. Subsequently, this provides an opportunity to take preventive and supportive actions to promote proper nutrition for the betterment of health and well-being.

However, to detect various clinical and sub-clinical forms of growth deficiencies and malnutrition, only height and

weight values do not help. Therefore the height and weight data need transformation to suitable indices. Growth indices are constructed by combining height and weight with age and sex.[1] Three sex and age-specific indices are most commonly used for the evaluation of growth and nutritional status in children and adolescents up to 19 years of age. They are height-for-age (HAZ), BMI-for-age (BMIAZ) and weight-for-age (WAZ).[2]

The Height-for-age (HAZ) is a height-based indicator and indicates linear growth. It compares whether a child or adolescent has achieved the expected level of height as compared to a child from a healthy well-nourished reference population of the same age. A low HAZ indicates a short stature condition as compared to age which is called stunting or linear growth retardation and reflects a state of chronic malnutrition. Body mass index (BMI) is used to identify if an individual has an abnormal weight in proportion to their height. BMI-for-age (BMIAZ) is a weight-based index that assesses both over and undernutrition.

The BMIAZ compares the BMI of a child, at a particular age with the BMI of a child representing the reference population of a similar age group. Given that the BMI reflects relative fatness of the body, BMIAZ identifies conditions of overnutrition that include overweight and obesity. Both overweight conditions and obesity are considered as chronic states of malnutrition.Furthermore, low BMIAZ scores indicate a condition of undernutrition termed as “thinness” or “wasting”. BMIAZ has been recognized as the best direct indicator of thinness during adolescence.[3] Thinness directly indicates an acute state of malnutrition.[4] Several studies have estimated the height and weight trends and the prevalence of different categories of malnutrition among Indian adolescents across diverse socio-demographic and economic conditions.[5-13] The reports of these From these studies, it appeared that there is a significant prevalence of malnutrition among the adolescent population of different Indian states.

Himachal Pradesh is the most progressive hilly state of India. It has its own geographically unique, isolated lifestyle and culture that differs considerably from the majority of Indian states. Furthermore, the state has undergone a socio-economic transformation during the last two decades. It is a well-established fact that the economic status is a major determinant of nutritional status of the community and socio-cultural and economic transition can affect the nutritional standard of particularly the children and the adolescent.[14] To date, there is a paucity of data regarding the physical growth standard and malnutrition of the Himachali adolescent population. Only a few studies have reported on the anthropometric profile of Himachali children and adolescents.[15-18] These studies were conducted on children below 15 years of age.

Against this backdrop, the present study was conducted among the adolescent school-going boys of Himachal Pradesh aged 15-17 years. This age group represents the late adolescent period and to date, very few studies have reported the nutritional standard of boys belonging to this age group. The present study is aimed to evaluate the physical growth standard of 15-17 years boys in terms of height and weight. The study also intends to report the prevalence of different categories of malnutrition among these boys.

METHODS

Study design and location

A cross-sectional survey design was adopted in the present study which was conducted in the Mandi district of Himachal Pradesh. To avail the logistic advantage, a wider range of geographical locations including hilly regions of the districts were excluded and only the non-hilly zones and valley regions of the districts were selected. This includes three subdivisions of Mandi district; Mandi Sadar, Balh, and Sundernagar. These zones cover urban, peri-urban, and as well as rural areas.

Subjects

A total number of 298 boys were selected from both the government and private schools. The children suffering from any type of chronic disease or those who reported any illness during the last one month before the survey date were excluded from the study. Before the study, all the students were explained about the purpose of the study and the extent of their involvement in presence of the respective class teachers. The same was also conveyed to their parents through the class teachers.

Physical measurement

Determination of age: the date of birth (DOB) was obtained from the school register which is based on the birth certificate presented at the time of admission. From this DOB, the exact age at the time of admission was obtained and expressed as year and month. Determination of height: height was measured with an anthropometric rod with shoes removed and head aligning in the Frankfurt plane. Readings were taken to the nearest 1 cm. Determination of weight: weight was measured in kg by using a bathroom scale with minimum clothing and shoes removed to the nearest 500 grams. Determination of BMI: BMI was obtained as the square of height in meter divided by body weight in kg according to the formula: BMI-height (m^2)/weight (kg) and expressed kg/m^2. Anthropometric assessment of nutritional status: classification of nutritional status was made according to public health criteria recommended by the World Health Organization expert committee.[19] To evaluate the conditions of undernutrition and overnutrition, five outcome variables were considered; stunted, thin or wasted, coexistence of both, or thin and stunted,

overweight, and obese. These conditions were assessed from the WHO recommended z scores of two nutritional indices. The z scores of the Height-for-age index were used to assess stunting while the z scores of the BMI-for-Age index were used to assess the other three categories, i.e., thinness, overweight, and obesity.

Calculation of Z scores

The HAZ z score for an individual subject of the study population belonging to a particular age was calculated as: (measured height-median height of the reference population of the same age)/SD of the ref population. For calculating the z- scores of BMIAZ, the body mass index values of the study population were converted to exact z scores from the L, M, and S values of the reference charts of the corresponding age groups, using the following formula:

$$Z\ score = ([BMI\ score\ of\ study\ population\ /M]^{L} - 1) / LS$$

Where L, M and S are Box-Cox power, median, and coefficient of variation of the corresponding age of the reference population respectively.[20] Cut off values of Z scores for defining malnutrition: **c**ategories of malnutrition were defined according to the cut-off values of z scores presented in the WHO growth reference data for 5-19 years old adolescents.[2] The following cut-offs for the Z-score of HAZ was used to define different categories of undernutrition as per HAZ: stunted= z score <-2SD to ≤-3SD, severely stunted= z score <-3SD**.** The following z scores cut-off values of BMIAZ were used to define the different conditions of under and overnutrition: wasted =z score is <-2SD to ≤-3SD, severely wasted=z score = <-3SD, overweight = z score >1SD, obese= z score is >2SD**.** A subject was considered normal if the z scores for both HAZ and BMIAZ were found to be >-2SD.

RESULTS

The mean height at 15, 16, and 17 years was 167.2±7.01 cm, 168.3±6.13, and 168.7±5.84 cm respectively which shows an increasing trend with age. At 15 and 16 years age group government boys were slightly taller than the private boys, however, the mean differences in the height were not found to be statistically significant. However at 17 years of age, the private boys appeared to be statistically significantly taller (mean height 170.8±5.24 cm) as compared to the government boys (mean height 166.4±5.69 cm, t=3.30, p=0.002) (Table 1). The mean weight showed an increasing trend with age. The mean height at 15, 16, and 17 years was 52.4±1.0 kg, 53.6±8.8 kg, and 56.1±7.0 kg respectively. At 15 and 16 years, the boys from government school were heavier than the private school boys and the mean difference appeared to be statistically significant. At 17 years of age, the private boys appeared to be slightly heavier than the government boys, but this difference was not statistically significant (Table 2). The mean BMI at 15, 16, and 17 years was 18.7±3.21, 18.9±2.69, and 19.7±1.95 respectively which also showed an increasing pattern with age. At all age groups, there was no statistically significant effect for school category despite the government schoolboys have higher BMI as compared to the private boys (Table 3).

Table 1: Descriptive summary of height.

Age (years)	School (N)	Mean	SD	Median	Mean difference	t	P value
15	Govt. (60)	167.8	6.69	168.0	1.20	0.973	0.33
	Pvt. (71)	166.6	7.27	167.0			
	Total (131)	167.2	7.01	168.0			
16	Govt. (43)	168.8	6.69	169.0	0.90	0.725	0.470
	Pvt. (57)	167.9	5.70	168.0			
	Total (100)	168.3	6.13	168.7			
17	Govt. (32)	166.4	5.69	165.0	-4.40	3.30	0.002
	Pvt. (35)	170.8	5.24	170.0			
	Total (67)	168.7	5.84	167.0			
Total	Govt. (136)	167.8	6.48	168.0	-0.20	0.265	0.791
	Pvt. (163)	168.0	6.51	169.0			
	Total (298)	167.9	6.49	168.0			

The overall prevalence of stunting was found to be 5.7%. In different age groups, the percentage of stunted boys varied between 5% in 16 years, to 6.1% in 15 years. At 17 years the stunting rate was 6%. The Pearson's chi-square test showed that and there was no significant level of association between the prevalence of stunting with the age group's age (χ^2 square=0.140(2), p= 0.932). None of the boys were found to be severely stunted (Table 4). The overall prevalence of thinness was found to be 15.8%. The highest prevalence of thinness (19.8%) was found among the 15 years old boys followed prevalence of (16%) at the age of 16 years and 7.5% at 17 years of age.

In different age groups, none of the boys were severely wasted. The overall prevalence of overweight and obesity was 5.4% and 1.7% respectively. The percentage of overweight boys varied between 3% at 17 years to 6.9% at 15 years of age.

Table 2: Descriptive summary of weight among boys of Government and private schools.

Age (years)	School (N)	Mean	SD	Median	Mean difference	t	P value
15	Govt. (60)	53.7	1.0	51.5	2.30	13.12	0.000
	Pvt. (71)	51.4	1.0	50.0			
	Total (131)	52.4	1.0	51.0			
16	Govt. (43)	55.1	1.02	53.0	2.60	2.25	0.03
	Pvt. (57)	52.5	7.5	51.0			
	Total (100)	53.6	8.8	52.0			
17	Govt. (32)	55.2	8.29	52.0	-1.70	0.99	0.33
	Pvt. (35)	56.9	5.63	55.5			
	Total (67)	56.1	7.0	55.0			
Total	Govt. (136)	54.5	9.71	52.0	1.60	1.51	0.133
	Pvt. (163)	52.9	8.65	52.0			
	Total (298)	53.6	9.2	52.0			

Table 3: Descriptive summary of BMI among boys of government and private schools.

Age (years)	School (N)	Mean	SD	Median	Mean difference	t	P value
15	Govt. (60)	19.0	3.36	18.3	0.60	1.06	0.29
	Pvt. (71)	18.4	3.07	18.0			
	Total (131)	18.7	3.21	18.1			
16	Govt. (43)	19.3	3.11	18.1	0.70	0.02	0.98
	Pvt. (57)	18.6	2.32	18.1			
	Total (100)	18.9	2.69	18.1			
17	Govt. (32)	19.9	2.21	19.2	0.40	0.84	0.41
	Pvt. (35)	19.5	1.68	19.3			
	Total (67)	19.7	1.95	19.3			
Total	Govt. (136)	19.3	3.04	18.6	0.60	1.85	0.07
	Pvt. (163)	18.7	2.58	18.5			
	Total (298)	19.0	2.81	18.5			

Table 4: Prevalence of stunting among Himachali boys; N (%).

Age group (years) (N)	Normal	Stunting (<-2SD)	Severe. stunting (<-3SD)	X^2 (P value)
15 (131)	123 (93.9)	8 (6.1)	0 (0)	0.140 (0.932)
16 (100)	95 (95)	5 (5)	0 (0)	
17 (67)	63 (94)	4 (6)	0 (0)	
Total	281 (94.3)	17 (5.7)	0 (0)	

The prevalence of obesity was 3.1% at 15 years and 1% at 16 years. None of the boys at the age of 17 years were found to be obese. The Pearson's Chi-Square test showed that there was no significant level of association between the prevalence of different categories of malnutrition with the age groups (Chi-Square=10.633(6), p=0.100) (Table 5). Five different categories of malnutrition were identified. Wasting or thinness was much higher as compared to other categories of malnutrition. The coexistence of both stunted and wasted children was found only at the age group of 15 years (Figure 1).

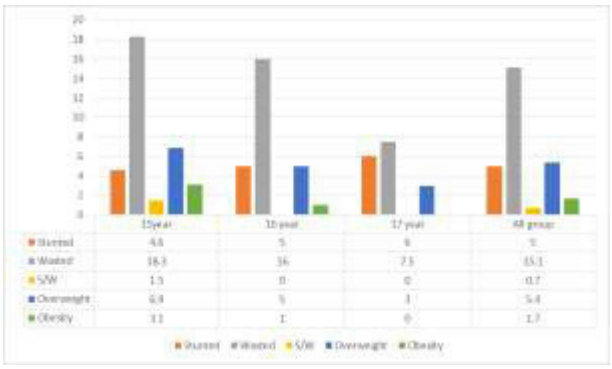

Figure 1: Representation of different categories of malnutrition.

Table 5: Prevalence of thinness among Himachali boys; N (%).

Age group (years) (N)	Normal	Thinness (<-2SD)	Severe thinness (<-3SD)	Overweight	Obesity	X^2 (P value)
15 (131)	92 (70.2)	26 (19.8)	0	9 (6.9)	4 (3.1)	10.633 (0.100)
16 (100)	78 (78)	16 (16)	0	5 (5)	1 (1)	
17 (67)	60 (89.6)	5 (7.5)	0	2 (3)	0 (0)	
Total	230 (77.2)	47 (15.8)	0	16 (5.4)	5 (1.7)	

DISCUSSION

Assessment of height and weight and converting them into nutritional indices is a standard procedure worldwide for the assessment of the nutritional profile of a population. The present study reported the nutritional profile of the Himachali adolescent boys within the age group of 15-17 years of age.

Height of the Himachali boys

The height of the Himachali boys examined in the present study varied between 167.2 cm at 15 years to 168.8 cm at 17 years. These boys were found to be taller than the Shabar tribal adolescents of Orissa; mean height 155.9 cm at 15 years, 156.5cm at 16 years, and 157.7 cm at 17 years of age, but comparable with the heights reported for the north Indian school children; mean height 165.9, 169.3, and 172 cm at 15, 16, and 17 years of age respectively.[21,22] On a comparative account, it appeared that the 15 years old Himachali boys were slightly taller as compared to the north Indian boys reported in this study. However, the 16 and 17 years old north Indian boys appeared to be taller than the Himachali boys by 1 cm and 3.2 cm respectively.

In a more recent study, much lower heights (155.5 cm at 15 years, 157.5 cm at 16 years, and 158.6 cm at 17 years) were reported for rural adolescent children from West Bengal[8] as compared to Himachali boys. For the age group of 15 years, the mean reported heights available in different studies varied from 153.6 cm for urban adolescent boys of south Gujarat and 161.2 cm for urban children of Nagaland Himachali boys were taller as compared to these populations. However, the mean height (168.4 cm) of 15 years old children from Kharad, Maharastra, was higher than the present 15 years old Himachali boys.[6,23,24]

Weight of Himachali boys

Like the height, the mean weight of the present Himachali boys was higher than the weights reported for the Shabar tribal adolescents of Orissa, for all the age groups considered; 42.5 kg at 15 years, 44.2 kg at 16 years, and 45.7 kg at 17 years. Himachali boys were also found to be heavier than the rural adolescent boys from West Bengal with a mean weight of 42.8 kg at 15 years, 44.2 kg at 16 years, and 47.2 kg at 17 years.[8,21] In comparison to the North Indian school children, the mean weights of Himachali boys were found to be lower at all age groups.[21,22] The mean weight of Himachali boys at 15 years was 52.4 kg. Almost similar weight (52.2 kg) was obtained for 15-year-old urban boys from Karad Maharastra.[24] Two other studies reported a mean weight of 36.2 kg for the urban adolescents of South Gujrat and 48.7 kg for the Naga children which were much lower as compared to the present Himachali boys.[6,23]

Comparison of stunting

The prevalence of stunting of the Himachali boys in three different age groups was almost similar and varied between 5-6%. This is much lower as compared to the stunting reported among the rural adolescents from nine different Indian states.[25] In this study, the stunting rates were 48.9%, 51.8%, and 59.7% in the age groups of 15, 16, and 17 years respectively. Higher rates of stunting were also reported among the rural adolescent boys of U.P (27.4%) rural adolescent boys of West Bengal (59.5%)[8] and adolescent boys of UP and Bihar (27.3%) of similar age group.[10,13]

Comparison of thinness

The rate of thinness in the present Himachali boys showed a decreasing trend from 15 to 17 years. Varying from 19.8% to 7.5% respectively, with an overall prevalence rate of 15.8%. Some studies also reported a similar decreasing trend in the age group of 15-17 years.[8,21] The rate of thinness among the present Himachali boys (15.8%) was lower as compared to the urban Bengali adolescent boys, from urban and rural areas with a prevalence rate of 20.6%, and 38% respectively.[5,8] Chakraborty and Bharti reported a prevalence of thinness that varied between 33.3%-25% between 16-17 years with the lowest prevalence of 25% observed in 17 years of age. These values were also higher as compared to the present study.[6,21]

An overall prevalence rate of 25.7% was reported among the Naga children, [6] which was also higher than the rate obtained in the present study. In contrast to the above mentioned higher prevalence rates of thinness reported from different Indian states, the rate of the thinness of the boys from Mandi district of Himachal Pradesh, almost matches with previous findings that reported 18.2% thinness among the 15 years old boys from Naggar area of Kullu district of Himachal Pradesh.[16]

Comparison of overweight and obesity

In the present study obesity and overweight, both categories of over nutrition were found among the Himachali boys. The overall prevalence of overweight and obesity was found to be 5.4% and 1.7% respectively. The findings on the overweight were lower in all the age groups in comparison to the rate of overweight reported among Bengali urban adolescents.[5] The prevalence of overweight and obesity among present Himachali boys was 3% -6.9% which was lower as compared to the overweight and obesity rate among urban Bengali boys.[5] However, the prevalence of overweight was almost similar to that of the rural Bengali boys.[8] The present rate of overweight among the 15 years old boys was higher as compared to the two previous reports of overweight among Naga children and Himachali boys from Naggar district of Kullu.[6,16]

CONCLUSION

Himachali boys appeared to be taller than most of the Indian population of boys of similar age groups. Prevalence of the different categories of overnutrition and undernutrition were also lower as compared to that obtained for other Indian studies on adolescent boys. The existence of overweight and obese individuals points towards the double burden of malnutrition.

ACKNOWLEDGEMENTS

The authors would like to express their gratitude to all the participants. The authors are also grateful to the school authorities for their kind cooperation and for providing the necessary facilities to conduct the study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Pathania NS, Biswas R. Assessment of nutritional status of adolescent school going boys of Himachal Pradesh. Int J Community Med Public Health 2021;8:4960-6.

e-ISSN 2320 –7876 www.ijfans.org
Vol.11, Iss.7, 2022
 UGC CARE Listed (Group -I) Journal

Type of article: Original article

"Anthropometric Study Of Nutritional Status Of Adolescent Girls Of Himachal Pradesh"

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Running title: "Nutritional status of adolesent Himachali girls".

Contribution Details (to be ticked marked as applicable):

	Contributor 1	Contributor 2	Contributor 3	Contributor 4
Concepts			√	
Design			√	
Definition of intellectual content	√	√	√	
Literature search	√		√	
Clinical studies				
Experimental studies				
Data acquisition	√	√	√	
Data analysis	√		√	
Statistical analysis			√	
Manuscript preparation	√		√	
Manuscript editing	√	√	√	
Manuscript review	√	√	√	
Guarantor			√	Abstract Page

Title of the article: Anthropometric study of nutritional status of adolescent girls of Himachal Pradesh

Abstract:

Background:

Adolescents represent a very significant part of the community as they represent the future generation. Proper nutrition of adolescent girls is of immense public health importance for positive pregnancy outcomes to break the intergenerational malnutritional cycle. Very few reports are available on the anthropometric growth and nutritional standard of the Himachali adolescent girls.

Aims:

The present study aims to assess the prevalence of malnutrition of Himachali adolescent girls from their anthropometric growth standards.

Methods and Material:

A cross sectional study was conducted among school going girls within the age group of 10-17 years selected from non- hilly regions of Mandi district of the Himachal Pradesh. Height, weight and age at the time of survey were determined. Z-score for height for age and BMI for age was calculated and compared with WHO growth reference standard to detect stunting, wasting, overweight and obesity.

Results:

There is a progressive increase in the mean height, weight and BMI of girls across all the age groups. The maximum gain of 6 cm in height and 5.6 kg in weight was recorded between 11-12 years. Prevalence of thinness, stunting and overweight was 17.6%, 9% and 4.3% respectively.

Conclusions:

As compared to the 50th percentile Indian growth reference standard the mean height of Himachali girls at all age groups appear to be slightly lower except for 10 and 13 years of age but the mean weights of all age groups appeared to be lower. Thinness appeared to be most prevalent form of malnutrition

Key-words: Physical growth, nutrition, height, weight, stunting, wasting, adolescent girls, Himachal Pradesh.

Introduction:

Anthropometric measurements include somatic measurements. Height and weight are the two primary somatic measurements that reflect physical growth of an individual. The normal physical pattern of growth is majorly determined by the genetic makeup of an individual and continues with a standard level of gain in both height and weight with chronological age. Human growth occurs during infancy, childhood and adolescence. In each phase, the growth pattern depends on nutrition. Poor nutrition hinders optimal growth and results in growth deficiencies. Growth deficiency is the inability to gain normal level of height at a particular age, or the inability to gain a normal level of weight for a particular height. To determine the growth pattern and growth deficiencies, the height and weight data are transformed into suitable indices in relation to age and sex of the individual. These indices serve as important proxy measures of nutritional standard and detect malnutrition that evolves from nutritional imbalance or deficiencies. [1]

The adolescent period is considered as a period of rapid physical development with attainment of secondary sexual characteristics. Due to high nutritional demand required for rapid growth this period is also considered as the most vulnerable period from the view point of nutrition. A wide range of studies have indicated that nutritional inadequacies in adolescence can retard growth and can make one susceptible to various diseases in the adult life. [2, 3]

The domain of adolescent's growth and nutrition is immensely important as the adolescents are the future workforce and bearers of next generation. Even more importance is placed on the nutritional standards of the adolescent girls because they represent future mothers and therefore. contribute significantly to the nutritional status of the community. Optimal nutrition among adolescent girls brings positive pregnancy outcome and break the intergenerational malnutrition cycle. [4-5]

Reports on the physical growth and nutritional status of Himachali adolescent girls are scanty. In this backdrop this cross-sectional study was designed to evaluate the nutritional status of adolescent girls from non-hilly region of Himachal Pradesh within the age group of 10-17 years.

Materials and Methods:

Study Design

A cross sectional study was conducted among a sample of 749 Himachali girls aged 10-17 years. Data were collected from four schools belonging to the Mandi Sadar, Balh, and Sundernagar subdivisions of the Mandi district of Himachal Pradesh. The data for study was collected between the month of May 2018 to August 2018.

Sample Size Calculation

For estimating the sample size, the study adopted a conservative approach to estimate the prevalence of malnutritional conditions in the target population and a 50 % prevalence rate was selected. Sample size was estimated by the following formula:

$n=Z^2P(1-P) / d^2$

Where n is the sample size, Z is the statistic corresponding to the level of confidence, P is expected prevalence, and d is precision (corresponding to effect size).

In the present study, the sample size was estimated from the following values:

z- The Z score at 95% confidence interval = 1.96
p - the assumed prevalence = 50 %
1- p = 50 %
d = precision level or margin of error = 5%
Accordingly, the total sample is calculated = $\frac{1.96*1.96*0.5*0.5}{(0.5*0.5)}$ X 100
= 385

However, presuming an attrition rate of 20%, the number of students that this study will cover will be approximately 385 + (20 % of 385) = 385 + 77 = 462. The minimum number was rounded to 470. However, in practice the study covered a much large number of samples, A total of 749 girls were selected for the study.

Ethical approval and consent

The ethical approval for this survey was obtained from the Institutional Ethics Committee (IEC) of Himachal Dental College, Sundernagar, District Mandi, Himachal Pradesh, IEC number 2017-24, dated:19.12.2017.

Exclusion and inclusion criteria

Prior to the study, the students were explained about the purpose of the study and the extent of their involvement in presence of the respective class teachers. The same was also conveyed to their parents through the class teachers. The students who consented to participate in the study, through their parents, according to the design of the experiment were included. The children suffering from any type of chronic disease or those who reported any illness during the last one month before the study date were excluded from the study.

Physical Measurement

Age was obtained from the Date of Birth (DOB) as mentioned in the school register. Height was measured with an anthropometric rod with shoes removed and head aligning in the Frankfurt plane. Readings were taken to the nearest 1 cm. Weight was measured in kg by using a bathroom room-scale with school uniform and shoes removed, to the nearest 500 grams. Body Mass Index (BMI was obtained as the square of height in meter divided by body weight in kg according to the formula:
BMI = height (m^2) / weight (kg) and expressed kg/m^2.

Calculation of Z scores

The height for age (HAZ) z score was obtained for all subjects. This was calculated as the difference of measured height and the median height of the WHO reference population of the same age, divided by the SD of the reference population.
The Z scores for BMI for age (BMIAZ) was calculated from BMI vales of the subjects using the L, M, and S values of the WHO reference population of the corresponding age groups. [6]
Assessment of Nutritional Status
For analytic purposes, five different malnutritional conditions, viz., 1) stunted 2) thinness 3) coexistence of both stunted and thinness, 4) overweight, and 5) obesity were considered.

Categories of malnutrition were defined according to the cut-off values of the following z scores recommended by the WHO, according to the growth reference data for 5 – 19 years old adolescents. [7-8]

- Stunted: Height-for-Age Z score < - 2SD to ≤ - 3SD,
- Severely stunted: Height-for-Age Z score < - 3SD
- Wasted: BMI-for-Age Z score < - 2SD to ≤ - 3SD,
- Severely wasted: BMI-for-Age Z score = < - 3SD,
- Overweight: BMI-for-Age Z score > 1 SD
- Obese: BMI-for-Age Z score is > 2 SD

A subject was considered normal if the z scores for both HAZ and BMIAZ were found to be > -2SD.

Result

Height and Weight of the subjects

The mean height, weight and BMI of the subjects are presented in table 1. The data showed that there is a progressive increase in the mean height, weight and BMI of girls with chronological age. Mean heights at 10 and 17 years were 139.4 cm 156.6 cm respectively, depicting a total gain of 17.2 cm between these years. Similarly, the mean weight increases from 29.3 kg at 10 years to 46.5 kg at 17 years. The total increase in mean weight was 17.2 kg.

Maximum gain in height and weight was obtained from 11 to 13 years. For height the gain is 6 cm between 11-12 years and 5.3 cm between 12 to 13 years. For weight, maximum gain was 5.6 kg between 11-12 years 3.6 kg between 11-12 years.

As compared to the 50th percentile height of the Indian reference population,[9] the mean height of the Himachali girls at all groups appeared to be slightly lower except for 10 and 13 years of age. In contrast, the mean weight at all age groups appeared to be lower than the 50th percentile weight standards. (Figure 1 & 2).

Prevalence of Malnutrition

Table 2 summarizes the prevalence of stunting across all age groups. Stunting was maximum at age group of 11 (N = 19, 17.9 %) and minimum at 10 years of age (N = 2, 2,5%). No age-related trend was obtained in the prevalence rate of stunting. Severely stunted girls were found only in the age group of 12 (N = 3, 2,7%) and 15 (1, 1.1%) years. Overall prevalence of stunting was 9 %.

Prevalence of thinness across all age group was higher than stunting. Maximum thinness was found among 10- and 11-years group, while minimum thinness was obtained at 12, 14 and 15 years. (Table 3)

Prevalence of overnutrition was minimum as compared to stunting and thinness. Overweight and obese girls were more in 11, 12 and 16 years, highest prevalence of overweight and obesity were obtained at 16 and 12 years respectively (Table 4).

Prevalence of stunting, wasting, and combined overnutrition were found to be higher in the early adolescent girls between 10 – 14 years (N = 460), as compared to the late adolescent group, aged between 15 – 17 years (N = 289). The proportion of the subjects who were stunted, thin and in the overnutrition category did not vary significantly with respect to the

adolescent category, chi square (2, N= 232) = 1.511, p = 0.47. The prevalence of different categories of malnutrition among the early and late adolescent groups is presented in figure 3.

Discussion:

Height and Weight of Himachali Girls as compared to other Indian studies

Attempt has been made to compare the height and weight of the present Himachali girls with other Indian pollution of adolescent girls of similar age group as reported in some earlier studies.

The mean height of Himachali girls was 150.7 cm. Higher mean heights of 152 cm and 152.3 cm has been reported for Indian school children [10] and Rajput females from Shimla district of Himachal Pradesh [11] respectively.

Himachali girls were found to be taller by 7 to 8 cm as compared to the mean height of Indian rural adolescents [12], Shabar tribal adolescents' girls from Odissa [13], and rural adolescent girls from West Bengal[14] which was reported to be 143.1 cm, 142.2 cm, and 143.5 cm respectively for the same age group. However, similar height of 150 cm was reported for the north Indian girls. [15]

The mean weight of Himachali girls was 40.1 kg. A higher group mean weight 45.6 kg and 41.4 kg was reported for Indian school children [10] and north Indian girls [15] respectively. While lower mean weight was reported for Rajput females from Shimla district of Himachal Pradesh [11], Indian rural adolescents [12], Shabar tribal adolescents' girls from Odissa [13], rural adolescent girls from West Bengal [14] and which were 39.9 kg, 33.7 kg, 34.2 kg and 34.1 kg and respectively.

Malnutrition in Himachali girls as compared to other Indian studies

The present Himachali girls represents urban and peri urban population. The prevalence rate of different categories of malnutrition of this girls can be compared with the prevalence rates of malnutrition reported for adolescent girls from different parts of India covering both rural and urban areas.

Comparison of the prevalence of stunting

The overall rate of stunting appeared to be 9 %. This is lower than the stunting rates reported for urban adolescent girls of Maharashtra [16], Uttar Pradesh [17], Assam [18]and Uttar Pradesh and Bihar [19] but higher as compared to the urban adolescent girls from Bangalore [20].

Compared to different rural populations, the present rate of stunting was higher as compared to reports from Karnataka [21] , and Medinipur [22] and Jalpaiguri districts of West Bengal [23], but much lower as compared to the reports available from Bijapur [24] and Mandya [25] districts of Karnataka, and also from Bareilly [26] Uttar Pradesh Jammu [27] and Birbhum and Medinipur districts of west Bengal [14] and rural adolescent of Uttar Pradesh and Bihar[19] The comparative prevalence of stunting is depicted in figure 6.

Comparison of the prevalence of thinness

The overall rate of thinness appeared to be 17.6 %. This is lower as compared to almost all the studies conducted in different rural adolescent girls from West Bengal [28,14], Karnataka [21,24], Uttar Pradesh [26,29] Tamil Nadu [30] and Himachal Pradesh [31], but higher as compared to the reports from Bihar and UP [19].

The wasting rates of the Himachali girls are much lower as compared to the wasting rates reported for urban populations from Varanasi [32], Mysore [33], Assam [18] and Uttar Pradesh [29]. The comparative representation of wasting rate is presented in figure 7.

Comparison of the prevalence of overweight

In comparison to other reports of overnutrition on Urban population [32,34,35] the prevalence rate of overweight of Himachali girls (3 .3 %) is slightly higher, but lower as compared to urban and rural girls from Uttar Pradesh [29]. In comparison to other reports of overweight among rural adolescent girls [14,28,31], overweight among Himachali girls was obtained to be higher. (figure 8).

CONCLUSION

This is one of the first large scale study conducted on urban and peri urban adolescent Himachali girls from non-hilly regions of the state, which reported the height, weight and the prevalence of different categories of malnutrition among the Himachali girls

In comparison to the height and weight of Indian growth reference at different age groups from 10 – 17 years, the mean heights of Himachali girls in different age groups appeared to be almost similar, but the mean weights were found to be lower.

Across all age groups, thinness appeared to be most prevalent form of malnutrition, followed by stunting and overnutrition. No age-related trend was observed for malnutrition categories. The prevalence rates of different malnutrition categories when compared between the early and late adolescent groups, appeared to be statistically insignificant.

The prevalence of stunting and thinness obtained for the Himachali girls were found to be lower as compared to the most of the reports available for different population of Indian adolescent girls.

Acknowledgement:

The authors are thankful to all school authorities and participants for their kind support during data collection.

Financial Support and sponsorship

Nil

Conflicts of Interest

There are no conflicts of interest.

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Table 1: Height, weight and BMI of Himachali girls (N = 749).

Age (year)	N	Height (cm)		Weight (kg)		Body Mass Index (kg / m^2)	
		Mean	SD	Mean	SD	Mean	SD
10	79	139.4	6.45	29.3	4.85	14.9	1.74
11	106	142.1	7.79	32.2	6.51	15.9	2.45
12	110	148.1	7.53	37.8	7.46	17.2	2.90
13	90	153.4	5.93	41.4	7.95	17.5	2.67
14	75	154.1	5.24	43.5	7.39	18.3	2.79
15	89	155.4	5.28	43.9	5.75	18.2	2.19
16	112	156.1	5.06	46.2	8.65	18.9	3.37
17	88	156.6	5.48	46.5	6.45	19.0	2.36
Total	749	150.6	8.76	40.1	9.20	17.5	2.94

Table 2. Prevalence of stunting across all age groups

Age group (N)	Stunted		Severe stunted		All stunted	
	N	%	N	%	N	%
10 (79)	2	2.5	0	0	2	2.5
11 (106)	19	17.9	0	0	19	17.9
12 (110)	11	10	3	2.7	14	12.7
13 (90)	8	8.9	0	0	8	8.9
14 (75)	7	9.3	0	0	7	9.3
15 (89)	8	9	1	1.1	9	10.1
16 (112)	5	4.5	0	0	5	4.5
17 (88)	4	4.5	0	0	4	4.5
All (749)	64	8.5	4	0.5	68	9

Table 3. Prevalence of wasting across all age groups

Age group (N)	Wasted		Severe wasted		All wasted	
	N	%	N	%	N	%
10 (79)	16	20.3	5	6.3	21	26.6
11 (106)	15	14.2	9	8.5	24	22.6
12 (110)	9	8.2	5	4.5	14	12.7
13 (90)	13	14.4	4	4.4	17	18.9
14 (75)	8	10.7	2	2.7	10	13.3
15 (89)	8	9	3	3.4	11	12.4
16 (112)	13	11.6	6	5.4	19	17.0
17 (88)	11	12.5	5	5.7	16	18.2
All (749)	93	12	39	5	132	17.6

Table 4. Prevalence of overweight and obesity across all age groups

Age group (N)	Overweight		Obese		All overnutrition	
	N	%	N	%	N	%
10 (79)	1	1.3	0	0	1	1.3
11 (106)	6	5.7	0	0	6	5.7
12 (110)	5	4.5	4	3.6	9	8.2
13 (90)	1	1.1	1	1.1	2	2.2
14 (75)	2	2.7	1	1.3	3	4.0
15 (89)	2	2.2	0	0	2	2.2
16 (112)	8	7.1	1	0.9	9	8.0
17 (88)	0	0	0	0	0	0
All (749)	25	3	7	1	32	4.3

Figure 1: - Mean height of the Himachali girls at different age groups compared to the corresponding 50th percentile values of Indian growth standard.

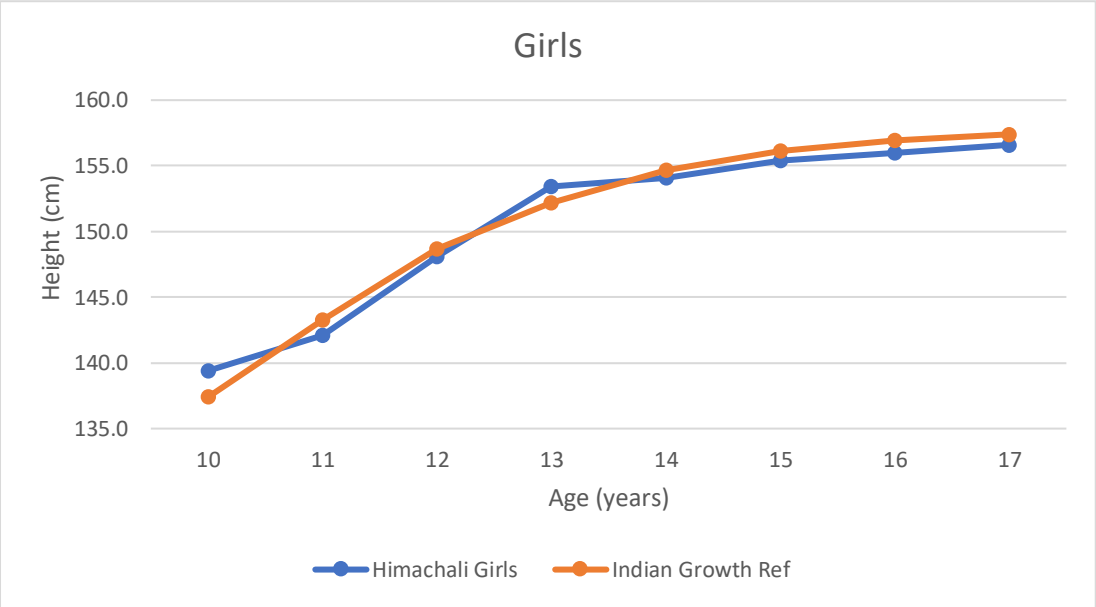


Figure 2:- Mean weight of the Himachali girls at different age groups compared to the corresponding 50th percentile values of Indian growth standard.

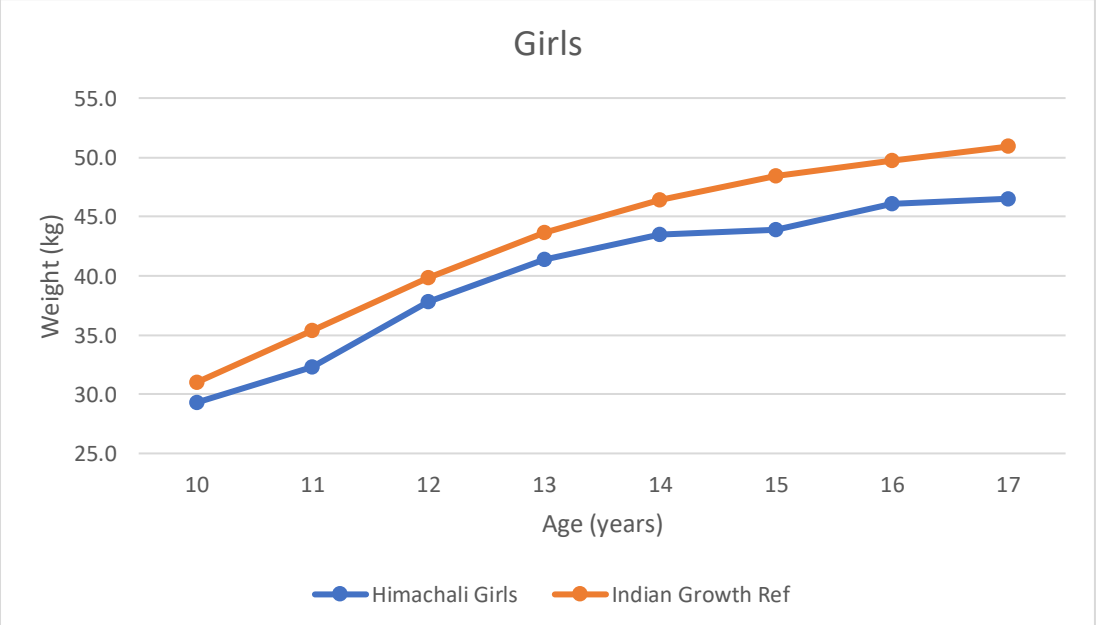


Figure 3. Prevalence of under and overnutrition across early and late adolescent categories

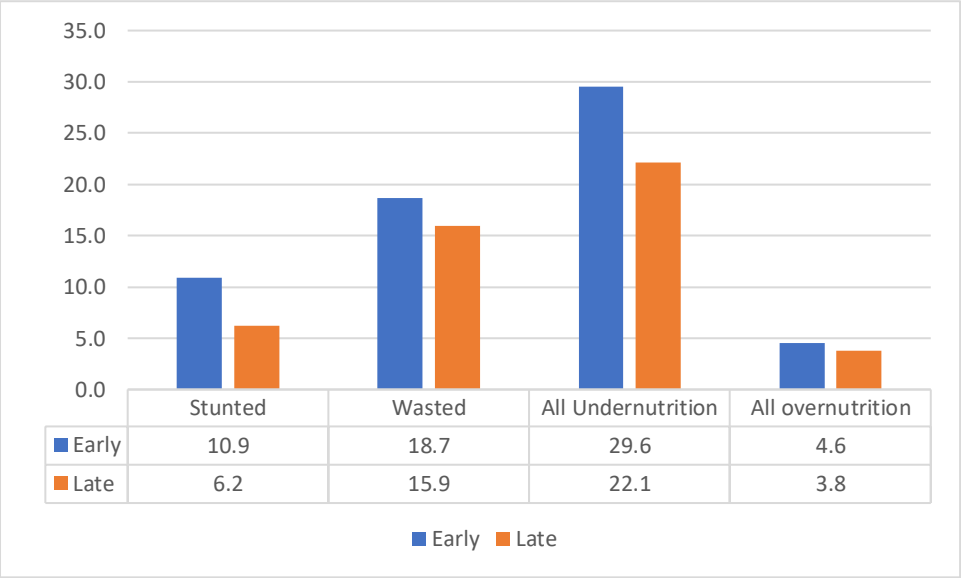


Figure 4. Comparison of height of the Himachali girls with other Indian populations

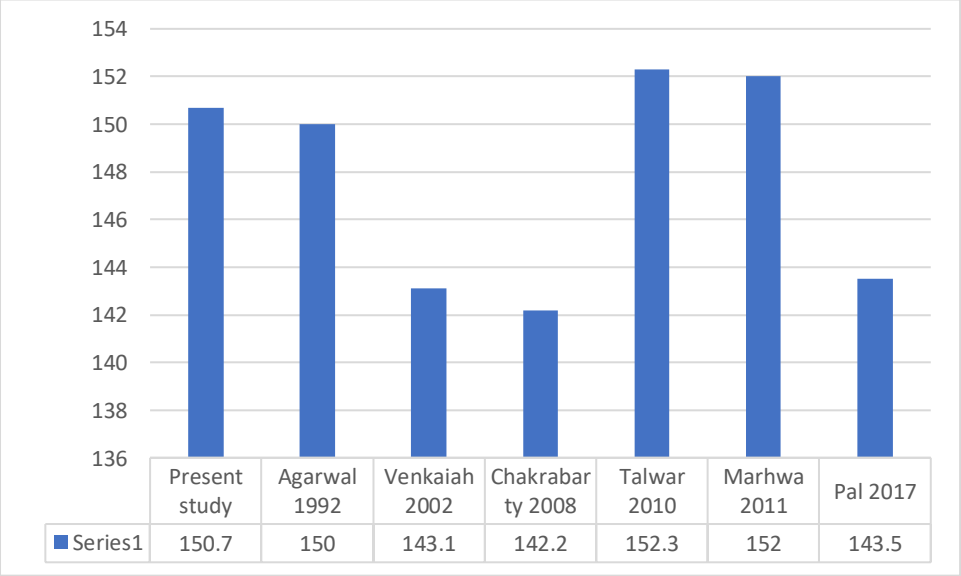


Figure 5. Comparison of weight of the Himachali girls with other Indian populations

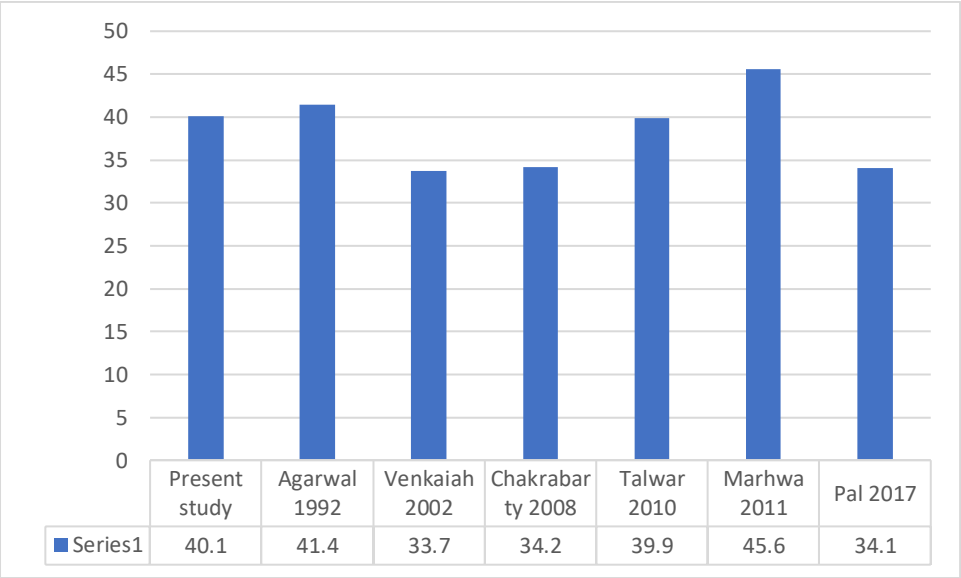


Figure 6:- Prevalence of Stunting of Himachali girls as compared to other Indian studies

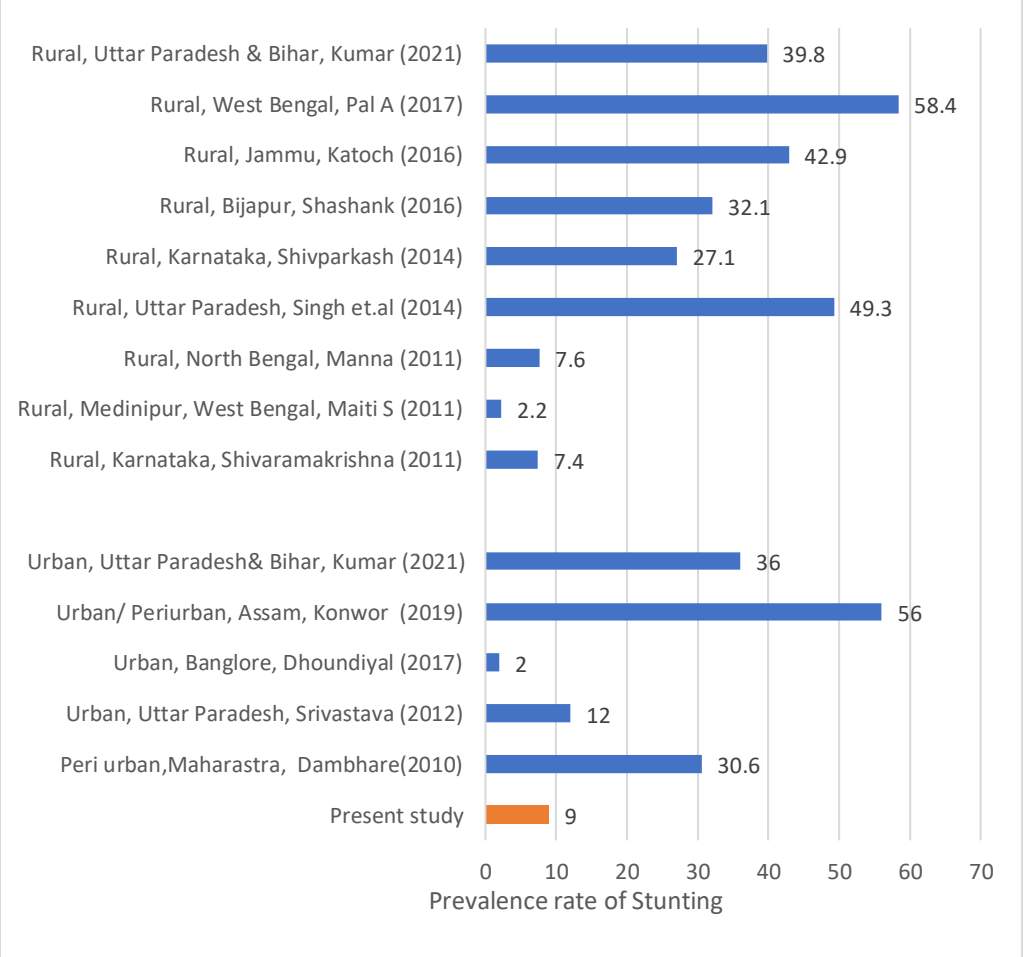
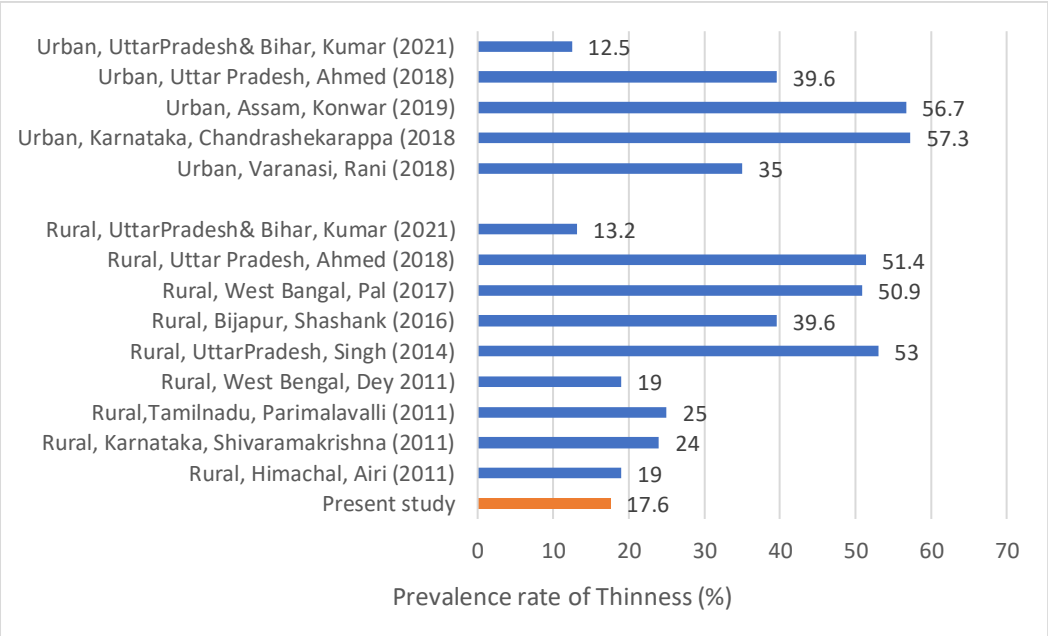


Figure 7:- Prevalence of thinness of Himachali girls as compared to other Indian studies



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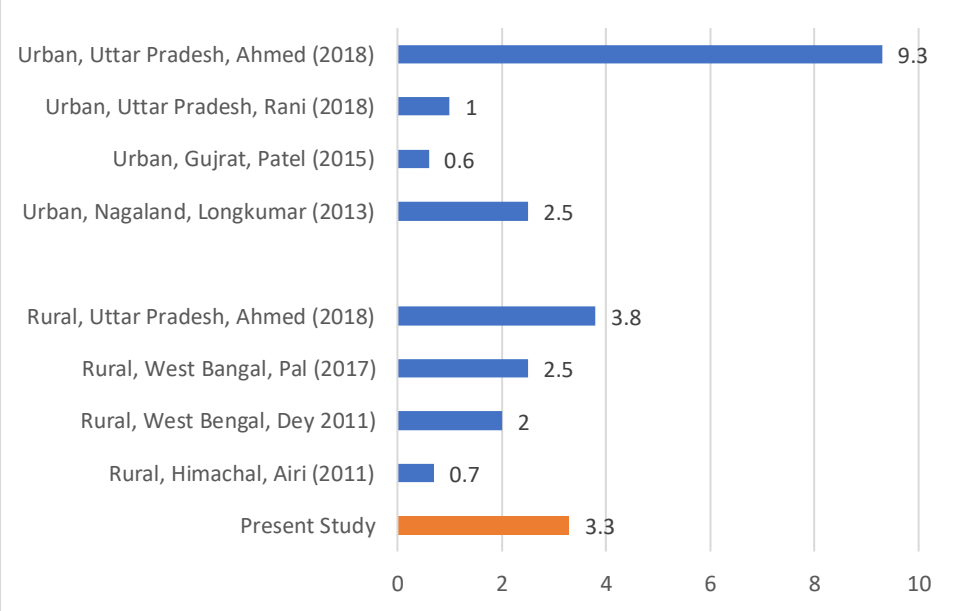

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