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Neonatal Ponderal Index Variations across the Outer and Inner Himalayas of Himachal Pradesh

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ABSTRACT

Introduction: Overweight is increasingly recognized as a significant health concern across many countries. Both genetic and environmental influences are acknowledged as key factors contributing to this issue, yet our understanding of it is still lacking. Studies indicate that genetic factors play a substantial role in overweight and body mass index (BMI), which is calculated as weight divided by height squared (BMI=weight/height2).

Methods: The present study was undertaken in the state of Himachal Pradesh. A total of 409 newborns were included. The measurements were recorded on the newborn babies with-in 12-24 hours of birth. All the neonates were the outcome of full term normal deliveries, delivered at various civil hospitals of the above mentioned regions. These regions included district Dharamshala, Una, Hamirpur, Bilaspur, Kangra, Solan, Shimla, Rampur, Kullu, Mandi and Reckong-peo. Ethical clearance and permission to conduct study was taken and all the measurements were done under the guidance of pediatrician of the hospital.

Results: The normal ponderal index was 2.44 for outer Himalayas and 2.25 for inner Himalayas. In the outer Himalayas, the PI showed a strong positive correlation with weight and a strong negative correlation with height. When the weight increased, the ponderal index increased and when height increased, PI decreased. In the inner Himalayas, the PI showed a strong negative correlation with height and strong positive correlation with weight. When the height increased, the ponderal index decreased and when weight increased, the ponderal index increased.

Conclusion: It is clear from our study on newborns in Himachal Pradesh that when height increases the ponderal index decreases and when weight increases the ponderal index increases.

Key Words: Ponderal Index, Himalayan, Himachal, Anthropometry, Newborn, Neonates, Weight, Crown heel length and height.

INTRODUCTION

Overweight is increasingly recognized as a significant health concern across many countries. Both genetic and environmental influences are acknowledged as key factors contributing to this issue, yet our understanding of it is still lacking.[1] Studies indicate that genetic factors play a substantial role in overweight and body mass index (BMI), which is calculated as weight divided by height squared(BMI=weight/height^2).

After adjusting for age, an analysis of US research published between 1970 and 1972 showed that, among children who were fat, the risk of becoming obese as an adult was twice that of children who were not obese.[3] The body mass index (weigh/height^2) is a commonly used indicator of obesity and thinning in both adults and children.[4]

It is usually preferred to the ponderal index (weight/height^3) as it provides a better adjustment for height, being less correlated with height.[5]The ideal index in a statistical sense is highly correlated with weight and uncorrelated with height (Benn 1971). Such an index, known as Benn index, is of the general form (weight/height^n) where n is a number calculated from the data to ensure zero correlation between the index and height. If the correlation is zero, then the adjustment is perfect. The power n usually takes a value somewhere between 1 and 3, but is not usually a whole number. The correlation between the index and weight falls as n gets larger, and varies inversely as the strength of the correlation between weight and height.[6]

Despite the popularity of the body mass index during other stages of life, some neonatologists prefer to utilize the ponderal index. There is little published evidence as to which index should be preferred at birth.[7-8]

To evaluate asymmetrical intrauterine growth retardation, Rohrer's ponderal index, which measures newborns (birth

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weight/height3 x 100), has been employed as an indicator of fetal growth status. The relationship between the quantity of soft tissue mass and skeletal development is calculate by the ponderal index.[9]

Researchers are becoming more aware of the pathophysiologic variability associated with intrauterine growth retardation. Infants with growth retardation are divided into two groups based on the ponderal index: symmetric and asymmetric growth retardation. Asymmetric growth retardation is characterized by a low ponderal index and weight proportionately more affected than height at a given gestational age. Individuals with symmetric growth retardation exhibit a normal ponderal index, affecting weight as well as height.[10]

The pathophysiology of these two subgroups of intrauterine growth retardation may differ from one another in terms of time, underlying etiologic causes, postnatal morbidity, and growth characteristics.[11]

Genetic or toxic factors, as well as inadequate nutritional supply, can all contribute to intrauterine growth retardation. A lack of nutrients during crucial stages of fetal development can change how certain homoeostatic systems are supposed to evolve.[12]

The geographical location, racial and environmental factors are responsible for the differences in growth and body composition in individuals. In view of this, we selected to undertake an anthropometric study of normal newborns in hills of Himachal Pradesh, which is known for its unique and uncanny socio-political and cultural tradition. Its unique composition, location, and character all makes it the bounder land.[13]

AIM AND OBJECTIVE

To measure ponderal index of full term newborn of Himachal Pradesh and to calculate and compare mean value and standard deviation. Determine the correlation between weight, height and ponderal index in each group and compare the present findings with the available literature. The data for each newborn was recorded in a form and analyzed. For comparison of the means of the anthropometric measurements unpaired t- test was used.

MATERIALS AND METHODS

The present study was undertaken in the state of Himachal Pradesh. A total of 409 newborns were included. According to the different zones of Himachal Pradesh, the newborn infants were divided into following categories (Table 1).

Table 1: Distribution of subject in outer and inner Himalayas.

	MALE	FEMALE	TOTAL
Outer Himalayas	120	108	228
Inner Himalayas	96	85	181

The measurements were recorded on the newborn babies with-in 12-24 hours of birth. All the neonates were the outcome of full term normal deliveries, delivered at various civil hospitals of the above mentioned regions. These regions included district Dharamshala, Una, Hamirpur, Bilaspur, Kangra, Solan, Shimla, Rampur, Kullu, Mandi and Reckong-peo.

Ethical clearance from university and permission to conduct the study was taken from the Director of Health Services Shimla and subsequently from Chief Medical Officer / Medical Superintendent (CMO/MS) of the particular hospital. All the measurements were done under the guidance of pediatrician of the hospital.

Baby weight was recorded from the hospital record in the labor ward. The Height (crown heel length) was measured in supine position with full extension of knee and distance between top of head and heel when press against a vertical surface and role on a stabilizing board **(Fig.1).**

Figure 1: A, B, C & D Showing the method of taking measurements on a newborn's baby.

METHODS OF ANALYSIS

The ponderal index for each newborn was calculated as the ratio of birth weight (g) to the height cubed (cm^3) x 100. The total study population (n=409) was used to define the 10th, 25th, 50th, and 90th percentiles of the ponderal index distribution. The relationship between height, weight and ponderal Index in each group were computed and the statistical significance of these determined by F test. Newborns characteristics were examined for their association with mean ponderal index and with the probability of an infant having a ponderal index < the 10th percentile or > the 90th percentile.

These characteristics included Outer Himalayas and Inner Himalayas, **sex** (two groups- male and female). The practical significance of the relationship was analyzed by comparing among the two zones.

RESULTS

Table 2: Mean and SD values for Height, weight and ponderal Index for outer and Inner Himalayan region

Parameters	Outer Himalayan (N = 181)		Inner Himalayan (N = 228)	
	Mean	SD	Mean	SD
Weight (kg)	2.89	0.41	2.98	0.42
Height (cm)	49.25	1.86	48.9	1.65
Ponderal Index (gm/cm³)	2.44	0.45	2.58	0.44

Result of F test computed for PI between upper and lower zone

The test statistic **F** equals **1.0744, and the p-value = 0.6159**, ($P(F \leq 1.0744) = 0.69$). Results of the F-test for equality of variances indicated that there is a non-significant small difference between inner Himalayan ($SD_1 = 0.5$) and outer Himalayan ($SD_2 = 0.4$), $F(227,180) = 1.10744$, $p = 0.6159$. Since the p-value > α (0.05), the null hypothesis (H_0) cannot be rejected. Hence, the **outer Himalayan** population's variance ratio is considered to be equal to the **inner Himalayan** population's variance ratio.

Table 3: Percentiles of PI for outer and inner Himalayan

	10th	25th	50th	75th	90th
Outer Himalayan	2.00	2.29	2.58	2.80	3.11
Inner Himalayan	1.92	2.13	2.44	2.69	3.03

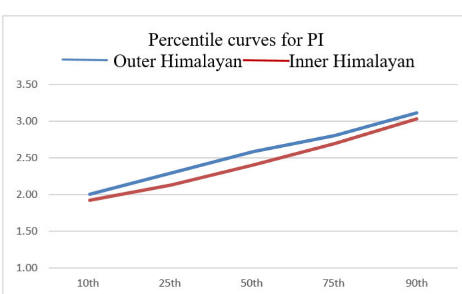

Figure 2: Percentile curves for Ponderal Index in outer and inner Himalayas.

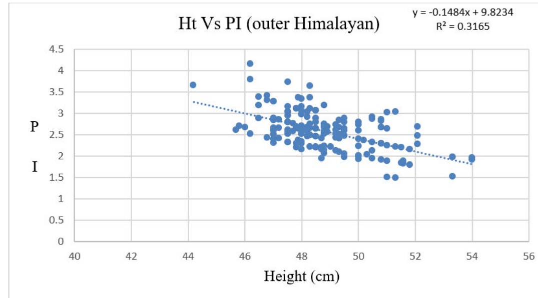

Figure 3: Correlation and Regression Analysis (outer Himalayan).

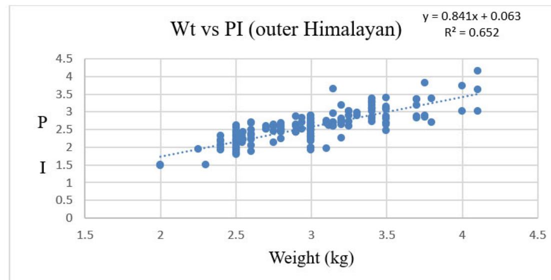

Figure 4: Correlation and Regression Analysis (outer Himalayan).

In the outer Himalayan group, the PI shows a strong positive correlation with weight; r (179) = 0.8176, p = < 0.0001, and a strong negative correlation with height, r (179) = - 0.5626, p = < 0.0001.

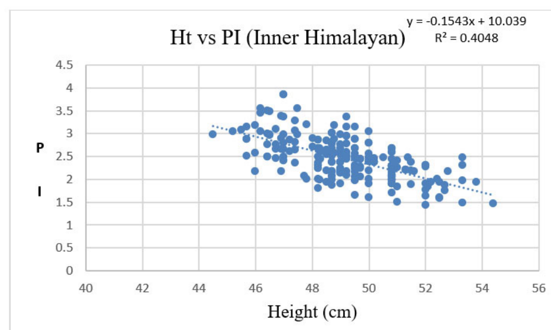

Figure 5: Correlation and Regression Analysis (Inner Himalayan).

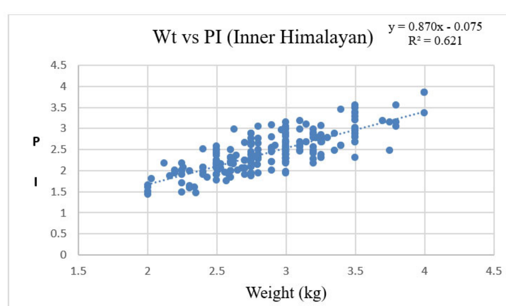

Figure 6: Correlation and Regression Analysis (Inner Himalayan)

In the inner Himalayan group, the PI shows a strong negative correlation with height, r (280) = 0.5626, $p < 0.0001$, and a strong positive correlation, r (280) = 0.7886, $p < 0.0001$, with weight.

DISCUSSION

An adjective like "slender," "medium," "fleshy," or "very fleshy" is used to characterize the physical build. The physiology of nutrition theory states that when food intake exceeds the amount needed for basal metabolism, the excess energy is used for building materials, which increases body weight. Alternatively, if there is a calorie deficit, body fat is burned to make up the difference, which causes weight loss.

In the first case the individual puts on weight, becomes fleshy or obese. In the second case, the individual loses in weight and becomes slender.

It is concluded that the nutritional theory is incomplete after a study involving a significant number of households. It implies that the economy of thickening differs genetically in various families.[14]

Two type of variation in build have to be distinguished.

(a) The ontogenetic change in normal build during development with increasing stature.

(b) The change in weight in adults of relatively invariable stature.

In type a, stature and other proportions are rapidly changing, but in type b, stature remains constant and throughout the race, stature does not differ as much in mature persons as it does from birth to maturity.[15]

It is well known that there are noticeable racial disparities in build. The thin Scotchman looks very different from the Greek, Russian, or South Italian Jew. Arctic environments seem to favor massive build, although Eskimo people are known for being fleshy. The thinnest race on earth is the Nilotic black. Because there are so significant racial disparities in body build, race should be considered in body build studies whenever possible.[15]

It is universally acknowledge the size at birth is an important indicator of fetal and neonatal health in the context of the both individuals and populations. Size at birth reflects two factors: duration of gestation and rate of fetal growth. It must therefore be considered with respect to gestational age; the increase in size that occurs with age will lead to severe confounding of growth and maturity.[16]

India is a land of diversity and people of different province have different food habits, life style, socio-cultural trend and ethnicity. The diversity is evident in their physical structure and anthropometric parameters. It is essential to study the physical features and environment in which a particular community is living.

The existing newborn anthropometric data against which deviations from normal could be assessed are generally lacking in developing countries. In this study, measurements of newborns' anthropometric parameters are compared with the standards of other countries. But these standards have some limitations related to differences in genetic, nutritional and environmental factors.

In our study we found that the mean birth wt 2.91±0.41 which is similar to study conducted by Kataria SK and Gaur S[18], higher with Kaur et al.[17,] Taksande et al.[19], Sunntha B and Kavita VK[20] and lower than Pachauri S and Marwah SM[21]. It was observed in this study that the difference in the mean birth weight between male and female newborn is significant ($p=0.013$).

Table 4: Comparison of birth weight and height

Authors	Work	Ethnic Group	Observations (Mean Values)
Kaur et al[17](2013)	Birth weight Height	Faridkot, Punjab.	Wt = 2.39±5.60 Ht = 46.1±3.3
Kataria SK and Gaur S[18](2014)	Birth weight Height	Jodhpur, Rajasthan	Wt = 2.92±0.39 Ht = 47.95±1.10
Taksande et al[19] (2008)	Birth weight Height	Maharashtra, India.	Wt= 2.82±0.28 Ht = 51.15±3.31
Pachauri S and Marwah SM[21] (1971)	Birth weight Height	New Delhi	Wt= 2.96±4.81 Ht = 47.84±3.93
Sunntha B and Kavitha VK[20] (2016)	Birth weight Height	Hyderabad	Wt= 2.64±0.49 Ht = 47.28±4.17
Present authors (2023)	Birth weight Height	Himachal Pradesh	Wt= 2.91±0.41 Ht = 48.71±3.82

Wt = Birth weight (Kg), Ht = Height (Crown Heel Length in cm)

CONCLUSION

The newborns were classified as LGA if their birth weight was >90th percentile, or SGA if it was <10th percentile.

The normal ponderal index is 2.44 for outer Himalayas and 2.25 for inner Himalayas. In the **outer Himalayas** the PI shows a strong positive correlation with weight and a strong negative correlation with height. When the weight increased, the ponderal index increased and when height increased PI decreased.

In the **inner Himalayas** the PI shows a strong negative correlation with height and strong positive correlation with weight. When the height increases the ponderal index decreases and when weight increased the ponderal index increases.

It is clear from our study on newborns in Himachal Pradesh that when height increases the ponderal index decreases and when weight increases the ponderal index increases.

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Conflict of Interest: None

Authors' Contribution; Dr. Pankaj Soni conceptualized and designed the study, coordinated data collection, and interpreted the results. Dr. Pradeep Kashyap and Dr. Manoj Kumar Sharma contributed to data collection, statistical analysis, and manuscript preparation. All authors reviewed and approved the final manuscript. The study was conducted under ethical guidelines with pediatrician supervision.

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