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**Research/Technical Note**

# Bruininks- Oseretsky Test Showed Strong Correlation Between Upper Limb Speed Dexterity and Upper Limb Coordination

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**Abstract:** *Background:* Daily living activities such as walking, dressing and feeding require adequate proficiency in gross and fine motor skills; however inadequate proficiency leads to multiple difficulties that range from increased anxiety and poor self-esteem to significant difficulties with academic achievements. Recent research findings claimed that children's skill proficiency tends to lag behind the established developmental norms. *Purpose:* The aim of this study was to examine the interrelationship among different subtests of gross and fine motor skill in school aged children in Al-Madinah Al-Munawara. *Methods:* Children (N= 99) from 2nd, 3rd and 4th grades completed the gross and fine motor composite of the Bruininks-Oseretsky Test of motor proficiency 2nd Edition (BOT-2). *Results:* Analysis revealed a weak correlation between gross motor composite and fine motor composite. A weak correlation was found for gross motor subtests except a significant correlation was found for the relationship between balance and bilateral coordination. *Conclusion:* Therapists should closely look at upper limb speed dexterity and upper limb coordination since they are significantly correlated.

**Keywords:** Motor Proficiency, Gross Motor Skills, Fine Motor Skills

## 1. Introduction

Human motor development is a dynamic process which is seen as progressive changes in movement behaviour throughout the human life cycle [1]. Motor skills must be learned and voluntarily produced to perform a goal-oriented task. Motor skills include gross and fine motor skills [2, 3]. Gross motor skills are movements which involve the use of large muscle group to perform gross physical activity such as crawling, standing up, walking and running. In the early years of life, gross motor skills are essential to explore of the environment [4-7]. Fine motor skills use small muscle groups to move the extremities& to manipulate objects [5]. Fine motor skills play a vital role in many activities of daily life such as dressing, writing and feeding oneself [8]. Manual ability and performance of dexterity tasks require coordinated gross and fine hand skills. Some children have difficulties performing manual activities such as grasping, manipulating or releasing objects, which are crucial in the performance of many activities of daily living [9-13].

The level of gross and fine motor ability was found to impact the perceived athletic and scholastic competence. Male who had better gross motor skills had also greater perceived athletic performance. It is necessary to assess specific types of motor deficits particularly within the academic setting.[3] It is essential to encourage a physically active life style among preschool children [4, 5]. Research studies have shown benefits of early identification of children with atypical or delayed development [14, 15].

Motor performance evaluation has been give increasing attention in literature. Bruininks-Oseretsky test of motor proficiency, 2nd edition is a standardized norm-referenced measure that is used to evaluate motor performance specially strength, agility, and body coordination. The environment has significant impact on motor development[7] but has not been studied in Saudi Arabia. The environmental characteristics, in which the child grows up, plays a fundamental role in developmental outcomes. Family-reared children show better gross and fine motor development profiles compared to children living in conventional institutions. Children in Saudi Arabia had been and are experiencing many challenges within the context of their daily life. Challenges including but are not limited to physical, economic, and societal factors and challenges were rapidly increasing over the last decade. The modern life style; that relies heavily on technology, rendered children less active with less needed physical demands. Moreover, many of children in Saudi Arabia schools do not have regular physical fitness class which is another burden since there is positive association between being physically inactive and developing a big class of health-related issues. Research has demonstrated the close relationship between the usual practice of physical activity and health indicators [16]. Therefore, it is important to assess gross and fine motor skills in this age group. Little is known about the variability in motor performance, regarding gross and fine motor subtests, among normally developed school-aged children in Al-Madinah Al-Munawarah, Saudi Arabia. The purpose of this study was to investigate the relationship between gross and fine motor subtests in order to have an educated clinical decision to effectively promote physical activity among children. The null hypothesis states that fine and gross motor subtest wouldn't equally contribute to the gross and fine motor composite.

# 2. Methods

### *2.1. Subjects*

Ninety nine children aged between (7–10 years old) recruited from 3 primary schools of Al Madinah Al-Munawarah. Informed consent was signed by both the parents and the designated staff members. Approval for this study was obtained from the Ethical Committee of the Taibah University. *Inclusion Criteria*: school going children in the age range from 7 to 10 years old. *Exclusion Criteria* children who have been diagnosed with any neurological or psychological disorder, suffering from systemic illness, significant congenital heart or lung disease, had recent surgery or sustained major trauma.

### *2.2. Materials & Methods*

Demographic data were collected including name, age, sex, date of birth, handedness, height, and weight. Gross and fine movement skills development was assessed using Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) and its revised 2nd edition (BOT-2). They are used to identify individuals with mild to moderate motor coordination deficits. The test is suitable for individuals aged 4 to 21 years. The complete BOT-2 features 53 items and is divided into 8 subtests: fine motor precision (7 items), fine motor integration (8 items), manual dexterity (5 items), bilateral coordination (7 items), balance (9 items), running speed and agility (5 items), upper limb coordination (7 items), strength (5 items). The items in every subtest become progressively more difficult. A short form of the BOT-2 is readily available, easily used screening tool used to evaluate and score overall motor proficiency. The BOT-2 Short Form comprises a subset of 14 items of the BOT-2 Complete Form and was constructed from data gathered in standardization [17]. The Short Form features items from all subtests. A high correlation ($\sim r = 0.80$s) was found between the short and long form of the BOT-2. SPSS version 21is the software used for data analysis. *P* value was set at <0.05.

# 3. Results

Descriptive statistics, correlation and regression analyses were conducted for gross motor skills and well as fine motor skills. Tests of normality were run using Shapiro-Wilk test and the results came out significant which dictated using non-parametric correlation analyses. Multiple linear regression analyses were conducted for gross and fine motor skills.

Table 1. Presents the demographic information for all children participated in the study. Spearman *rho* correlation coefficient was calculated for the relationship between gross motor composite and fine motor composite. A weak correlation that was insignificant was found [$r$ (97) = 0.2, $p >$ 0.05]. Figure 1: Three dimensional scatterplot showing the fine motor composite, upper limb speed dexterity and visual motor control is illustrated in Figure 1. Three dimensional scatterplot showing the fine motor composite and upper limb speed dexterity at different age strata is illustrated in Figure 2.

Spearman *rho* correlation coefficient was calculated for the relationship between all gross motor subtests. A weak and insignificant correlation was found for gross motor subtests except a significant correlation was found for the relationship between balance and bilateral coordination [$r$ (97) = 0.3, $p <$ 0.05].

Spearman *rho* correlation coefficient was calculated for the relationship between all fine motor subtests. A strong and significant correlation was found between upper limb speed dexterity and upper limb coordination [$r$ (97) = 0.7, $p < 0.001$]. A weak but significant correlation was found between upper limb coordination and visual motor control subtests [$r$ (97) = 0.2, $p < 0.05$]. A moderate and significant correlation was found between upper limb speed dexterity and visual motor control subtests [$r$ (97) = 0.5, $p < 0.01$].

A multiple linear regression was calculated to predict children's gross motor composite based on their gross motor subtests. A significant regression equation was found [$F(3,95)$= 48.69, $p < 0.001$), with $R^2$ of 0.61. Children's predicted gross motor composite is equal to 19.24+ 0.68

(balance) + 0.79 (strength) + 1.27 (bilateral coordination). The standard error of estimates for 95% of children will fall between ± (10.14).

A multiple linear regression was calculated to predict children's fine motor composite based on their fine motor subtests. A significant regression equation was found [$F(1,97)$= 1145.9, $p < 0.001$), with $R^2$ of 0.92. Children's predicted fine motor composite is equal to 7.95+ 1.19 (upper limb dexterity). The standard error of estimates for 95% of children will fall between ±(7.98).

Regarding the addition of visual motor control, a significant regression equation was found [$F(2,96)$= 4482.9, $p < 0.001$), with $R^2$ of 0.99. Children's predicted fine motor composite is equal to 0.46+ 1.005 (upper limb dexterity) + 0.96 (visual motor control). The standard error of estimates for 95% of children will fall

between ±(2.96).

***Table 1.*** *Descriptive statistics of study variables.*

| | Number | Minimum | Maximum | Mean | Standard Deviation |
|---|---|---|---|---|---|
| Age | 99 | 7.08 | 9.75 | 8.02 | 0.63 |
| Weight | 99 | 15.00 | 44.00 | 25.20 | 8.98 |
| Height | 99 | 1.07 | 1.56 | 1.19 | 0.06 |
| BMI | 99 | 11.40 | 28.72 | 17.24 | 5.67 |
| Running Speed Agility | 99 | 5.00 | 14.00 | 9.95 | 1.77 |
| Balance | 99 | 10.00 | 32.00 | 21.7 | 4.31 |
| Bilateral coordination | 99 | 6.00 | 20.00 | 10.32 | 2.61 |
| Strength | 99 | 10.00 | 40.00 | 16.06 | 4.41 |
| Gross Motor Composite | 99 | 44.00 | 80.00 | 59.95 | 7.96 |
| Upper Limb Coordination | 99 | 5.00 | 20.00 | 11.84 | 3.76 |
| Visual Motor Control | 99 | 3.00 | 24.00 | 13.96 | 4.45 |
| Upper Limb Speed Dexterity | 99 | 15.00 | 62.00 | 31.27 | 11.41 |
| Fine Motor Composite | 99 | 20.00 | 84.00 | 45.30 | 14.19 |

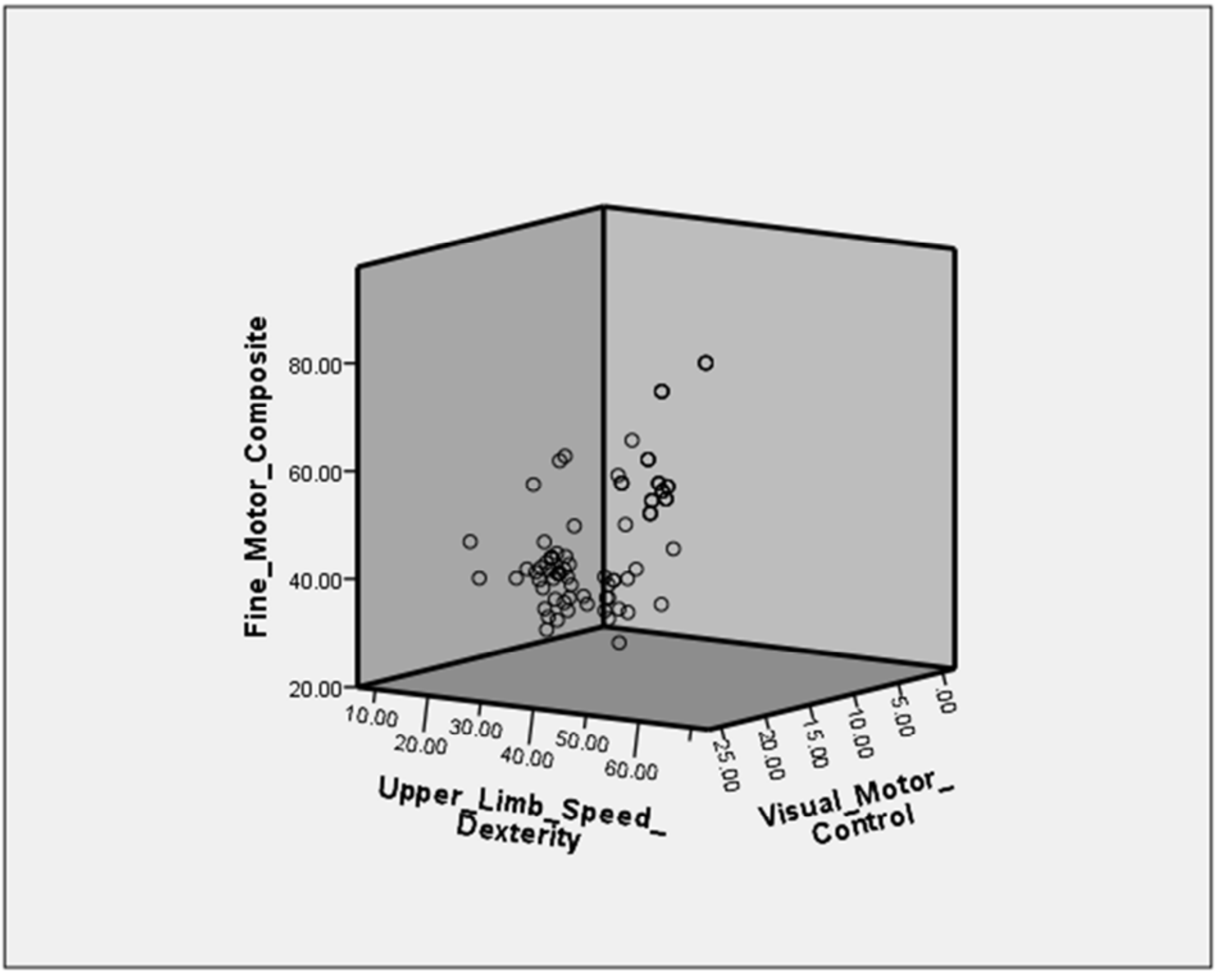


***Figure 1.*** *Three dimensional scatterplot showing the fine motor composite, upper limb speed dexterity and visual motor control.*

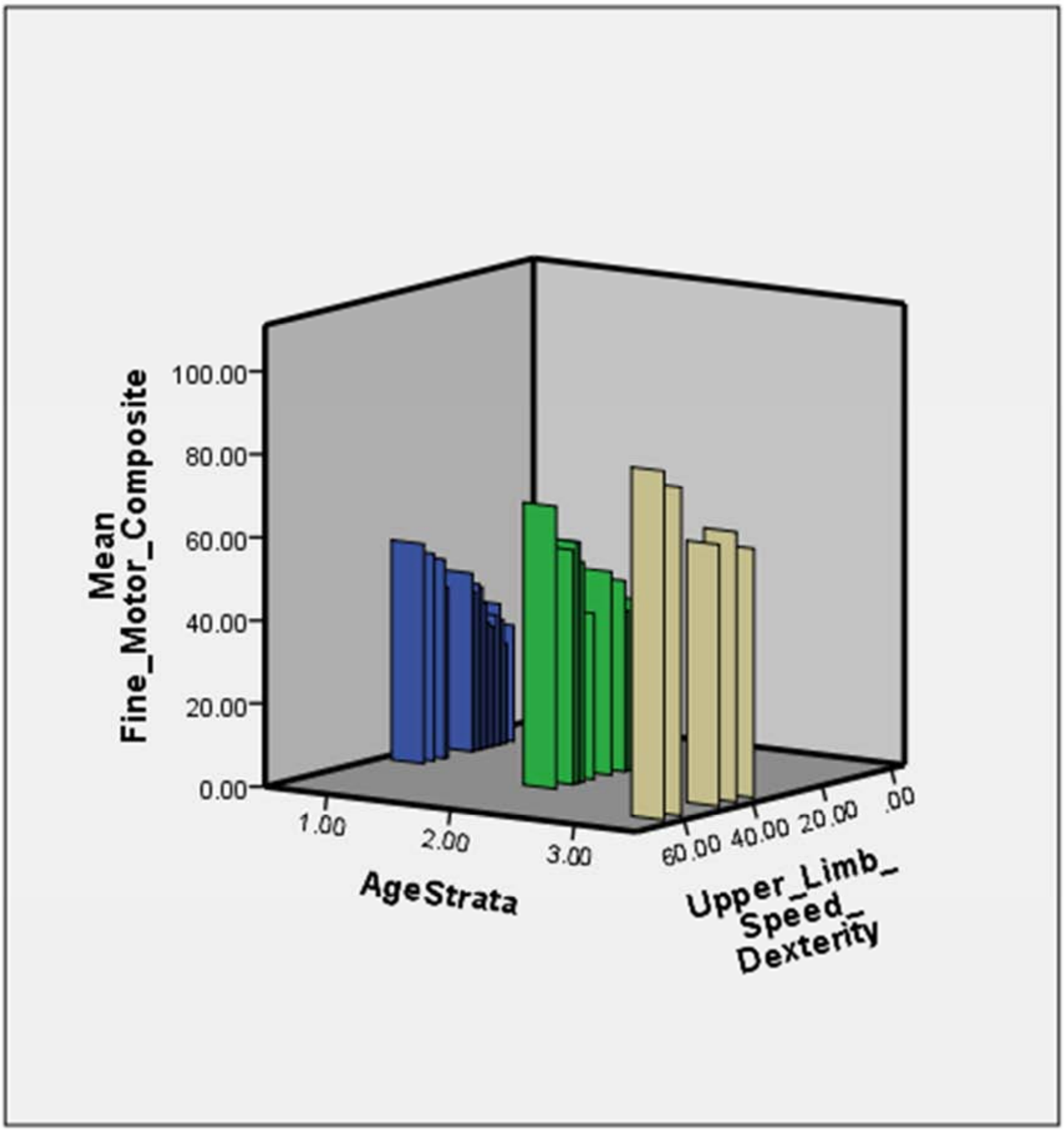


***Figure 2.*** *Three dimensional scatterplot showing the fine motor composite and upper limb speed dexterity at different age strata.*

# 4. Discussion

The findings of the present study indicated a weak correlation between gross motor composite and fine motor composite. Brahler et al. [17] reported very low association between individual subtests of the (BOT-2) short form and the subtest total score. There is independence of gross and fine motor skill development that is further supported by the evidence of the trajectories from infancy to preschool that are best described by different mathematical models [18]. It is possible that the neural systems independently foster posture and manual control development. Children who experience difficulties in motor development often have a deficit in fine, but not gross motor skills or vice versa [19, 20]. For example, children with spina bifida who had difficulties to stand up once they are seated they were capable to perform manual tasks with satisfactory control implying independent neural substrates responsible for skills development. The findings are in agreement with the research work that showed gross, but not fine motor skills, in infancy are the significant predictor of cognitive performance at school-aged children [21]. Meta-analysis studies showed that both of boys and girls had isolated advantages on specific motor tasks [22-24].

Wrotniak et al. [25] investigated the relationship between motor proficiency and physical activity in 65 children aged (8-10) year. Children's motor proficiency was assessed by the Bruininks-Oseretsky test of motor proficiency. Results showed that physical activity level had significant influence on motor proficiency. Children motor proficiency was positively associated with physical activity. Clinicians should look forward to the threshold of motor proficiency that is considered as a reasonable target for increasing physical activity. Researchers [26-28] studied the role of robot-assisted rehabilitation on functional recovery and showed the improvement of coordination. Liao et al. [26] studied the effect of robot-assisted upper limb rehabilitation on daily functional recovery in patients with chronic stroke. Patients received therapy each day, 5 days per week for four weeks. Results showed significant improvement in motor function and bilateral arm coordination. Therefore, symmetrical and bilateral robotic practice integrated with functional task training can improve motor function, activity and bilateral arm coordination. Desrosiers et al. [29] compared upper extremity motor function and functional independence of the unaffected upper extremity of elderly stroke and matched group of healthy subjects. Results showed marked deficits in the unaffected upper extremity of the elderly stroke compared with the healthy matched group. Interaction of many factors may have been behind the presence of this significant difference especially the frequency of use of the unaffected upper extremity and the severity of injury.

Several researchers investigated children performance during hand writing speed test [30, 31]. Tseng and Chow [30] examined the difference in perceptual-motor measures and sustained attention between children with normal speed hand-writers and slow hand writers attending elementary school. Results showed significant difference between children in the two groups reflected in the upper-limb coordination, spatial relation, visual-motor integration, visual sequential memory and sustained attention. Regression analyses determined a number of predictors. In reference to slow hand writers, the age, visual sequential memory, and visual motor integration were the three significant predictors however; age, upper limb speed and dexterity were the only two significant predictors for the normal speed hand writers. Researchers attributed the significant difference in motor performance to the presence of different perceptual motor systems. Therefore, clinicians should fully understand the underlying neural mechanisms that govern motor skills acquisition among slow and normal speed hand writers in order to set realistic achievable goals aiming to improve motor performance.

Kuhtz-Buschbeck et al. [32] examined the sensorimotor recovery in a 23 children diagnosed with traumatic brain injury. Children received 5 month of inpatient rehabilitation. The outcome measures included gross motor function measures, gait analysis and the developmental hand function test. Results showed significant deficits in fine motor skills and coordination. Gait analyses of ambulatory children showed significant reductions of velocity, stride length and cadence. The improvements in hand motor skills were less than the improvements in gait parameters which indicates different neural substrates and that dictates independent evaluation of gross and fine motor skills before correlating their different subtests. One of the limitations in this study is that the sample was only children in Al Madinah Al Munawarah. Given this limitation, we cannot generalize our findings to all typically developing children in Saudi Arabia.

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