RESEARCH ARTICLE

TRENDS OF VARIOUS ANTHROPOMETRIC MEASUREMENTS OF CHILDREN BORN IN A TERTIARY CARE CENTER

Prashant Kariya, Jigisha Patadia, Hitesh Patel
Department of Paediatrics, Government Medical College, Surat, Gujarat, India

Correspondence to: Jigisha Patadia (jigishanirav04@gmail.com)

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ABSTRACT

Background: One of the most important marker of general health of children is attained growth. Growth of a child is depend on various factors like socioeconomics and geography.

Aims & Objective: To study trends of various anthropometric measurements of children born in a tertiary care center.

Material and Methods: 120 full term infants were followed up monthly for 12 months. Physical growth was measured in the form of weight, crown heel length, chest circumference and cranial circumference by standard methods. Developmental screening test was done in various subdivision like Gross motor, Fine motor and vision, Hearing and speech and Social behaviour by standard methods. Passive tone was evaluated by measuring popliteal angle with the help of goniometer.

Results: It was observed that total weight gain in male baby was 5.52 kg while that in female baby was 5.26kg during 12 months duration after birth. Maximum weight gain was observed in first three months after birth. Mean length observed at birth in present study was 48.29 cm which increased to 72.47 cm at the end of 12 month. Maximum increment in length was recorded in first 6 months of life. Total increment in length was 24.42cm for male baby while increment for female baby was 23.91 cm. Maximum increment in length occurred in first three months after birth. Mean chest circumference in male baby observed in present study was 33.57 cm at birth, 44.49 cm at 12 month while in female baby the same was 32.34 cm and 43.47 cm at birth and at 12 month respectively. Total increment in popliteal angle during first year of life was 90.35 degree. Maximum increment in angle was observed during 6 months to 9 months period. Few growth parameters were better in higher socio-economical classes.

Conclusion: Periodic assessment of growth parameters should be done in different geographical areas to understand the pattern which may help in policy decisions.

Key-Words: Anthropometry; Growth & Development; Children

Introduction

Attained growth in children is an extremely sensitive index of general state of a health. The growth standards are likely to exhibit considerable regional variation in a country like India, and it is also fairly recognized that the growth of infants belonging to a different residential and social groups of the same geographical area, could vary to some extent, due to several social factors such as socioeconomic status, dietary, educational, cultural, available medical facilities etc. It is very important to assess the neurodevelopmental parameters of children at early stage to know presence or absence of brain damage as in early stage neurodevelopmental parameters closely mimics central nervous system development.[1] This assessment should be taken as opportunity to predict brain related outcomes in children.[2]

The very fact that we are concerned about finding the optimum growth potential of children makes it necessary to have a picture of growth statistics in different residential and social group of various geographical areas of the country. The wide variation in data of anthropometric measurement available from different parts of India proves that the data from one part may be fallacious when used in other part. Hence it becomes obligatory to have the regional norms on the basis of locally conducted study. In view of this the present study was conducted at New Civil Hospital Surat (NCHS). As NCHS is now catering the health needs of large portion of a population of different socioeconomic status of Surat and surrounding districts & whole South Gujarat region.

Materials and Methods

It is a longitudinal study of new-born of a healthy mother delivered in New Civil Hospital, Surat,

without having antenatal or postnatal complication. Study was conducted over a period of 12 months from October 2008 to October 2009. Consecutive sample of 120 total full term new born were recruited initially of which data of 23 were not included in the study due to lack of follow up or irregular follow up.

The mothers were informed about the study and their consent was taken. The infants were examined 24 hours after birth. Their weight, length, head circumference, chest circumference recorded. Clinical examination was done to rule out any obvious congenital anomaly. Cry, sucking, activity and primitive reflexes were noted in order to rule out any neurological damage.

Every effort was made to get a good follow up. Date for a monthly follow up was given. Socio-economic status was determined by Modified Prasad's classification. During monthly follow up, formal neurodevelopment screening was done along with detailed anthropometry recording. Nutritional advice and immunization advice was given. If the infant was ill on the day of testing, testing was postponed. However if the infant came 7 days after the predetermined appointment, the testing was not done.

Physical growth was measured in the form of weight, crown heel length, chest circumference and cranial circumference by standard methods. Developmental screening test was done in various subdivision like Gross motor (Head control, Ventral suspension, Prone position, Moro response, Bears weight on legs, Parachute response, Sits with support, Sits without support, Rolling, Crawls, Walks with support, Walks alone), Fine motor and vision (Stares, Follows horizontally to 90, Hand and foot regard, Grasping the object, Transfer and mouths, Pincer grasp), Hearing and speech (Startle response, Ringing a bell, Vocalises, Responds to own name) and Social behaviour (Smile, Put everything to mouth, Plays peek a boo, Plays pat a cake, Waves good bye) by standard methods. [3] Passive tone was evaluated by measuring popliteal angle with the help of goniometer.

Descriptive statistics reported in the form of mean, frequency and percentages.

Results

Distribution of different socio economical class according to gender is given in table 1. Mean weights of babies at different ages and with gender are shown in table 2 and figure 1 and increment in weight in different age shown in table 3. In present study it was observed that total weight gain in male baby was 5.52 kg while that in female baby was 5.26 kg during 12 months duration after birth. Maximum weight gain was observed in first three months after birth.

Table-1: Sex wise Distribution in Different Socio-Economic Class

Socio-Economical Class	Male	Female	Total
I	11	6	17
II	5	6	11
III	21	16	37
IV	16	16	32
Total	53	44	97

Table-2: Mean Weight of a Baby at Key Ages

Mean Weight (Kg)	At Birth	3 Month	6 Month	9 Month	12 Month
	2.75	4.70	6.01	7.09	8.13
+2 SD	2.31	3.83	4.74	5.61	6.46
-2 SD	3.18	5.56	7.28	8.57	9.80

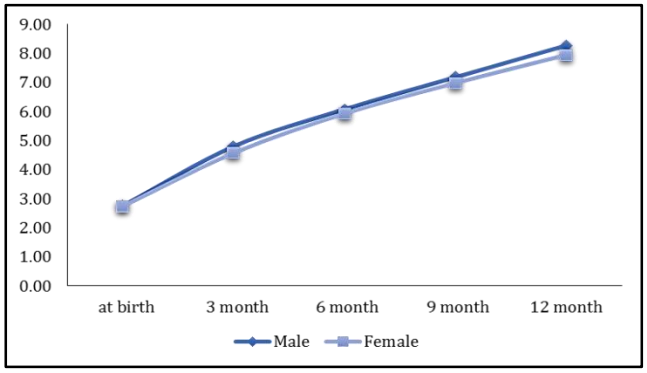

Figure-1: Mean Weight at Key Ages in Male & Female

Table-3: Increment in Weight in Male and Female Baby during First Year of Life

Months	Weight (kg)		
	Male	Female	Total
0 TO 3	2.05	1.83	1.95
3 TO 6	1.28	1.36	1.31
6 TO 9	1.11	1.11	1.08
9 TO 12	1.09	0.97	1.04
Cumulative	5.52	5.26	5.38

Table-4: Mean Length of Child at Key Ages

Mean Length (cm)	At Birth	3 Month	6 Month	9 Month	12 Month
	48.29	57.89	63.86	68.57	72.47
+2 SD	44.06	53.41	59.30	63.95	67.75
-2 SD	52.52	62.37	68.42	73.19	77.20

Table-5: Mean Length of Child at Key Ages in Male and Female

Mean Length	At Birth	3 Month	6 Month	9 Month	12 Month
Male	48.77	58.25	64.33	69.30	73.19
Female	47.70	57.47	63.30	67.69	71.61

Table-6: Increment in Length in Male and Female Baby during First Year of Life

Months	Length (cm)		
	Male	Female	Total
0 TO 3	9.47	9.76	9.60
3 TO 6	6.08	5.83	5.97
6 TO 9	4.97	4.40	4.71
9 TO 12	3.89	3.92	3.90
Cumulative	24.42	23.91	24.19

Table-7: Mean Head Circumference of Child at Key Ages

Mean Head Circumference (cm)	At Birth	3 Month	6 Month	9 Month	12 Month
	34.36	39.81	42.67	44.60	45.88
+2 SD	31.75	36.76	39.72	41.91	43.35
-2 SD	36.96	42.85	45.62	47.29	48.41

Table-8: Mean Head Circumference of Child at Key Ages in Male and Female

Mean Head Circumference (cm)	At Birth	3 Month	6 Month	9 Month	12 Month
Male	35.03	40.75	43.55	45.32	46.50
Female	33.55	38.62	41.57	43.69	45.10

Table-9: Mean Chest Circumference at Key Ages

Age (Months)	Length (cm)		
	Male	Female	Total
At birth	33.57	32.34	33.01
3	38.66	37.12	37.97
6	40.78	39.77	40.36
9	42.88	41.93	42.49
12	44.49	43.47	44.04

Table-10: Mean Age (Month) of Gross Motor Milestones Achievement

Milestones	Male	Female	Total
Full head control	2.98±1.49	3.12±1.45	3.04±1.47
Bears weight on leg	6.53±1.65	6.43±1.48	6.48±1.56
Rolling from prone to supine	6.11±1.15	5.67±1.22	5.93±1.27
Rolling from supine to prone	6.98±0.92	6.71±1.11	6.88±1.05
Parachute reflex	5.30±1.55	5.43±1.60	5.35±1.56
Sit with support	6.49±1.10	6.43±1.09	6.47±1.05
Sit without support	7.91±1.13	7.81±1.01	7.87±1.07
Crawl	9.42±1.14	9.31±1.21	9.35±1.19
Standing with support	9.89±1.28	9.83±1.39	9.87±1.31
Walking with support	11.04±1.01	11±1.25	11.03±1.17
Walking without support	12	12	12

Table-11: Mean Age (Month) of Fine Motor and Vision Development

Milestones	Male	Female	Total
Stares	1±0	1±0	1±0
Follows horizontally to 90°	1.53±0.50	1.57±0.50	1.55±0.50
Palmer grasp	1±0	1±0	1±0
Loss of Grasp Reflex	3.38±0.49	3.30±0.46	3.34±0.48
Hand Regard	3.57±0.50	3.38±0.51	3.53±0.50
Reaches for Objects	4.43±0.54	4.50±0.66	4.46±0.60
Bidexterous Grasp	5.43±0.54	5.50±0.66	5.46±0.60
Grasp feet & bring it to mouth	5.96±0.27	6.05±0.37	6.00±0.32
Transfer of objects	6.96±0.27	7.05±0.37	7.00±0.32
Pincer Grasp	9.09±0.30	9.16±0.37	9.12±0.33

Mean length observed at birth in present study was 48.29 cm which increased to 72.47 cm at the end of 12 month. Maximum increment in length was recorded in first 6 months of life [Table 4].

Table-12: Mean Age (Month) of Hearing and Speech Development

Milestones	Male	Female	Total
Startle response	At birth	At birth	At birth
Ringing a bell	At birth	At birth	At birth
Cooing	2.09±0.30	2.14±0.35	2.11±0.32
Monosyllabic babbles	6.85±0.36	6.82±0.39	6.84± 0.37
Polysyllabic babbles	7.96±0.44	7.95±0.57	7.96±0.50
Response to name	8±0.48	7.98±0.46	7.99±0.467
Speak meaning full words other than mama dada	11.63±0.52	12±0	11.84±0.38

Table-13: Mean Age (Month) of Social Milestones Achievement

Milestones	Male	Female	Total
Smile	2.13±0.48	2.11±0.54	2.13±0.51
Puts everything in mouth	6.13±0.39	6.23±0.60	6.18±0.50
Peek a boo	7.92±0.27	7.95±0.21	7.95 ±0.22
Pat a cake	8.06±0.23	8.09±0.29	8.07±0.26
Wave a good bye	9.06±0.23	9.09±0.29	9.07±0.26
Play simple ball Game	11.92±0.27	11.91±0.29	11.92±0.28

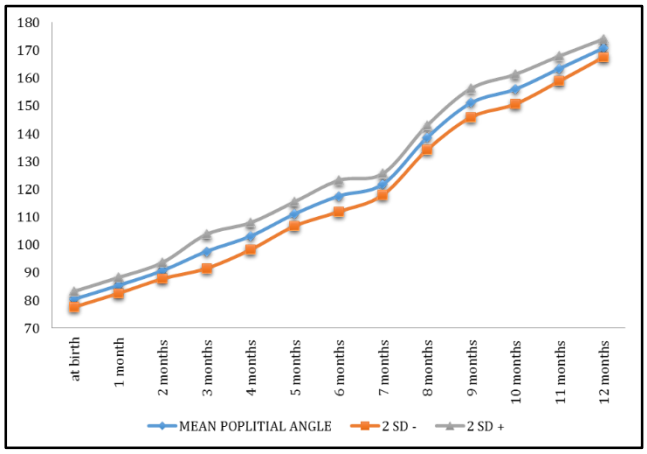

Figure-2: Popliteal Angle Reading Over 12 Month of Time

Table-14: Increment in Popliteal Angle during First Year of Life

Age (Months)	Popliteal Angle		
	Male	Female	Total
0 - 3	17.32	17.02	17.19
3 - 6	19.53	20.39	19.84
6 - 9	33.75	33.25	33.59
9 - 12	19.47	19.93	19.74
Cumulative	90.08	90.59	90.35

It was observed that the mean length of a male baby at birth, at 3 month, at 6 month, at 9 month and at 12 month was 48.77 cm, 58.25 cm, 64.33 cm, 69.30 cm, and 73.19 cm respectively while that of female baby was 47.70 cm, 57.47 cm, 63.30 cm, 67.69 cm & 71.61 cm at respective ages [Table 5]. It was observed that mean head circumference at birth, at 3, 6, 9 and at the end of one year was 34.36 cm, 39.81 cm, 42.67 cm, 44.60 cm and 45.88 cm respectively [Table 7, Table 8]. Mean chest circumference in male baby observed in present study was 33.57 cm at birth, 44.49 cm at 12 month while in female baby the same was 32.34 cm and 43.47 cm at birth and at 12 month respectively

[Table 9]. Values related to gross motor milestones achievement are shown in table 10 and values regarding fine motor milestone is shown in table 11. Values related to hearing and speech and social milestones are given in table 12 and 13 respectively. Values and increment of popliteal angle is shown in figure 2 and table 14. Present study showed that total increment in popliteal angle during first year of life was 90.35 degree. Maximum increment in angle was observed during 6 months to 9 months period. There was not much difference observed in increment in popliteal angle in male and female.

Table-15: Socioeconomic Status and Weight

Socioeconomic Status	At Birth	3 Month	6 Month	9 Month	12 Month
I	3.11	5.30	7.00	8.29	9.55
II	2.88	5.12	6.33	7.41	8.65
III	2.65	4.52	5.72	6.80	7.78
IV	2.61	4.43	5.71	6.68	7.60

Table-16: Socioeconomic Status and Length

Socioeconomic Status	At Birth	3 Month	6 Month	9 Month	12 Month
I	50.18	61.06	67.15	71.85	75.91
II	49.82	59.55	65.09	69.86	73.77
III	47.70	57.28	63.36	68.04	71.82
IV	46.91	56.34	62.27	67.00	70.95

Table-17: Socioeconomic Status and Head Circumference

Socioeconomic Status	At Birth	3 Month	6 Month	9 Month	12 Month
I	35.88	41.59	44.44	46.31	47.47
II	35.18	40.32	43.23	45.23	46.64
III	34.01	39.53	42.31	44.22	45.56
IV	33.66	39.05	42.02	43.95	45.19

Table-18: Socioeconomic Status and Mean Chest Circumference

Socioeconomic Status	At Birth	3 Month	6 Month	9 Month	12 Month
I	34.23	39.35	41.7	43.67	44.94
II	33.59	38.09	40.72	42.95	44.81
III	32.75	37.68	40.00	42.26	43.81
IV	32.5	37.5	40.03	42.08	43.62

Table-19: Socioeconomic Status and Popliteal Angle

Socioeconomic Status	At Birth	3 Month	6 Month	9 Month	12 Month
I	80.41	97.41	116.88	150.12	170.12
II	80.45	96.64	118.09	150.64	170.00
III	80.32	97.62	117.70	151.19	170.78
IV	80.66	98.16	117.59	151.66	171.38

Mean weight as per the socioeconomical class is shown in table 15. Table 15 shows mean weight at different ages during first year of life in different socio-economic class. In Socioeconomic class 1 birth weight was maximum 3.11 kg as compared to all other socio-economic class and mean weight remains more than the mean weight of babies from all other class throughout the 12 months durations after birth. Mean length as per the socioeconomical class is shown in table 16. Table 16 shows mean length at different ages during first year of life in different socio-economic class. At birth it was maximum 50.18cm in socioeconomic class 1 as compared to all other socio-economic class and it remains more than the mean length of babies from all other class throughout the 12 months durations after birth. Mean head circumference as per the socioeconomical class is shown in table 17. At birth maximum head circumference (35.88cm) was observed in class 1 as compared to all other socio-economic class and mean head circumference remains more than that of babies from all other class throughout the 12 months durations after birth. Mean chest circumference as per the socioeconomical class is shown in table 18. In class 1, head circumference at birth was 34.23cm which was maximum among the babies from all other socioeconomic class. Mean chest circumference remained more than that of babies from all other class throughout the 12 months durations after birth. Mean popliteal angle as per the socioeconomical class is shown in table 19. There was no major difference observed in popliteal angle measured at different ages in first year of life in a various socioeconomic groups in present study. At birth measured popliteal angle was 80˚ which gradually increases in first year of life and at the end of 12 month in reached to 170˚-171˚ in different socioeconomic groups.

Discussion

This study was done with the aim of observing the pattern of growth of newborn children in New Civil Hospital, Surat (Gujarat) which is a tertiary center for healthcare. In this study it was observed that mean birth weight was more in higher socio-economical classes as compared to lower socio-economical classes. This difference may be due to due to poor maternal health and nutrition in lower group. This observations of present study are comparable to those of Saigal et al[4], Datta Banik[5] and Parmar et al[6]. This observation is similar to the study done by Agarwal KN et al (1992)[7] where mean birth weight in an affluent class was 3.14 kg in male and 3.15 kg in female baby which increased to 9.32 kg

in male and 8.96 kg in female baby at the end of 12 months, while in present study the same was 3.11 kg in male and 3.13 kg in female in Higher socioeconomic class which was increased to 9.64 kg in male and 9.36 kg in female at the end of 1 year. Study of KN Agarwal et al showed that mean birth length in an affluent class was 50.38 cm in male and 50.27 cm in female baby which increased to 74.32 cm in male and 73.49 cm in female baby at the end of 12 months, while in present study the same was 50.16 cm in male and 49.66 cm in female which increased to 75.9 cm in male and 74.08 cm female.

In present study mean birth weight in male baby was 2.75 kg while the same in female baby was 2.74 kg which is comparable to Parmar et al[6], ICMR[8], Dixit et al[9]. In Harward study[10] mean birth weight observed was higher than present study. This may be because of difference in population of mother as in new civil hospital majority of parents are from lower socio-economical class. Total weight gain in first 6 months of life recorded in present study was 3.33 kg in male baby and 3.19 kg in female baby without much difference. This observation is comparable to study of Sethna and Mukherjee[11], Datta and Banik[12], but the same was lower in comparison to study of Ghai and Sandhu[13], Kumar et al[14], Ghosh et al[15]. Mean weight at key ages that was observed in present study during first year of life was comparable to other Indian studies like Ghai et al[16], ICMR[8], Purohit et al[17], Dixit et al[9], Parmar et al[6]. But this observed mean weight was less than that of Harvard study which may be because of the different population (Developing country Vs Developed country).

The average length observed in present study at birth was 48.77 cm for male and 47.70 cm for female which was comparable to most of the Indian studies as mentioned in above table but it was lesser than the mean birth length observed in a Harvard study[10] i.e. 50.6 cm in male & 50.2 cm in female. Total increment in length recorded in first 6 months in present study was 15.55 cm and 15.59 cm, increment in length for male baby was comparable to that of Purohit et al[17], Sethna and Mukherjee[11] and Datta Banik[12], while increment in length was less than that of the study of Ghosh et al[15] and Kumar et al[14]. Total increment in length recorded in first 6 months in female babies were comparable to the same in the study of Purohit et al[17], Sethna and Mukherjee[11], Datta Banik[12] and Ghosh et al[15], while less than the Kumar et al[14]. Mean birth length observed in present study was 48.29 cm which was similar to the most of the Indian studies like ICMR[8], Phatak et al[18], Ghai et al[16], Dixit et al[9] and Parmar et al[6], lower than the mean birth length observed in American Harward study[10]. Mean length at the end of 12 months recorded in present study was 72.47 cm which was higher than Parmar et al[6], Dixit et al[9], lower than Harward study[10] and ICMR study[8] while similar to that of Phatak et al[18] and Ghai et al[16]. All the above studies showed that mean increment in length was maximum in first three months of life.

The mean head circumference at birth recorded in present study was 34.36 cm which was slightly higher than the observations of other Indian studies as tabulated above and similar to the observation of Harward study.[10] Mean head circumference observed at the end of 12 months in present study was greater than mean head circumference observed in various Indian studies like Parmar et al[6], ICMR data[8] but less than the observation of Harward study[10]. In present study, mean chest circumference at birth was 33.57 cm in male baby and 32.34cm in female baby which was greater than the same observation in different Indian studies as tabulated above but similar to the observation of a Harvard study.[10]

In comparison to different Indian studies the mean chest circumference was almost similar at the end of 12 months in present study while it was lesser than the mean chest circumference observed in a Harward study.[10] Mean age for social smile in present study was 2.13 months and that is similar to other Indian studies like Katiyar et al[19], Parmar et al[6] and Harvard study[10], but it was achieved later than the mean age for social smile that was observed in study of Illingworth[15] and ICMR[8] data.

Mean age for Head control observed in present study was 3.04 months which is comparable to study of Katiyar et al[19], Parmar et al[6], but in comparison to Harvard study[10] and ICMR[8], head

control was achieved much earlier in present study. Mean age for sitting with support observed in present study was 6.47 month which is similar to Harvard study[10] but it was later than the mean age of same milestone recorded in other Indian studies like Katiyar et al[19], Parmar et al[6] and ICMR[8]. Mean age for crawling observed in present study was 9.35 month which is similar to Harvard study[10] but it was later than the mean age of same milestone recorded in other Indian studies like Katiyar et al[19], Parmar et al[6] and ICMR[8]. Mean age for standing with support recorded in present study was 9.87 month which is later than the mean age of same milestone observed in ICMR[8] study but it is comparable to study of Katiyar et al[19], Parmar et al[6] and Harvard Study[10]. Mean age for walking with support recorded in present study was 11 month which is later than the mean age of same milestone observed in ICMR[8] study (10.6 month) but it is comparable to study of Katiyar et al[19], Parmar et al[6] and earlier achievement of walking with support milestones was observed in comparison to Harvard study[10] (12 month).

Range of the popliteal angle measured in present study during first year of life was similar to the observation of Amiel-Tison et al[20] as tabulated above. In comparison with the study of Sudha Chaudhary et al[21], popliteal angle range observed in 6 months to 12 months duration was different than the observation of present study as showed in above table. Range of popliteal angle in first year of life, recorded in study of Dobowitz et al[22] was 90 to 180 degree while in present study it was 77-174 degree. According to study of St Anne Dargassies[23] mean popliteal angle at birth was 90˚, while in present study it was 80.4˚. Study of Waugh et al[24] showed that mean range of popliteal angle 113˚-173˚ in first year of life while in present study it was 77-174 degree.

Conclusion

Periodic assessment of growth parameters should be done in different geographical areas to understand the pattern which may help in policy decisions.

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