**Assessment of upper limb coordination using Bruininks-Oseretsky test of motor proficiency, 2nd edition (BOT-2), in 5-15 years school going children**

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**ABSTRACT:**

**Background:** The purpose of the study was to assess the upper limb coordination in school going children of 5-15 years using Bruininks-Oseretsky test of motor proficiency. Motor skill is a learned series of movements that combine to produce a smooth, efficient action. Coordination is achieved when subsequent parts of the same movement, or the movements of several limbs or body parts are combined in manner that is well timed, smooth, and efficient with respect to the intended goal.

**Material and methods:** A Cross sectional analytical study was conducted using BOT-2 Short Form. A multistage stratified sampling of children (n=516) aged 5-15 years was done that included 268 females and 248 males.

**Results:** 516 children were assessed (268 females, mean age 10.69 years±3.04 & 248 males, mean age 10.66 years ±3.02). 8.87 females showed well below average score whereas 1.87 males showed below average score.

**Conclusion:** The study concluded that performance of females was poor as compared to males. Children of 12, 13, 14 & 15 years showed better results than 5-11 years children.

**Keywords:** Upper limb coordination (ULC), Bruininks-Oseretsky test (BOT), Developmental Coordination Disorder (DCD), Motor Coordination.

**INTRODUCTION:**

Motor development refers to the gradual process by which a child gains use and coordination of the large muscles of the legs, trunk and arms and the smaller muscles of the hands. The neuromuscular development starts in embryonic stage which continues after birth. According to studies done in different parts of the world, development of motor skill is associated with physical activity like throwing or catching a ball, in both children and adolescent. Physical activity has been an additional determinant of motor performance along with other factors.

When subsequent parts of same movement, or the movements of several limbs or body parts are combined in a manner that is well timed, smooth, and efficient with respect to the intended goal, coordination is achieved. This involves the integration of proprioceptive information detailing the position and movement of musculoskeletal system with the neural processes in the brain and spinal cord that controls, plan and relay motor coordination. Age plays a key role in upper limb coordination. It allows a person to be involved in the participation of sport with a reasonable amount of success as it will aid fluid body movement for skill performance. The participation in sport is helpful in developing a social network and achieving a sense of belonging in a community or social setting as well as in maintaining self regulation for daily tasks. Thus, children will be able to maintain appropriate and controlled body movement during task performance which reduces the energy required and thus minimises fatigue.
Upper limb coordination deficit is observed in children with Development coordination disorder (DCD), Learning Disabilities, Sensory Integrative Dysfunction and other motor impairments. In clinical practice, upper limb coordination deficits in children are identified by observations of poor coordination of two body sides, avoidance of crossing of midline, failure to develop a preferred hand and possibly right-left confusion. For assessing this upper limb coordination many scales are available such as, Movement Assessment Battery for children (Movement ABC-2) Peabody Development Motor Scales (PDMS 2) Maastrichtse Motoriek Test (MMT) 

**Bruininks-oseretsky Test of motor proficiency, Second Edition (BOT-2)**

It is an individually administered test that uses engaging, goal-directed activities to measure a wide array of motor skills in individuals of age 4-21. The BOT-2 uses a subset and composite structure that highlights motor performance in the broad functional areas of stability, mobility, strength, coordination and object manipulation. The Bruininks-oseretsky Test of motor proficiency-BOTMP,(Bruininks,1978) consists of 46 items grouped under eight different subtests of motor proficiency for children between 4 and 15 years of age.

The upper limb coordination subset of BOTMP is the seventh subset under gross motor composite. The scoring system varies with each item, ranging from a 0-point (pass/fail) to a 5-point scale. The number of performance trials for each item is specified. A raw score is recorded in the unit measured (e.g. number of catches, dribbles) and then converted to a numerical point score. This motor-area composite measures control and coordination of the arms and hands, especially for object manipulation.

The Upper Limb Coordination subtest consists of activities designed to measure visual tracking with coordinated arm and hand movement.

**AIMS AND OBJECTIVES:**

This study conducted with the aim: To assess upper limb coordination using Bruininks-oseretsky Test of motor proficiency, Second Edition (BOT-2), in 5 to 15 years school going children.

The objectives of the study were, to find out Upper limb coordination point score and descriptive category using Bruininks-Oseretsky Test of Motor Proficiency, 2nd edition, to find out upper limb coordination point score and descriptive category among males and females using Bruininks-Oseretsky Test of Motor Proficiency, 2nd edition and find out upper limb coordination point score and descriptive category, according to age groups using Bruininks-Oseretsky Test of Motor Proficiency, 2nd edition.

**MATERIAL AND METHODS:**

Research committee of Dr. D.Y. Patil College of Physiotherapy approved this study. The tools used in this study were BOT-2 kit includes examiners manual, individual record form, student booklet, tennis ball and target. A table and chair of appropriate to child’s height and clipboard were additionally used.

Five hundred sixteen samples were assessed, in which 268 were females (mean age 10.69 years±3.04) and 248 were males (mean age 10.66 years±3.02). Information provided by the class teacher and school records were used to include the 5-15 years old children in five groups. (The age group 1-5.0-7.11, age group 2-8.0-9.11, age group 3-10.0-11.11, age group 4-12.0-13.11 and age group 5-14.0-15.11), according to the following criteria: no neurological trauma like spinal fracture.
months back, no visual and musculoskeletal problems, no neurological deficit or other diagnosed medical condition. The sample characteristic of the 516 is described in the table 1.

<table>
<thead>
<tr>
<th>AGE GRP</th>
<th>FEMALE</th>
<th>MALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(5,6,7)</td>
<td>59</td>
<td>52</td>
</tr>
<tr>
<td>2(8,9)</td>
<td>46</td>
<td>49</td>
</tr>
<tr>
<td>3(10,11)</td>
<td>61</td>
<td>47</td>
</tr>
<tr>
<td>4 (12,13)</td>
<td>51</td>
<td>49</td>
</tr>
<tr>
<td>5(14,15)</td>
<td>51</td>
<td>51</td>
</tr>
</tbody>
</table>

**PROCEDURE**

Subjects were selected on the basis of multistage sampling method. In the first stage, 3 English schools and 3 Marathi schools was selected randomly out of the total schools in Pimpri Chinchwad Area. In the second stage, from each standard, 1 division was selected. In third stage, from every division, boys and girls of same age were selected by stratified random sampling method.

A written informed consent was obtained from the parents one day prior to the assessment. A pre assessment was taken to record their socio demographic data and other parameters. Proper precautions was taken so that there was no harm to the child. Every child was asked to do 7 tasks-

1. Dribbling the ball with one hand- The examinee was asked to drop the ball and then dribble the ball with preferred hand. Second trial was conducted if the examinee does not earn the maximum score of 10 dribbles on

A catch was incorrect if, the examinee catches the ball against his or her body or if the ball was thrown above the shoulders, below the knees or outside the examinee’s reach. The number of correct catches out of 5 trials was recorded.

2. Dropping and catching the ball with one hand- The examinee was asked to drop the ball and after it bounces once, catch with preferred hand .A catch was counted incorrect if the examinee traps the ball against his or her body or catches with the non-preferred hand. After that , the examinee catches the ball from 10 feet distance with one hand- The examinee was asked to stand just behind the line (i.e 10 feet from the examiner) and catches the ball with preferred hand which is carefully tossed underhanded and with a slight arc between the examinee’s shoulders and waist. A catch was incorrect if, the examinee catches the ball against his or her body or if the ball was thrown above the shoulders, below the knees or outside the examinee’s reach. The number of correct catches out of 5 trials was recorded. Then dribbling the ball with one hand- The examinee was asked to drop the ball and then dribble the ball with preferred hand. Second trial was conducted if the examinee does not earn the maximum score of 10 dribbles on
the first trial. Correct number of dribbles was recorded up to 10. A Dribble was counted incorrect, if the examinee dribbles with non preferred hand, catches the ball or allows the ball to bounce more than once between dribbles. The sixth task was Dribbling the ball with alternating hand- The examinee was asked to drop the ball and then was asked to dribble the ball with alternating hands. Second trial was conducted if the examinee does not earn the maximum score of 10 dribbles on the first trial. Correct number of dribbles was recorded up to 10. A Dribble was counted incorrect, if the examinee does not alternate hands with each dribbles, catches the ball or allows the ball to bounce more than once between dribbles, and last task was Throwing a ball at a target- The examinee was asked to stand just behind the line (i.e.7 feet from the target) and is asked to throw the ball with preferred hand, over handed or with modified side arm motion. Number of correct throws was recorded out of 5. A Throw was counted incorrect if examinee misses the target, threwed underhand or stepped over the line while throwing.

Subjects were assessed for these tasks and these raw score were then converted to a numerical point score.

**OBSERVATION & RESULTS:**

All the subjects completed the upper limb coordination assessment and the results of the findings were converted on the percentage scale to get a better estimation of the upper limb coordination score in 5-15 years school going children.

The followings are the graphical representation of the findings of the study:- firstly, Mean and Standard deviation of upper limb coordination point score, and DESCRIPTIVE ANALYSIS, which will consider Age, Gender & Descriptive category according to BOT-2.

For interpretation of results, the values of mean & standard deviation was calculated by epi info 7. The mean score and standard deviation of the age group 1-5 according to male and female was interpreted.

### TABLE 2: SUMMARTIVE VALUES OF UPPER LIMB COORDINATION MOTOR POINTSCORE ACCORDING TO AGE GROUPS

<table>
<thead>
<tr>
<th>Age Gr.</th>
<th>Sex</th>
<th>N</th>
<th>ULC Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>COM</td>
<td>111</td>
<td>16.9</td>
<td>9.07</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>59</td>
<td>19.67</td>
<td>9.09</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>48</td>
<td>13.76</td>
<td>8.05</td>
</tr>
<tr>
<td>2</td>
<td>COM</td>
<td>95</td>
<td>27.47</td>
<td>8.32</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>46</td>
<td>30.89</td>
<td>7.25</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>49</td>
<td>24.26</td>
<td>8.04</td>
</tr>
<tr>
<td>3</td>
<td>COM</td>
<td>108</td>
<td>32.23</td>
<td>6.03</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>61</td>
<td>34.9</td>
<td>3.99</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>47</td>
<td>28.76</td>
<td>6.5</td>
</tr>
<tr>
<td>4</td>
<td>COM</td>
<td>100</td>
<td>34.02</td>
<td>4.25</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>51</td>
<td>35.62</td>
<td>2.74</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>49</td>
<td>32.34</td>
<td>4.88</td>
</tr>
</tbody>
</table>
According to the graph, as the age group increases, the upper limb coordination total motor point score also increases.

Graph 2 - DESCRIPTIVE CATEGORY ACCORDING TO GENDER

<table>
<thead>
<tr>
<th>Gender</th>
<th>WAA</th>
<th>AA</th>
<th>A</th>
<th>BA</th>
<th>WBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>0</td>
<td>8.06</td>
<td>37.9</td>
<td>45.16</td>
<td>8.87</td>
</tr>
<tr>
<td>Male</td>
<td>0</td>
<td>56.34</td>
<td>20.9</td>
<td>20.9</td>
<td>1.87</td>
</tr>
</tbody>
</table>
The performance of the students was interpreted by the descriptive category and was compared among male & female. According to this, 45.16% females showed Below average performance where as only 20.9% males showed Below average performance, where as 8.87% females showed Well Below average performance, where as only 1.87% males were under the category of Well Below average.

GRAPH 3: DESCRIPTIVE CATEGORY ACCORDING TO AGE GROUP

![Graph](image)

According to above graph, the scores of students were mostly higher in average category, except Age Group 3, where below average were more and Age Group 5 showed similar number in both average and below average category.

DISCUSSION:

The primary aim of the study was to find affection of upper limb coordination in the school going children of age 5-15 years using BOT 2 Scale. The upper limb coordination subtest of BOT 2, which is the seventh subtest under gross motor composite. Sample’s score is consistent with individuals who generally can catch a tennis ball that is tossed from 10 feet away about 50% of the time, dribble a tennis ball two to five times, and hit a target with a tennis ball from 10 feet away about 25% of the time. The scoring system varies with each item, ranging from a 0-point (pass/fail) to a 5-point scale.

The total number of samples were 516, (mean age 10.67 years ± 3.02 ) in which 268 females (mean age 10.69 years ± 3.04 ) & and 248 were males (mean age 10.66 years ± 3.02 ).

Descriptive category according to gender, showed a vast difference between males and females. According to the study done, 45.16% females showed Below average performance where as only 20.9% males showed Below average performance, where as 8.87% females showed Well Below average performance.
average performance, where as only 1.87% males were under the category of Well Below average. These performance differences in males and females can be due to the dietary intake of boys is more than that of girls (satabdi ghosh et al 2013). Nutritional status appear to be significant predictor for both fine and gross motor development. It also alters the learning process by influencing brain development and physical growth and accordingly modify the movement proficiency of the children by adjusting the strength, power, coordination and perception. Total motor point score according to age group, in which the study reveals that as the age increases the mean values of point score also increases. Barnekow- Bergkvist et al. (1998) found that performance in physical tests; height, weight and physical activity at the age of 13 contributed best to explain adult physical performance and physical activity. Therefore, it may be concluded that so far all the subtests of coordination was concerned age factor was responsible for higher mean value. Age group 4 &5 having higher age, they had significantly performed better in comparison to age group 1, 2 & 3 boys and girls. Coordination was also related to limb length, general musculature and neuromuscular coordination, which are definitely influenced by the advancement of age. The remaining motor performance is related to lean body mass, general musculature, aerobic capacity and certain psychological state of mind (willingness to accept pain) and development of all of which are influenced by advancement of age. Therefore, it is obvious that age group 1, 2 &3 will have less motor quality than that of age group 4&5 because of structural and functional differences of higher age groups. Descriptive category according to age groups, in which the study revealed that BA and WBA were more in the age group 1 & 2 as compared to age group 3, 4 & 5. It is observed that children of age 8, 9, & 10 are less in the activities played with a tennis ball than the children of age 11, 12, &13. Environmental factors including the schedules of school’s physical education activities may explain some of the remaining variability of scores. From the foregoing discussion of the leading researchers it has also been evident that the growth and development of body parts and functional capacity of the organs and systems improve rapidly during pre-pubertal stage and each year during this stage results significant improvement in stature. Chatterjee et al. (1992) has also reported that gradual increase in motor fitness measurements with the advancement of age on school going children of 5-15 years age. Therefore, it is expected that during pre-adolescent stage with advancement of age (12-15 years) that motor activity involving neuromuscular coordination will also increase, that is the reason age group 1&2 had WBA performances more than Age group 3,4 &5.

**LIMITATIONS:**
In our study, we were not able to take the socioeconomic status that can be probably a reason for the performance score difference amongst different age group students.

**FURTHER SCOPE:**
To establish normative data & to consider different medium schools and body mass index of the children.

**CONCLUSION**
The study concluded that, there is very slight score difference in males and females, although males showed better performance than females in coordination skills like catching and throwing of objects. Children of age 12,13,14,15 years showed better results than children of age 5, 6, 7, 8, 9, & 10 years i.e. as the age advanced performances of the students increased.
ACKNOWLEDGEMENT

Having surmounted all the difficulties and after reaching the shore by completing the work of this study, I am realizing the limitations of language and words while acknowledging thanks to all those who helped me in this voyage.

I thank my mother Mrs. Dipti Dighe, my father Mr. Dilip Dighe & my brother Akshay Dighe for their moral support, prayers and encouragement that have been a pillar of strength throughout this work. Words are few and language seems feeble when the heart is full of gratitude, these few words cannot express my deep sense of gratitude to my esteemed Guide Dr. Mrs. Sanjivani Dhote, who has been a constant source of inspiration to me since the very beginning of this work. Her unsurpassable teaching experience & scientific approach has increased my interest and knowledge in the subject. It is only because of her constructive supervision and overall encouraging sympathetic attitude that my work has acquired the present shape.

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Lastly I would like to thank God for sending all these wonderful opportunities and giving me a chance to prove myself.

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