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## **“Anthropometric Study Of Nutritional Status Of Adolescent Girls Of Himachal Pradesh”**

### **1. Pathania S Neetu. (M. Phil).**

Ph.D. Scholar, Department of Chemistry, Pacific Academy of Higher Education and Research (PAHER), Pacific Hills, Pratap Nagar Extension, Debari, Udaipur – 313024, Rajasthan, India

### **2. Choudhary Varsha (Ph. D).**

Department of Chemistry, Pacific Academy of Higher Education and Research (PAHER), Pacific Hills, Pratap Nagar Extension, Debari, Udaipur – 313024, Rajasthan, India

### **3. Biswas Rajib (Ph. D) – Corresponding Author**

Department of Physiology,  
Himachal Dental College, Sundernagar, Himachal Pradesh – 175002, India.

Phone numbers – 9805022394

E-mail address – [ergoraj@gmail.com](mailto:ergoraj@gmail.com)

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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 50<sup>th</sup> 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 = 
$$\frac{(1.96*1.96*0.5*0.5)}{(0.5*0.5)} \times 100$$
$$= 385$$

However, presuming an attrition rate of 20%, the number of students that this study will cover will be approximately  $385 + (20 \% \text{ of } 385) = 385 + 77 = 462$ . 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<sup>2</sup>) / weight (kg) and expressed kg/m<sup>2</sup>.

#### 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 values 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  $\leq -3SD$ ,
- Severely stunted: Height-for-Age Z score  $< -3SD$
- Wasted: BMI-for-Age Z score  $< -2SD$  to  $\leq -3SD$ ,
- Severely wasted: BMI-for-Age Z score  $= < -3SD$ ,
- Overweight: BMI-for-Age Z score  $> 1SD$
- Obese: BMI-for-Age Z score is  $> 2SD$

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 50<sup>th</sup> percentile height of the Indian reference population,<sup>[9]</sup> 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 50<sup>th</sup> 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 population 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 <sup>[10]</sup> and Rajput females from Shimla district of Himachal Pradesh <sup>[11]</sup> respectively.

Himachali girls were found to be taller by 7 to 8 cm as compared to the mean height of Indian rural adolescents <sup>[12]</sup>, Shabar tribal adolescents' girls from Odissa <sup>[13]</sup>, and rural adolescent girls from West Bengal<sup>[14]</sup> 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. <sup>[15]</sup>

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 <sup>[10]</sup> and north Indian girls <sup>[15]</sup> respectively. While lower mean weight was reported for Rajput females from Shimla district of Himachal Pradesh <sup>[11]</sup>, Indian rural adolescents <sup>[12]</sup>, Shabar tribal adolescents' girls from Odissa <sup>[13]</sup>, rural adolescent girls from West Bengal <sup>[14]</sup> 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 <sup>[16]</sup>, Uttar Pradesh <sup>[17]</sup>, Assam <sup>[18]</sup> and Uttar Pradesh and Bihar <sup>[19]</sup> but higher as compared to the urban adolescent girls from Bangalore <sup>[20]</sup>.

Compared to different rural populations, the present rate of stunting was higher as compared to reports from Karnataka <sup>[21]</sup>, and Medinipur <sup>[22]</sup> and Jalpaiguri districts of West Bengal <sup>[23]</sup>, but much lower as compared to the reports available from Bijapur <sup>[24]</sup> and Mandya <sup>[25]</sup> districts of Karnataka, and also from Bareilly <sup>[26]</sup> Uttar Pradesh Jammu <sup>[27]</sup> and Birbhum and Medinipur districts of west Bengal <sup>[14]</sup> and rural adolescent of Uttar Pradesh and Bihar<sup>[19]</sup> 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 <sup>[28,14]</sup>, Karnataka <sup>[21,24]</sup>, Uttar Pradesh <sup>[26,29]</sup> Tamil Nadu <sup>[30]</sup> and Himachal Pradesh <sup>[31]</sup>, but higher as compared to the reports from Bihar and UP <sup>[19]</sup>.

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.

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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 <sup>2</sup> )	
		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

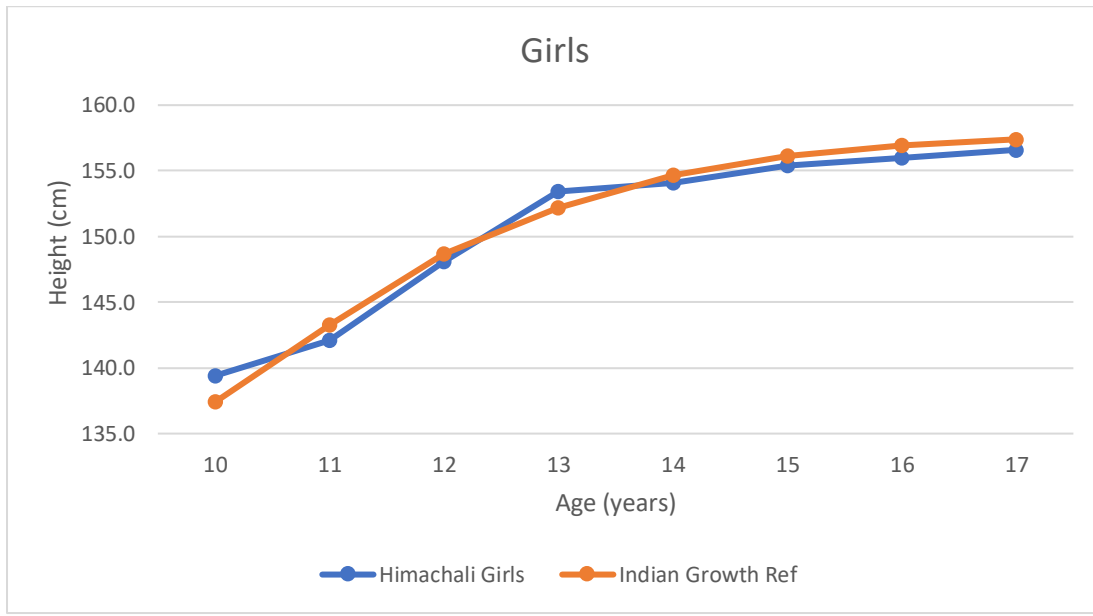
**Table 3. Prevalence of wasting across all age groups**

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

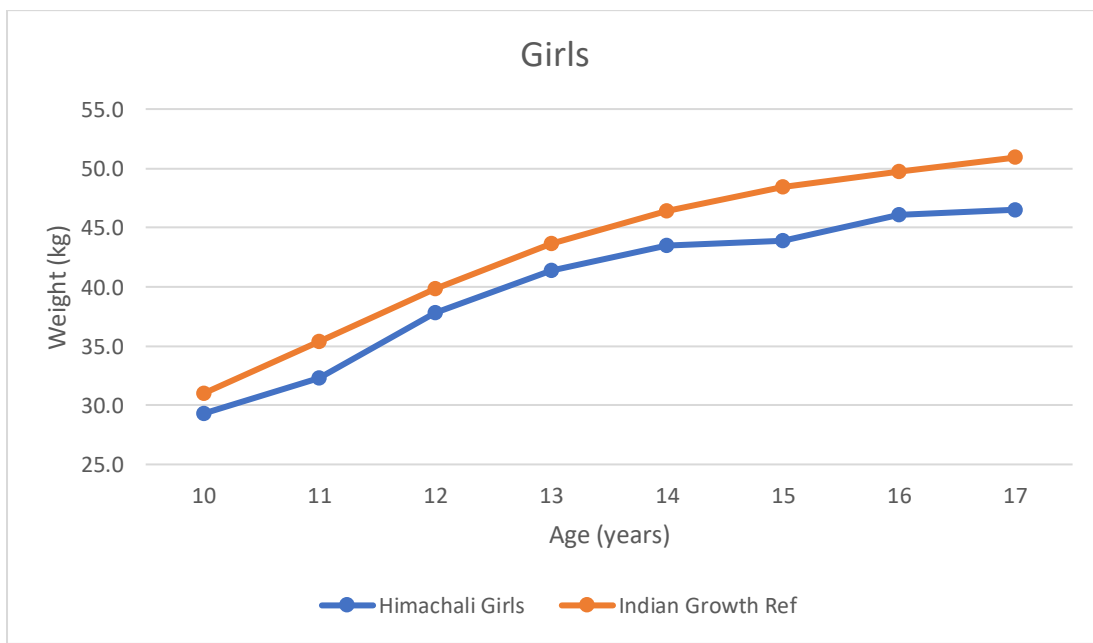
**Table 4. Prevalence of overweight and obesity across all age groups**

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

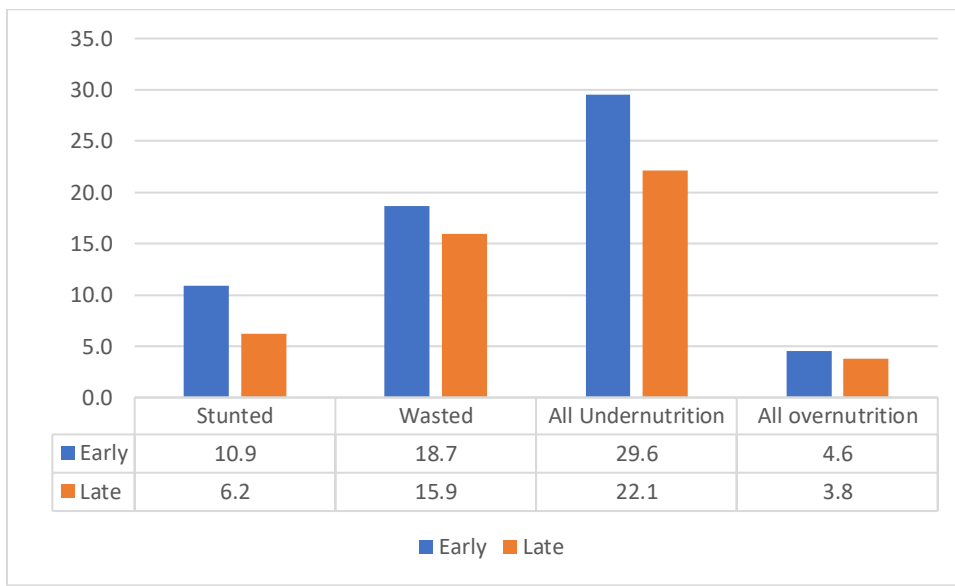
**Figure 1: - Mean height of the Himachali girls at different age groups compared to the corresponding 50<sup>th</sup> percentile values of Indian growth standard.**



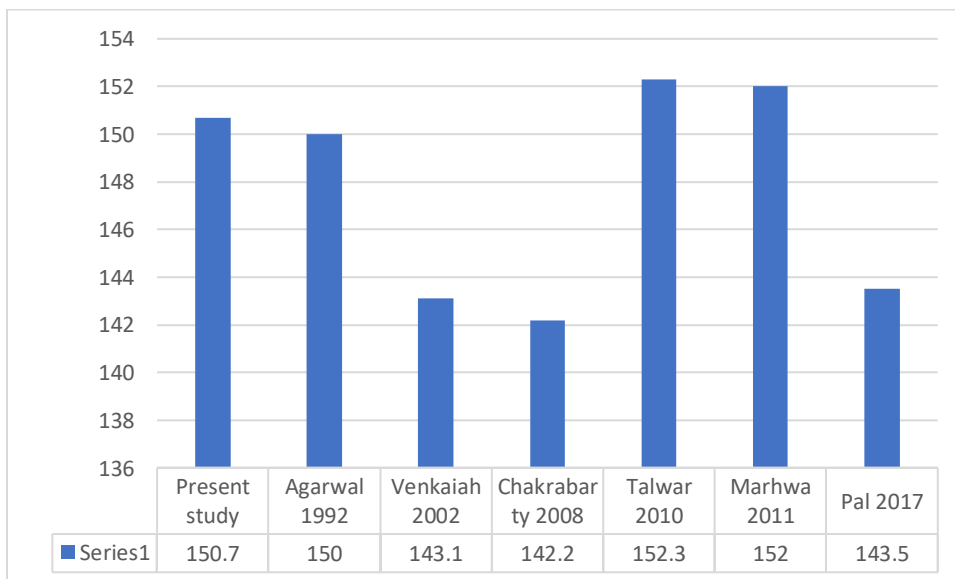
**Figure 2:- Mean weight of the Himachali girls at different age groups compared to the corresponding 50<sup>th</sup> percentile values of Indian growth standard.**



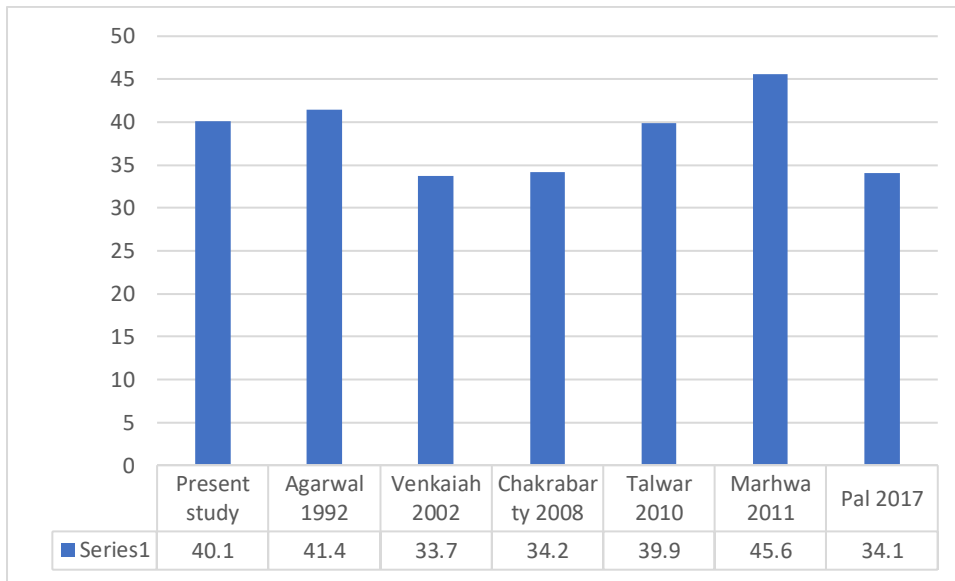
**Figure 3. Prevalence of under and overnutrition across early and late adolescent categories**



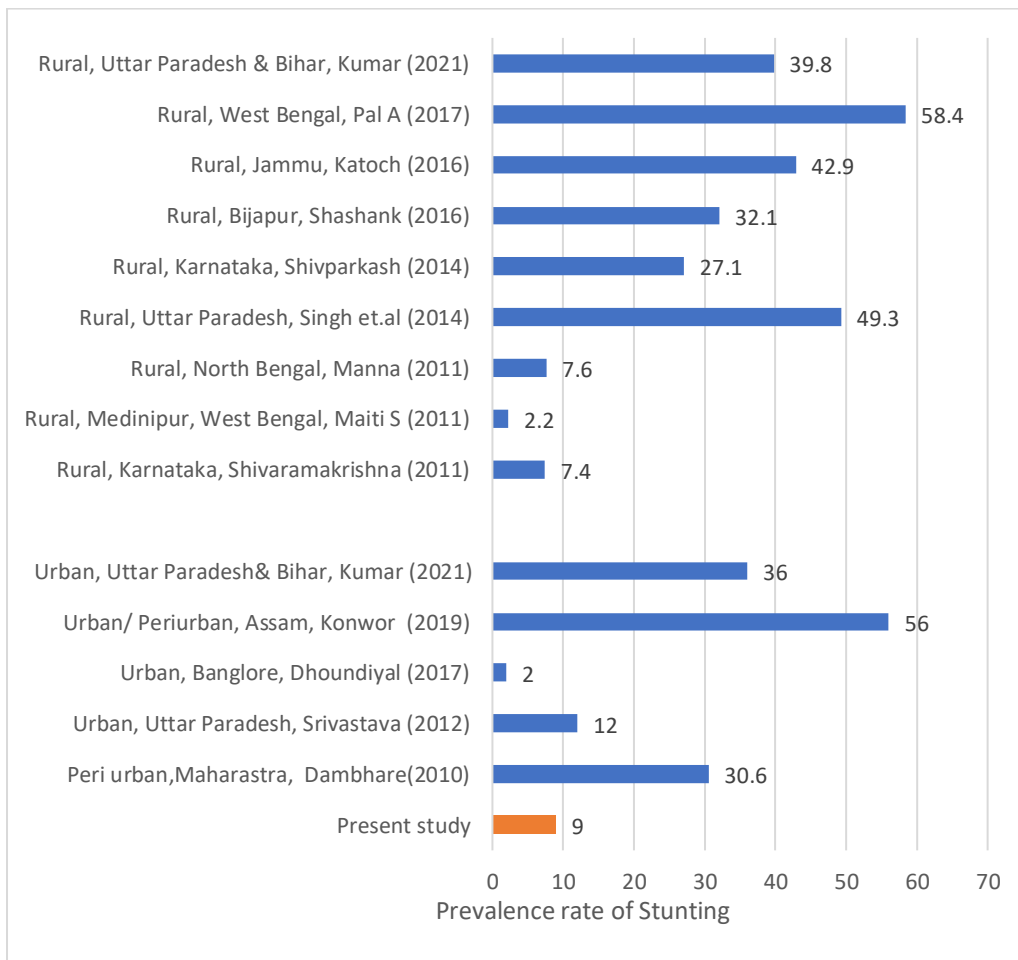
**Figure 4. Comparison of height of the Himachali girls with other Indian populations**



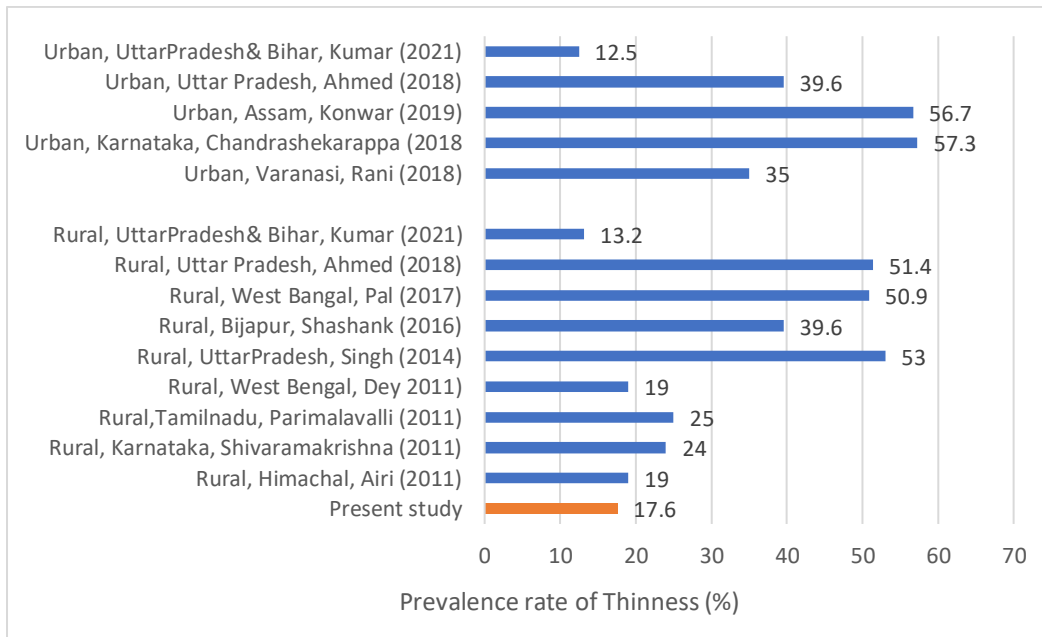
**Figure 5. Comparison of weight of the Himachali girls with other Indian populations**



**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**



**Figure 8: – Prevalence of overweight of Himachali girls as compared to other Indian studies**

