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Establishing Normative Data for Fine manual control composite of Bruininks Ose-retsky test of Motor Proficiency-2nd edition, for Children of 4-5 years in Western Maharashtra region

Dr. Bhagyashree Gokhale (PT)[1], Dr. Atiya Shaikh (PT)[2]

(DESBJCOP)

[1]*M.P.T (Neurosciences), DESBJCOP, Pune.*

[2]*Assistant Professor, MPT (Neurosciences), PhD Scholar KEM Mumbai, DESBJCOP, Pune*

***Corresponding Author**: **Dr. Bhagyashree Gokhale**

Email id: gobhagyashree@gmail.com

ABSTRACT

Gain in normal fine motor skills is essential for activities like, eating, zipping, and dressing, undressing, so delay in attaining such activities can hinder day-to-day activities can affect schooling and social participation thus affecting self image. Culture, Environment, socio-economic status, Gender, mother's education and presence of siblings are some of the factors that can influence motor development. Children from different areas or regions may show different pattern of development. Using the same logic, the present study was planned with the aim to Establish Normative Data for Fine manual control composite of Bruininks Ose-retsky test of Motor Proficiency-2nd edition, for Children of 4-5 years in Western Maharashtra region. BOT-2(test re-test reliability - 0.86 to 0.89, and validity - 0.78), is a standardised measure to evaluate Fine and Gross Motor Skills in individuals aged 4-21 year. One of the composite of BOT-2 (Fine manual control) was used as an outcome measure with total 15 items. This cross-sectional study involved 307 healthy participants (146 females, 161 males), screened from various schools and day-care centres of western Maharashtra region. The normative data for the same was obtained using Mean and standard deviation. The normal ranges of standard scores for Fine manual composite of BOT-2 between the age of 4-5 years female, male and combined were 58-70, 60-72, 56-68 respectively. Female and male scores comparison using Unpaired t- test (p value- 0.0205) showed significant difference. The Obtained data can be used for appropriate analysis, motor delay detection, clinical analysis and future researches.

Keywords: Normative Data, Fine Motor skills, Bruininks Ose-retsky test of Motor Proficiency-2nd edition (BOT-2).

INTRODUCTION

The process of evolution from a helpless infancy to an independent adulthood is known as child development [1]. Child development involves various interdependent aspects like sensory, motor, cognitive, social and emotional domains [2]. Attainment of specific behavioral, physical, socio-emotional and cognitive milestones at specific age of life is termed as a normal development [3]. It is a systemic process which refers to the progressive

orderly coherent changes leading to goal of maturity. Fine Motor Skills involves motor behaviour such as discrete finger movements, manipulation, and eye-hand coordination; for example- Folding a paper, writing, building blocks etc [4, 5]. To perform activities in daily life, motor process and social interaction skills both are required. The development and maturation of reach, grasp and manipulation skills is very complex and it involves the development of much other behaviour, each of which emerges sequentially over time with the maturation of the nervous and musculoskeletal systems and also with the self-experience [6]. First few years of life are the most critical and sensitive period of motor development [7]. In this period brain develops through axonal and dendritic growth, neurogenesis, synaptogenesis as well as through rapid and progressive maturation of association areas [2]. All Hand skills are developed by two years except handling and manual dexterity which improves at preschool age and reaches maturity by 5 years of life [5]. Gain in Fine Motor Skills is essential for eating, dressing and undressing which involves buttoning, lacing, zipping, hooking etc, writing, drawing, manipulation of objects and coordinated activities like counting and typing and playing [10-15]. A delay in attaining above can hinder child's day to day activities, affects quality of learning and schooling, and thus hampers social participation and achievements and influence negatively on child's image and self-confidence [13-15]. Such problems if assessed on time can help for early intervention and prevention of above stated deficits that can have detrimental effects on a child's life. Thus early assessment, appropriate analysis and correct treatment play a very crucial role in normal and proper on time development of a child. Few tests that can be used to assess motor abilities in children are-

- Movement Assessment Battery for Children (Movement-ABC)
- Peabody Development Scales (PDMS)
- Test of Gross Motor Development (TGMD)
- Nine Hole Peg Test
- MAc Test of SIPT
- Motor Performance School Readiness Test
- Test of Visual Motor skill.
- The Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) [7].

Out of the above few BOTMP is used commonly [16]. It is a standardized measure to evaluate Fine and Gross Motor Skills in individuals aged 4-21 years. The test re-test reliability for BOTMP is proven to be 0.86 to 0.89, and it has an excellent inter-observer reliabil0ity and the validity is 0.78. Many a times BOTMP is used as a gold standard to correlate with new outcome measure [7, 17, 18]. The test was revised in 2005 with the aim of improving quality of kit equipment's, improving item presentation, improvement of functional relevance, improvement of measurements on young children of 4-5 years, and extension coverage of fine and gross skills [19]. And it has been used widely since then. The test is individually administered and highlights motor performance [20]. It is divided into two sets involving four subsets; Fine Manual Control (Fine Motor Precision, Fine Motor Integration), Manual Coordination(Manual Dexterity, Upper Limb Coordination), Body Coordination(Balance, Bilateral Coordination)and Strength and Agility (Speed-Agility, Strength) [19].

Literature reviews denotes the fact that Up-bringing of an Indian child varies from a United State child in many aspects.

Socio-economic status

Freitas and Gabbard in 2013 provided the fact that family SES affects the motor affordances in the home environment. This, they explained on the basis of less space dimension at home that is the small area of residence for playing, and unavailability of various play materials and objects. Also, Opportunities in the form of various puzzle games, drawing and colourings activities, and different toys for manipulations; when made available at schools and home enlightens the knowledge of hand skills [21, 22].

Nutrition

The maternal nutritional status affects child's growth and development [23]. There are impacts of prenatal and postnatal factors on child development. Under-nutrition jeopardizes children's health, growth and slows down national progress towards developmental goals.

Culture and environment

Amita Gupta, explained the differences of rearing practices in India and US with her writing. She emphasised that in India, within large network

of families, relatives and friends, a child is pampered, nurtured, loved a lot that reduces the opportunity for a child to explore and learn [22]. An Indian child is accustomed to eat with his/her hand instead of using a fork or a spoon. Also, in schools an Indian child uses a small thickness pencil/pen for drawing, writing and colouring. All this can influence a person's development of a particular skill [24].

Family considerations

Presence of sibling's diverts mother's attention for a child. A child of a working woman becomes independent early which is not very common in India.

Others

Practices like the awareness of early schooling and playing activities are less observed in India. The brain myelinates and matures with respect to motor development on the basis of above various aspects [25]. Thus the development of a child in a particular area/country may be different from a child of another. This study is being proposed with aforementioned objectives and this information can be useful to defined normative range of scores for fine motor precision and fine motor integration of BOT-2 test, which in turn will help in rating and grading of an individual's performance, and so for the decision of continuation or the modification of the treatment. The obtained information can be used for appropriate analysis, motor delay detection, clinical analysis and future researches.

Methodology

The study is a cross-sectional observational study; performed on 307 healthy individuals between 4-5 years of age from various preschools and day-care centres in western Maharashtra region. Individuals with known musculo-skeletal, cognitive or neurological impairment, with attention deficits, Upper limb fractures or surgeries in past 3 months, with any history of seizures or convulsions were excluded from the study. Materials included- BOT-2 kit (Examinee Booklet, Red pencil, A pair of scissors), Table, Chair, Individual record form, Pen and Paper.

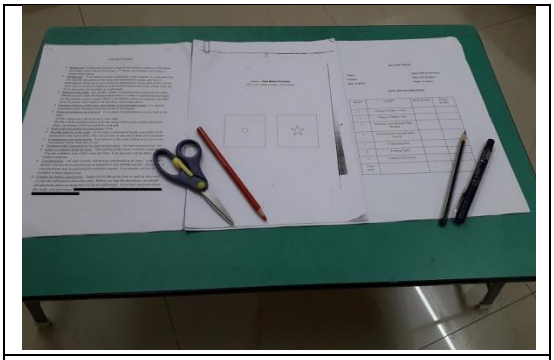


Figure 1- Materials

Procedure

After the clearance from the college Ethics committee various Schools and day- care centres were approached for the sample collection. Children were selected according to inclusion and exclusion criteria. Oral consent and assent was taken from the child and a signed informed consent was taken for each child from his/her teacher/parent/Guardian. The assessment was performed with the child sitting comfortably with the table and chair of appropriate height so that the feet rest on the floor. Standard instructions as per BOT-2 manual for each task were given and each task was explained to the child, using verbal and non-verbal directions as necessary. After ensuring the examinee's understanding, each task was assessed. One time only one child was assessed so as to ensure complete concentration and attention of the child. The subset items of Fine manual control composite of BOT-2 included 15 tasks which were

1. Colouring a Circle
2. Colouring a star.
3. Drawing lines through crooked path
4. Drawing lines through curved path.
5. Connecting dots
6. Folding a paper
7. Cutting out a circle.
8. Copying a Circle

9. Copying a Square.
10. Copying Overlapping Circles
11. Copying a Wavy Line
12. Copying a Triangle
13. Copying a Diamond
14. Copying a Star, and
15. Copying Overlapping Pencils [19]

Scoring was done for each task according to the guidelines explained in examiner's manual of BOT-2. Raw scores obtained were entered in the record sheet of each child [19]. Finally, the initial raw scores were converted into the Standard composite score [19].

Raw score ➡ Point score ➡ Scale score ➡ Standard Composite score

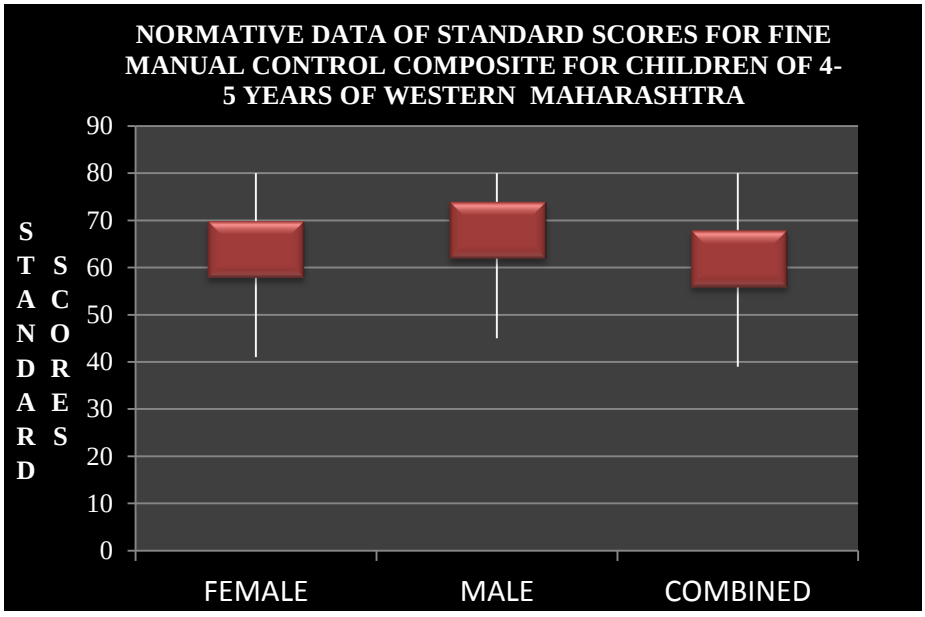
Data management and analysis- Standard Scores obtained were entered in the Excel sheet. The normative data was established with Mean and SD with confidence interval of 90 %; as per suggestion of the authors of BOT-2 [19]. Comparison of Standard composite scores between female and male participants was done using Unpaired t-test. Age wise comparison of Scale scores between female and male participants was done using Unpaired t-test. And, the data was represented in the descriptive category as per BOT-2 manual.

Figure 2- Child Performing Task

Statistical analysis and Graph

Table-1 Normative Data

Normative data for standard scores of fine manual control composite for children of 4-5 years of western Maharashtra	
Female	58-70
Male	62-74
Combined	56-68



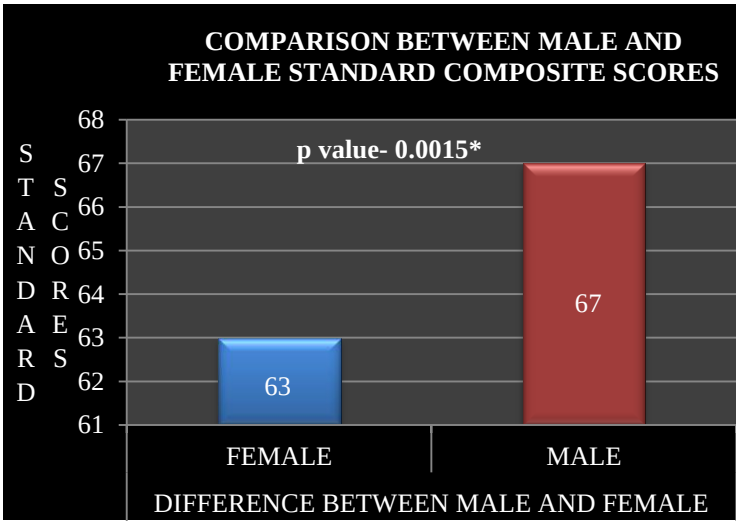
Graph-1 Normative Data

Inference

The normal ranges of Standard scores for fine manual composite for female male and combined are 58-70, 62-74, 56-68 respectively.

Table-2 Comparison between Male and Female Standard Composite Scores

Comparison between male and female standard composite scores					
Female		**Male**		**P value**	**Inference**
Mean	SD	Mean	SD		
63.19	10.33	66.87	9.747	0.0015	Very significant *



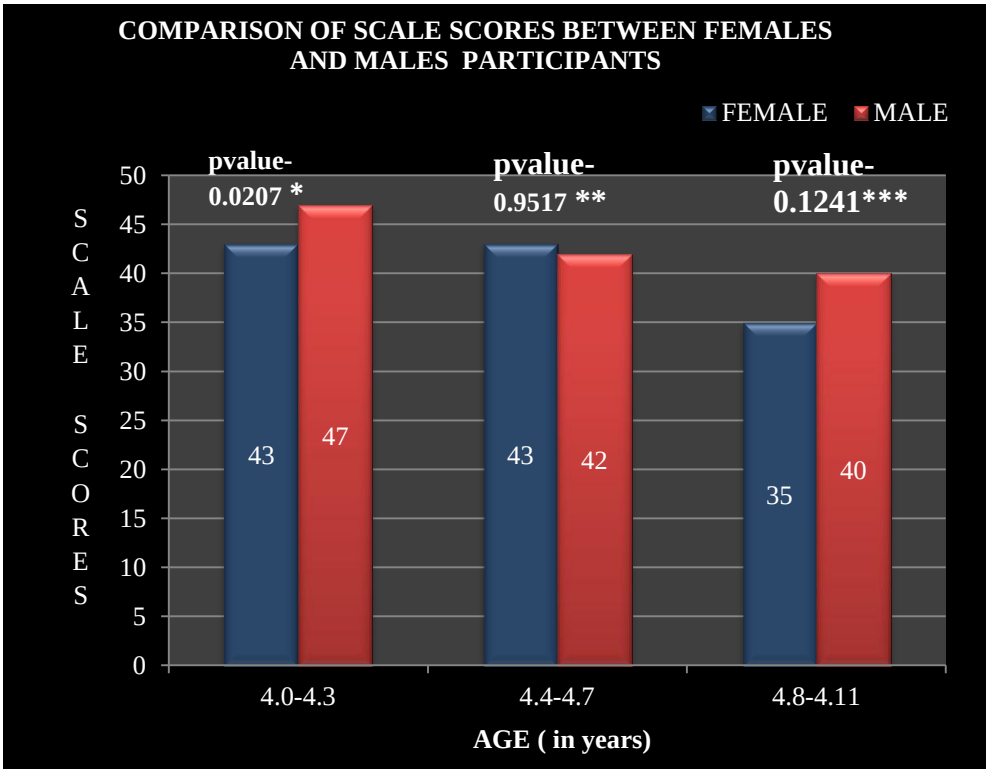
Graph-2 Comparison between Male and Female Standard Composite Scores

Inference

Male participants had more score than Female participants. There was a statistically significant difference between Standard composite scores of male and female participants. According to the BOT-2 manual the lesser the score the better is the performance, so female participants outperformed males in the Fine motor composite of BOT-2.

Table-3 Comparison of scale scores between females and males Participants

	Female		Male		P Value	Inference
	Mean	SD	Mean	SD		
4.0-4.3	43.13	9.913	47	7.752	0.0207	Significant *
4.4-4.7	42.57	7.24	42.46	9.32	0.9517	Not significant **
4.8-4.11	35.33	9.305	39.56	7.862	0.1241	Not significant ***



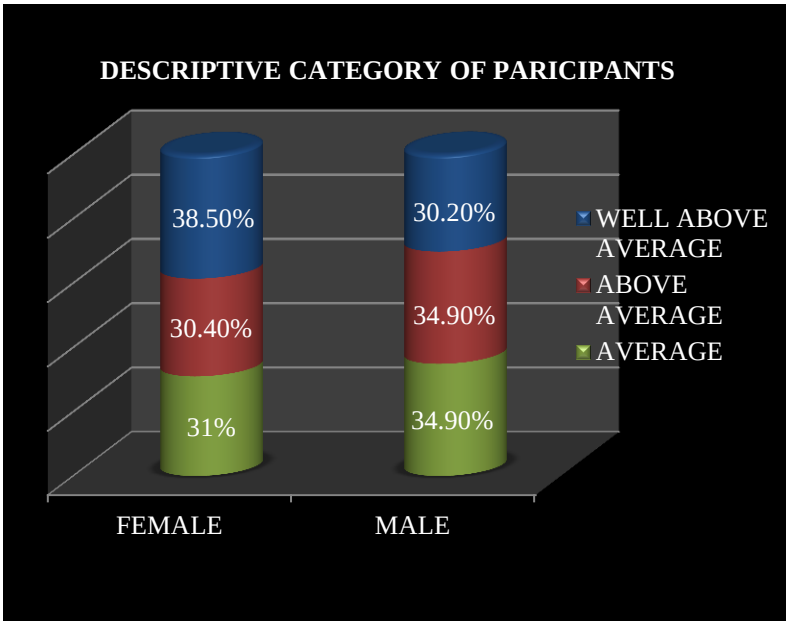
Graph-3 Comparison of scale scores between females and males Participants

Inference

A significant difference was observed between scale scores of female and male participants of Group A (4.0-4.3 years). Later on there was no significant difference observed after 4.4 years.

Table-4 Descriptive Category of Participants

	Female	Male
Average	31%	34.90%
Above average	30.40%	34.90%
Well above average	38.50%	30.20%



Graph-4 Descriptive Category of Participants

Inference

Maximum participants (38.5%) were well above Average amongst the Female Participants. Maximum participants (34.9%) were Above Average amongst the male Participants.

DISCUSSION

Primary aim of the study was to establish normal range of scores for fine manual control composite of BOT-2 for children of 4-5 years in western Maharashtra. Table 1 and Graph 1 denote the normative data of standard scores of fine manual composite in children of 4-5 years of western Maharashtra. According to the table, the normal range for standard score for fine manual composite for female population was 58-70 and that for male population was 62-74 and combined are 56-68. The obtained normal values in the present study can be used for appropriate assessment and evaluation of child's functional skills and to know whether he/ she is normal or has some difficulties or delays in fine motor performance.

It is known that the anatomical and physiological structure of brain differs in males and females [26]. It has been indicated that, brain structure and development differs between sexes during infancy, which may have residual effects during the toddler years [26-32].Some differences observed are-

Structural differences

Gender differences in the brain electrical activity were reported in previous study [32]. Evidenced has explained that the enhanced development of the brain's left hemisphere, which is mainly related to enhanced language acquisition, fine motor skills, and social cognition in young preschool females compared to males [26, 27]. Thus, differences in brain maturation could suggest that 3- to 4-year old boys may need more time to develop fine motor skills.

Utilisation of white matter

Scientists generally study four primary areas of differences in male and female brains: processing, chemistry, structure and activity. According to his findings, females utilise white matter ten times more than males. Main function of white matter is making a networking grid that connects grey matter to other processing centres. This difference may explain that females are great multi-taskers (Gregory L Jantz et. al.) [33]

More number of neurons

Females have larger extent of cortical neuron projections, and 11% more neurons per unit volume as compared to males (Witelson et al.) [34]. The cortical function unit has a different input and

output in males and females; which could be a possible reason in differences in cognition and behaviour in male and female children.

Neuro-transmitter differences

Neuro-chemicals differences in both the genders are also responsible for skill differences. Serotonin is more dominant in females, which is essential transmitter for attention function. Thus, girls are better in paying attention, listening & following instructions as compared to boys [33].

Environment and socio-cultural factors

Preschool females spend more time in language, literacy, art, and fine motor activities than males and males are in different gross motor games and activities [26, 32]. Female participation in sports and physical activities is not supported as it is with the males [27, 35].

Thus considering above points it can be said that the females may be better at performing fine motor skills (FMS) than males. Some to check this hypothesis, secondary objective of this study was formed. Secondary aim of the study was, to compare the Standard composites scores of males and females in order to analyze if, the skills are same in both the gender. The statistical analysis was done with Unpaired t test. Statistically very significant difference was found with the p value of 0.0015, (as seen in Graph-2 and Table-2), suggesting females were better at performing above fine motor skills as compared to male children.

The preschool period is different for every child with regards to cultural believes, customs, environment and biological factors. The brain maturation and development is modified by the quality of environment that they get in this period. Growth potential in a child is greatly affected by the surrounding [2]. Study by Jakub Kokstej et. al showed that, gender differences in FMS proficiency exist in preschool children, but that the differences may not be uniform throughout the whole preschool period [26]. In their study younger children of 3-4 years showed gender differences in motor skills of manual dexterity and balance while that between 5-6 years did not showed any significant difference [26]. Filippos Vlachos et. al. also found that girls and boys present different developmental patterns in motor skills during preschool years [27]. As per the researchers different rate of growth and development of body parts and functional capacity of organs and systems varies with age advancement may be the reason for such differences [20]. Similar findings were noted in the current study too. According to the BOT-2 manual, the participants were divided into 3 groups A (4.0-4.3 years), B (4.4-4.7 years), C (4.8-4.11 years) as using the scale score. The age wise comparison of scale scores between females and males was done the p- value was found to be significant in group A (p value 0.0207) and no significant difference was found in group B and group C (p value-0.9517 and 0.1241 respectively); i.e. skills do not differ after the age of 4.3 years in female and male participants, (as seen in table 3 and graph 3). Data collection for the study was done from the similar schools and day care. It is possible that in schools and day-care centres both gender children were exposed to similar external environment. The study evaluated similar activities that children practised in the school and at day care centres like, folding and cutting of paper, colouring activities etc. The chances of same activities taught and practised by both females and males may be high due to similarity of environment and training in their schools. Considering the similar schools, home assignments for the child may also have been on the similar grounds and thus the parenting skills might get modified and transformed later on into an identical and similar way as that of the schools. Hence both the genders practised similar skills and no gender discrimination in fine motor skill development was observed. All the above factors can be the reason for current study findings.

Cross- cultural difference in motor development is an important issue studied by previous researchers [2, 7-9, 20, 24, 25, 36-43]. Differences in Fine motor scores of Bruininks Ose-retsky scale of Motor Proficiency was observed between healthy children in Hong Kong and those in the United States. The children in Hong Kong performed better in the Upper limb speed and dexterity component which might be due to early exposure of fine manipulation tools like chopsticks by Hong Kong children at early age (Mandy et al) [42]. The comparison of performances in Australian preschoolers with the US norms also indicated the differences between the two groups (Annabel et. al) [41]. With the similar aim another two studies were performed in an Indian population for children aged 61/2 to 91/2 and 91/2 -141/2 respectively by Jaya Shankar Tedia et.al and the normative data was established for the children in

India [8, 37]. Considering above information it was decided to observe the category of participants with respect to that of the USA children. Descriptive Category expresses in words the approximate distance of the scores from the mean. BOT-2 scale describes skills of the participants as, above/below average based on their composite scores. This Descriptive category table of BOT -2 was used for this comparison (as seen in Table 4 and Graph 4). A study by D. Livesey et.al in 2007 assessed movement skills in Australian Children of 4-5 years and compared the obtained results with the USA children norms [44]. The results emphasized that Australian 4 year old children performed better than American children in motor test but these differences disappeared at the age of 5. Thus, it may be appropriate to say that at the age of 5 years American norms can be considered appropriate for Australian children [45]. The present study also gives the similar conclusion. Moumita et. al in 2017 explained the impact of Globalisation on childhood. In India globalization is a recent phenomenon that has emerged in the last two decades. The Indian society and culture has changed with the introduction of computer and television [45, 46], which is vastly influencing lifestyles and skills. Globalisation has changed the lifestyle, recreational approach, dressing and habits, this is reflected as mirroring of USA lifestyle and culture in India [47, 48]. Improved parental education leading to revision of parenting skills have been observed in the 21st century in India [45]. Parents are more aware about the development of child due to their higher level of awareness about global scenario hence, children are being exposed to different languages, skills and tasks from start at house. The educational system in India might also have changed with set up of International schools with the generalised pattern and syllabus of learning and teaching which has a vast influence of US. Thus fine motor skills in children were seen to be developing at similar rates in both the regions (western Maharashtra and US). It may be possible that in spite of geographical and cultural differences, children of both the regions are getting similar stimulation and training which might be responsible for similar rates of development of Fine motor skills (FMS).

To conclude, current study provided the normal range for fine manual composite of BOT-2 scale in males, females and combined scores in children of 4-5 years of western Maharashtra that are 58-70, 62-74, 56-68 respectively. Incidental findings were obtained about the gender and age wise differences in fine motor skills that highlight the need to differentiate skill assessment and training as per gender till the age of 4.4 years in children for Fine motor skills.

CONCLUSION

The normal range of standard composite scores of BOT-2 were 58-70, 62-74 and 56-68 in females, males and combined respectively.

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