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Down Syndrome– Correlation of Head Circumference, Weight and Height

Authors

Mrs. Panneer Selvi. G[1], Dr K.R Srinivasan[2], Dr P. Koteeswary[3], Dr Deepti Shastri[4], Dr Senthil Kumar Babu[5]

[1]Tutor, Department of Anatomy, Vinayaka Mission's Kirupananda Variyar Medical College and Hospital, Salem- Tamilnadu-636 308
Email: *drpango2921@gmail.com, Mobile No: 09884946604*

[2]Professor, Department of Anatomy, Vinayaka Mission's Kirupananda Variyar Medical College and Hospital, Salem- Tamilnadu-636 308
Email: *krsrinivasanms@gmail.com*

[3]Professor and Head, Department of Transfusion Medicine, Vinayaka Mission's Kirupananda Variyar Medical College and Hospital, Salem- Tamilnadu-636 308
Email: *krsrinivasanms@gmail.com*

[4]Professor and Head, Department of Anatomy, Vinayaka Mission's Kirupananda Variyar Medical College and Hospital, Salem- Tamilnadu-636 308
Email: *deepthirahul@yahoo.co.in*

[5]Lecturer, Department of Anatomy, Vinayaka Mission's Kirupananda Variyar Medical College and Hospital, Salem- Tamilnadu-636 308
Email: *skdrchinu88@gmail.com*

ABSTRACT

Aim: *The study aimed to find the difference in the head circumference of both male and female Down syndrome cases.*

Objectives: *The main objective of the study is to assess the correlation between the height, weight and head circumference of Down syndrome children and also to find out the regression equations.*

Materials and Methods: *Study samples were randomly selected from various special schools for Down syndrome in Tamilnadu state of India. Ninety six (59 males and 37 females) cases of Down syndrome ageing from one to 40 years were selected. After obtaining consent from parents and Principals of above Special schools, the head circumference, weight and height were measured in centimetre. The analysis of data were done in a Microsoft excel and various statistical program from SPSS Version 16.0.*

Result: *The study states that there were significant differences in head circumference of both sexes in all age groups up to 21 years of age. The results of the present study shows significant correlation between weight and head circumference of males Down syndrome cases (r^2 = 0.565, $P < 0.0001$). There were significant correlation with height of female Down syndrome cases (r^2 = 0.536, $P < 0.001$).*

Conclusion: *There are many studies on anthropometric assessment of head circumference, weight and height of the normal population. Studies dealing with head circumference of Down syndrome in relation to height and weight are very few. This study is the first of its kind to find absolute regression equation for determination of head circumference in India for Down syndrome cases.*

Keywords: *Correlation, Down syndrome, Head circumference, Regression equation*

Introduction

Measurement of head circumference is one of the most important tools in the paediatric medical examination. This physical examination provides the medical practitioner about the knowledge of the cranial growth and status of brain development[1]. There are many syndromes associated with microcephaly and macrocephaly[2]. Usually the normal variation in the head size is familial[3]. Head circumference was highly correlated with body size particularly with body weight in both sexes[4]. A standard reference curve for head circumference of both sexes with Down syndrome from birth to 36 months of age was framed by Palmer et al (1992)[5].

After birth, Down syndrome can be usually diagnosed based on features like small head (microcephaly), flat face, upward slanting eyes, Saddle sign, Simian crease and hypotonia. Every person born with Down syndrome is different presenting with clinical features.

Microcephaly is often found in children with Down syndrome and other genetic disorders. Several hundreds of gene mutations are linked with microcephaly which interferes with brain growth. Children with Down syndrome have characteristic feature of growth retardation, particularly in relation to head circumference. Hence assessment of head circumference provides a vital guide for the brain development of Down syndrome cases.

Aim

The study aimed to find the difference in the head circumference of both male and female Down syndrome cases.

Objectives

The main objective of the study is to assess the correlation between the height, weight and head circumference of Down syndrome children and also to find out the regression equation.

Materials and Methods

Study sample were randomly selected from various special schools of Tamilnadu state of India. Selected 96 (59 males and 37 females) Down syndrome cases ageing from one to 40 years. After obtaining consent from parents and Principals of above Special schools, the head circumference was measured using non stretchable tape. Weight was measured with electronic digital scale and height with portable stadiometer. Infant length board was used to measure the length of the infants and toddlers who were unable to stand unsupported.

Statistical Analysis

Growth measurements were charted according to World Health Organization and Centre for Disease Control and Prevention (CDC) growth chart. The analysis of data were done in a Microsoft excel and various statistical program from SPSS Version 16.0. Mainly linear regression equation analysis was used and $P < 0.05$ is considered to be statistically significant.

Results

All Down syndrome children born are not having microcephaly. From the Table- 1 below it is evident that 40.7 % of male Down syndrome are having < 3rd percentile (Microcephaly) according to WHO and CDC. Similarly 32.4 % of female Down syndrome are having < 3rd percentile.

In order to find the head circumference difference between males and females of Down syndrome among age groups, the samples were first grouped into five as follows: 0- 5 years, 6-10 years, 11-15 years, 16-20 years and > 21 years. Table -1 showed there were no significant differences among the age group 0-5 years. There were highly significant difference in head circumference of both sexes of Down syndrome among age group 6-10 years ($P<0.0009$). Significant difference ($P<0.007$) were found among 11-15years, 16-20 years ($P<0.02$) and > 21 years. When total age range from 0-40 years were considered for analysis, the result showed a high significant difference between males and females of Down syndrome cases ($P< 0.002$). Since the total age group analysis showed highly significant difference between both sexes of Down syndrome there is no need to frame different age group categories for analysis.

Regression analysis revealed in Down syndrome cases, both height and weight were significantly associated in both sexes. When the independent variable weight and height were added separately for male Down syndrome cases , the weight was the stronger independent variable for head circumference (R^2= 0.563) but when both were added together, the variance is highest for male (R^2= 0.565) which to near to weight independent variable as shown in Table-3. When both weight and height are considered together, the regression equation yielded a significant relationship. This can be used for finding head circumference and to construct chart for male Down syndrome only.

When the variable of weight and height were added separately for female Down syndrome cases, the height was the stronger independent variable for head circumference (r^2= 0.536). But when both weight and height were added together, the regression analysis showed the same value (r^2= 0.536) as shown in Table - 4 and also lesser than male independent variable of height and weight. The closer the value of R^2 to 1, the stronger the relationship between the height and head circumference of female Down syndrome (r^2= 0.536).

The lesser the value of the Standard Deviation Residual (SDR), the nearer will be considerable distribution fit for all groups of data. The Mean Residual (MR) between the observed and predicted value were found to be Zero. The table-5 shows the lesser SDR value for HC versus weight for both male and female were 2.08 and 2.21 respectively. Hence, it proves that most of the measured values of weight variable follow the normal distribution within the ± 2 standard deviation regression line (Fig-1 and 2).

Table-1: Percentage of head circumference < 3^{rd} percentile according to WHO and CDC:

Sex	No. of Cases	No. of cases < 3^{rd} percentile	Percentage (%) of < 3^{rd} percentile
Male	59	24	40.7
Female	37	12	32.4
Male & female	96	36	37.5

Table-2: Comparison of Head circumference between male and female DS cases using unpaired't' test:

Age range	Mean ± SD Male	Mean ± SD Female	P value
0-5 years	44.2±2.7	41.3± 4.4	0.1 #
6-10 years	48.5± 1.5	45.3±1.0	0.0009**
11- 15 years	49.2±1.6	46.8±1.8	0.02*
16-20 years	49.1±2.7	48.1±2.6	0.02*
>21years	50.1±2.0	47.9±1.4	0.007*
Total age range 0- 40 yrs	48.1±3.1	46.0±3.4	0.002**

Insignificant value; * Significant; ** Highly significant

Table-3: Regression formulas for Head Circumference (HC) as dependent variable and Height or Length (H) and Weight (W) as independent variable for Male:

Sex	Variables	Regression formula	R^2	P value
Male	Weight	HC= 43.04+ 0.131 × W	0.563	P<0.0001
	Height/Length in children	HC=36.84+0.086 ×H	0.488	P< 0.0001
	Weight and Height	HC= 41.982+ 0.114 × W + 0.013×H	0.565	P< 0.001

Table- 4: Regression formulas for Head Circumference (HC) as dependent variable and Height or Length (H) and Weight (W) as independent variable for Female:

Sex	Variables	Regression formula	R^2	P value
Female	Weight	HC= 40.902+ 0.133 × W	0.483	P< 0.005
	Height/Length	HC=34.111+0.096 ×H	0.536	P< 0.001
	Weight and Height	HC= 33.486+(-)0.015 × W + 0.105×H	0.536	P<0.001

Table-5: Analysis of Standard Deviation residuals (SDR) and Mean Residual (MR) for male and female:

Regression equation	SDR male	SDR female	MR for both male and female
Weight Vs HC	2.08	2.21	0.0
Height Vs HC	2.51	2.33	0.0
Weight and Height Vs HC	2.21	2.34	0.0

Fig-1: Scatter plot for Observed Head circumference of Male (HcM) and predicted value using weight

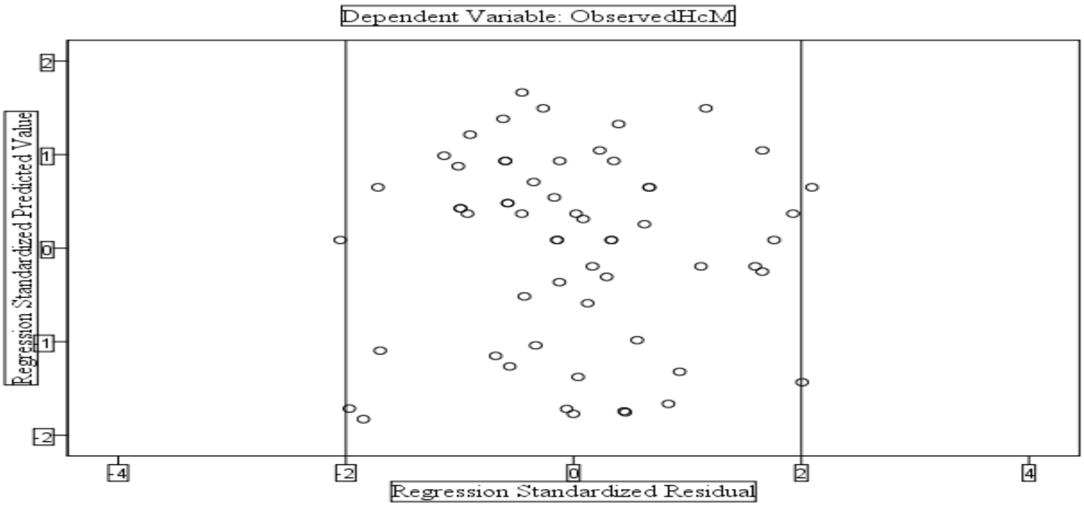
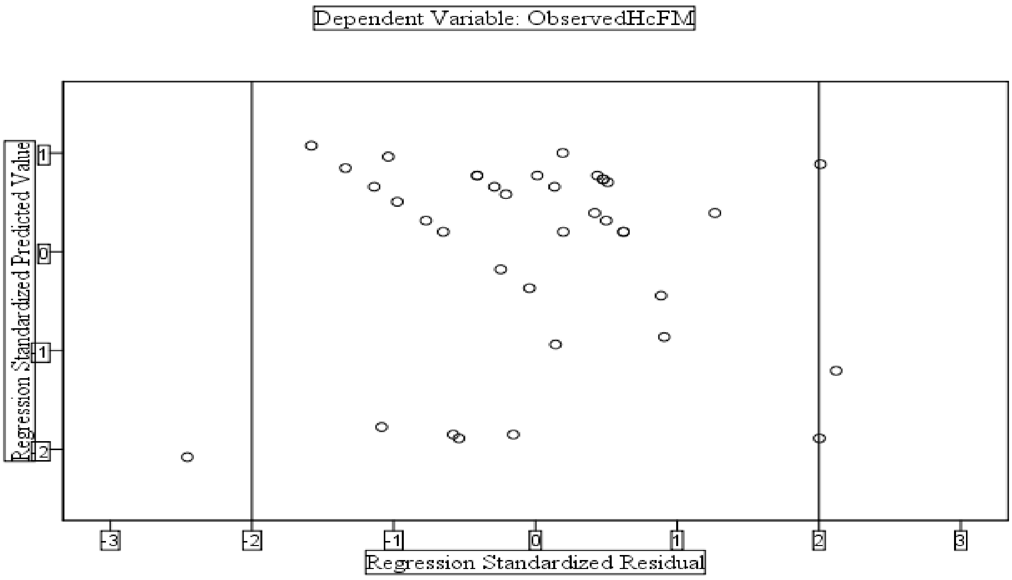


Fig- 2:Scatter Plot for Observed Head Circumference of Female(HcFM) and Predicted value using weight



Discussion

Farkas et al (1992)[8] stated that the head circumference matures at 15 years of age in males, which is contrary to our study that shows findings of head circumference increase up to the age of 21 years as follows: 49.2 ±1.6 (11-15 years) and 50.1± 2 (>21 years) in males and similarly in females it is 46.8±1.8 (11-15 years) and 47.9±1.4 (>21 years).

There were significant differences in head circumference of both sexes in all age groups up to 21 years of age (Table -1). In our study, the head circumference of males was found to be 2cm higher than that of female Down syndrome whereas in the study of Isparta and England showed the difference as 1.33 cm in normal population[9].

Palmar et al (1992) had done a study on head circumference in Down syndrome cases from 0-36 months. His study showed that 50% of Down syndrome cases had head circumference as that of the general population range[5].

A study done by Wisniewski et al (1987, 1990) reported that only 20% of Down syndrome cases had normal head circumference range[6, 7]. Our study shows 63% of Down syndrome cases having normal range of head circumference that have been calculated using CDC and WHO chart. (Table-1)

The study of Geraedts et al during 2010 stated that children with Insulin like Growth factor 1 receptor (IGF1R) gene mutation have significantly smaller head circumference for height than controls and contrary to mean head circumference for height is high in case of Sotos syndrome[2]. Sotos syndrome is a rare genetic disorder showing excessive physical growth.

Our study shows that weight correlates with head circumference in male Down syndrome than with height, probably due to combination of a heavier brain and bone weight.

Saxena et al during 1981 stated that the correlation coefficient between head length and height as 0.2048[10]. Mansur et al (2014) showed relatively higher correlation coefficient (0.398) between the stature and head circumference in male Down syndrome[11]. Therefore, the head circumference was found to be better than the head length for estimating individual's height.

Akhter et al (2009) study in Bangladesh showed significant positive correlation between head circumference and stature (0.278) of female Down syndrome[12]. Mansur et al (2014) showed higher correlation (0.302) between head circumference and stature[11]. Therefore, in their study head circumference was slightly better correlated with stature of Nepalese female than Bangladesh female. In our study the head circumference showed significant correlation with height (0.536) in female Down syndrome which is higher than the previous studies carried out in normal population.

The regression analysis also provides the best estimates for stature calculation[13-15]. Therefore, if either of the measurement of height or weight is known, the head circumference can be calculated by using regression equation and this would be useful for Anatomists, Anthropologists and Forensic Medicine experts.

Conclusion

The study states that there were significant differences in head circumference of both sexes in all age groups up to 21 years of age. The results of the present study shows significant correlation between weight and head circumference of males Down syndrome cases (r^2 = 0.565, P< 0.0001). There were significant correlation with height of female Down syndrome cases (r^2 = 0.536, P< 0.001).

There are many studies on anthropometric assessment of head circumference, weight and height of normal population. Studies dealing with head circumference of Down syndrome in relation to height and weight are very few. This study is the first of its kind to find absolute regression equation for determination of head circumference in India for Down syndrome cases.

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