ASSESSMENT OF FUNDAMENTAL MOTOR SKILLS (FMS) PROFICIENCY USING BRUININKS-OSERETSKY TEST, SECOND EDITION (BOT-2) IN CHILDREN WITH DOWN SYNDROME AT DOWN SYNDROME ASSOCIATION OF MALAYSIA: A PRELIMINARY STUDY

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ABSTRACT

This study was designed to evaluate two variables related to the Gross Motor Skills Test and Fine Motor Skills Test between children with Down Syndrome (DS), n = 14 (male = 7, female = 7) from the Down Syndrome Association of Malaysia. The purpose was to compare gender and identify the level of fundamental motor skills development among children with DS at the Down Syndrome Association of Malaysia by using Bruininks-Oseretsky Test, Second Edition (BOT-2) Short Form. In gross motor skills, the percentage of the male participants with DS, running, speed, and agility subtest is 86.37%, balance subtest is 56.76%, bilateral coordination subtest is 50%, strength subtest is 54.84%, and upper-limb coordination subtest is 56.67%. While the percentage for the female participants with DS, running, speed, and agility subtest is 13.63%, balance subtest is 43.24%, bilateral coordination subtest is 50%, strength subtest is 45.16%, and upper-limb coordination subtest is 43.33%. In fine motor skills, the percentage of the male participants with DS is response speed subtest is 50%, visual-motor control subtest is 0%, upper-limb speed and dexterity subtest is 0%. While the percentage for the female participants with DS, response speed subtest is 50%, visual-motor control subtest is 0%, upper-limb speed and dexterity subtest is 0%. The results are significant for running, speed, agility, balance, and strength. A Mann-Whitney test indicated that there was statistically significant difference on running, speed, and agility between gender, $U(N_{Male}=7, N_{female}=7), = 2.50, p=0.004$*, on balance between gender,* $U(N_{Male}=7, N_{female}=7), = 9.50, p=0.035$ *and on strength between gender,* $U(N_{Male}=7, N_{female}=7), = 6.50, p=0.010$*. This study indicated that the male participants with DS have better gross motor skills than the female participants. The fine motor skills test shows no differences between the male and the female participants with DS. The outcome of the study can be used as preliminary data to measure fundamental movement skills among children with DS.*

Keywords: Gross motor skills, disability, motor skills proficiency, motor impairments, physical activity

INTRODUCTION

Down Syndrome (DS) is a disease related to the presence of three copies of chromosome 21 and has a prevalence that varies from 1 on 400 to 1 on 1500 people in different countries (Kazemi et al, 2016). This neurodevelopmental disorder affects mental and physical health (Bittles et al, 2007). In particular, people with DS often have impaired balance (Villarroya et al, 2012) and resulting to be less active than their peers (Shields et al, 2018). Persons with DS face balance impairments and physical inactivity, which can lead to reduced quality of life and fundamental movement skills (Palomba et al, 2020). The low physical activity levels of youth with DS may be partially explained by poor motor skills in this population, as some current literature suggests a direct association between motor skills and physical activity (Nocera, Wood, Wozencroft & Coe 2021).

Some current data did recommend that approximately 30% of youth with DS are classified as obese (Styles, Cole, Dennis & Preece, 2002) which is higher than what is reported for youth without disabilities (17%) (Ogden, Carroll, Lawman, Fryar, Kruszon-Moran, Kit & Flegal, 2016) and those with other causes of intellectual disabilities (12–30%) (Rimmer, Yamaki, Davis, Wang & Vogel, 2011; Rimmer, Yamaki, Lowry, Wang & Vogel, 2010). A recent study by Diaz (2020) found that children with DS (mean age 12.5 ± 2.9) are 45% less likely to participate in regular physical activity and 52% less likely to participate in recreational sports compared to youth without disabilities. Even, youth with DS are more likely to engage in high volumes of television viewing (>2 h per day) (Diaz, 2020).

As such, physical activity is recommended to prevent excessive weight gain and promote weight loss (Murray & Ryan-Krause, 2010; Diaz, 2020). Physical fitness illustrates a physiologic state of well-being that allows individuals to meet the demands of both health-related and skill-related fitness (Abdullah et. al. 2015). However, the physical activity levels of individuals with Down syndrome remain low, and the majority of youth with DS do not meet national recommendations of 60 min of daily moderate to vigorous physical activity (Fox, Moffett, Kinnison, Brooks & Case, 2019; Esposito, MacDonald, Hornyak & Ulrich, 2012; Whitt-Glover, O'Neill & Stettler, 2006). Thus, researchers are tasked with developing strategies to increase the physical activity levels of individuals with DS. Early development of motor skills proficiency is essential among children with DS (Capio & Rotor, 2010). Apart from delayed cognitive and psychosocial developmental milestones, children with DS are challenged with delayed motor skills development due to limitations in their motor skills proficiency

Fundamental motor skill (FMS) is a movement pattern that has been created by a person who does some movement to move either from the same area or one area to other areas (Lubans, Morgan, Cliff, Barnett, & Okely, 2010). Balance skills, locomotor skills, and ball skills are an example of fundamental motor skills categories (Ulrich, 2013). Balance skills are movements where the body remains in place but moves around its horizontal and vertical axes. Locomotor skills such as running, jumping, hopping, and galloping. Ball skills such as catching, throwing, kicking, underarm roll, and striking (Lubans et al., 2010). Individualising instruction and designing appropriate task progressions is both critical and challenging when teaching motor skills to a large group of diverse learners. Regardless of gender, the stronger predictor of adult involvement and physical activities involvement, particularly in competitive sports, was related to gender. Becoming involved in physical activity and sport: A process of socialization. Therefore, it is important to investigate who learns motor skills and under what circumstances to better understand the impact these experiences may have on sports participation. In childhood and adolescence, males are more proficient in object control motor skills better than females (Booth et al., 2004).

Motor developments are analyzed using extensive performance instruments with functional relevance to the test content. A variety of assessment tools for motor development and proficiency are commonly used in youth with DS. These tools include the Test of Gross Motor Development (TGMD-2 and TGMD-3), the Motor Assessment Battery for Children (MABC-2), and the Bruininks–Oseretsky Test of Motor Proficiency (BOT-2) (Nocera, Wood, Wozencroft & Coe, 2021). These assessments were not developed for youth with disabilities, and normative data are typically not available for this population. Researchers have established test-retest reliability and internal validity for the TGMD-2, TGMD-3, and the MABC-2 in youth with DS (Alesi & Battaglia, 2019).

The BOT-2 was designed to measure motor proficiency of youth ages 4 to 21 years, as well as to identify motor impairments. Moreover, it has been used in youth with and without disabilities (Lucas, Latimer, Doney, Ferreira, Adams, Hawkes, Fitzpatrick, Hand, Oscar, Carter, 2013; Bruininks & Bruininks, 2005; Lam, Rubin, White, Duran & Rose, 2018). Lam, Rubin, White, Duran, and Rose (2018) recently established the test-retest reliability for the BOT-2 Complete Form (BOT-2 CF) for youth with Prader–Willi Syndrome. However, currently, there have not been any studies that have examined the test-retest reliability of the BOT-2 Short Form (BOT-2 SF) and specifically focused on youth with DS.

The BOT-2 has been frequently used as a motor skill proficiency assessment tool in a variety of settings including adapted physical education, occupational therapy, and physical therapy (Burton & Miller, 1998). Lee, Hong, and Park (2018) found that approximately 43% of occupational therapists used the BOT-2, making it the most commonly used test to assess motor proficiency. Furthermore, Ruiz-González and colleagues (2019) found that the BOT-2 was one of the most commonly used assessment tools of motor skills in the research setting for youth with DS. However, the BOT-2 involves 53 items and takes approximately 45–60 min to complete for a typically developing child. The length of this assessment may not be ideal for youth with Down syndrome to complete, as they may not be able to comprehend instructions for all of the different assessments and may lose interest and focus during the extended testing period (Nocera, Wood, Wozencroft & Coe, 2021).

Referring to the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2) (Bruininks & Bruininks, 2005a), motor skills proficiency is categorized into gross manual control (upper-limb coordination and manual dexterity), body control (bilateral coordination and balance), strength and agility (running speed and strength), and fine manual control (fine motor precision and fine motor integration). Thus the purpose of this investigation was to identify the level of fundamental movement skills in children with DS.

Statement of the problem

Children with DS lack FMS than able children and they will have a limitation on physical activity which can affect their health and fitness. To provide complex information of evidence for intervention plans, standardized FMS assessment methods for children with DS are necessary (Kennedy, Brown & Chien, 2012). The FMS can be assessed by using standardized product-oriented or process-oriented approaches. One of the most commonly used standardized measures of the FMS assessment for children with or without disabilities is the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2) by (Bruininks & Bruininks, 2005a). Currently, there are limited data on BOT-2 for children with DS. BOT-2 has been used as a clinical assessment tool for evaluating the disabled population (Spiegel, Steffens, Rynders, & Bruininks, 1990). The findings can be utilized by healthcare providers and the school system for students evaluation and placement These evaluations in physical and cognitive domains help children improve in other areas such as language, literacy, social, and emotional development. The BOT-2 can be used to improve the FMS for children with DS. Children with both attention and motor deficits have more problems in everyday life at home and in school than children with attention problems (Yochman, Ornoy, & Parush, 2006). Many educators believed that children inevitably developed motor skills as they matured, but now they start to believe that environmental factors play a vital role in children's motor development (Gallahue, Ozmun, & Goodway, 2006)

RESEARCH METHODOLOGY

Participants

A total of 14 individuals with DS (7 males and 7 females), ages 5 to 6 years old, volunteered to participate in the study. They are placed at the DS Association of Malaysia, Kuala Lumpur. They were recruited according to the following criteria: (1) participants been diagnosed with DS through genetic testing; (2) they are aged 5–6 years old; (3) they can ambulate independently; (4) they can follow simple instructions with two-step commands; and (5) have not been diagnosed with associated medical complications where physical activity is contraindicated. All the participants have been equipped with a detailed description of the study protocol as well as parents and/or caregivers. After the explanation of the study, parents/guardians/caregivers provided informed consent and the participants provided written assent. The protocol for this investigation was reviewed and approved by the University Ethics Committee. During this time, parents/guardians/caregivers were asked if their child had any atlantoaxial instability, which is prevalent in youth with DS, to determine if high-impact jumping activities were contraindicated. Then anthropometric assessments of each participant's height and weight were completed. Parents/guardians reported the date of birth and race/ethnicity of their children. Finally, participants completed the BOT-2. The inclusion criteria to participate are a) children with DS with trisomy 21, b) their age between 5 to 6 years old, c) they have been declared as having their own Orang Kurang Upaya (OKU) card, d) they are free from any injury. The exclusionary criteria are a) uncontrolled cardiopulmonary conditions, such as blood pressure, angina, or asthma, and b) carrying an injury. The gross motor skill test was held on the field and fine motor skills will hold in class. Before each assessment, a demonstration was performed by a trained researcher.

Test instrumentation: Bruininks–Oseretsky Test of Motor Proficiency, Second Edition (BOT-2)

This test is designed to measure the fine and gross motor skills of youth ages 4 to 21 years as well as to identify motor impairments (Lucas, Latimer, Doney, Ferreira, Adams, Hawkes, Fitzpatrick, Hand, Oscar & Carter, 2013). The BOT-2 was comprised of 14 items from the complete battery which provided a brief survey of general motor proficiency (Bruininks, 2005). This kit includes the examiner's manual, individual record form, student booklets, and testing equipment. Have 4 complete forms such as fine manual control, manual coordination, body composition, and strength and agility. Form 4 composites include 8 subtests: running speed and agility, balance, bilateral coordination, strength, upper limb coordination, response speed, visual-motor control, and upper limb speed and dexterity. Then to complete the form takes 40 to 60 minutes and 10 to 15 minutes to administer each composite. Before data collection, the researcher was extensively trained by an experienced evaluator on administration techniques, scoring, and interpretation using the BOT-2 manual, training video, and numerous practice rating trials until proficiency was attained. Participants had an opportunity for breaks to prevent possible fatigue and frustration. BOT-2 subtests provide a total motor composite score. The subtests include fine motor precision, fine motor integration, manual dexterity, body coordination, balance, running speed and agility, upper-limb coordination, and strength. The participants were asked to perform only one test trial in turn. To assure participants to perform maximally, verbal encouragement to participants was made if necessary. Then provide an additional demonstration for the subject that seems not to be clear about the instructions while administering two test trials and score each performance criterion on each trial. Finally, all data will be collected. These raw scores were converted into point scores so that they would be comparable to the standardized norms previously established.

Procedures

The FMS testing was organized into five stations according to the gross motor skills subtests: Station 1 (running speed and agility subtest), Station 2 (balance subtest), Station 3 (bilateral coordination subtest), Station 4 (strength subtest), and Station 5 (upper-limb coordination subtest). Three stations for the Fine motor skills subtest are Station 1 (response speed), station 2 (visual motor control), and station 3 (upper-limb speed and dexterity). The testers were individuals who had conducted both the familiarization process and evaluation of the motor proficiency tests on the study participants. The familiarization process of skill demonstrations and verbal instructions were standardized according to the Administration Easel of the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (Bruininks & Bruininks, 2005b). Each participant was evaluated through all motor proficiency tests and expected to spend about an hour to complete all tests.

Statistical analysis

The statistical analysis used to compare the different levels of fundamental motor skills among DS children at the Down Syndrome Association of Malaysia is the Mann-Whitney test due to the non-normality of the distribution data. The alpha value is set at 0.05 and $p<0.05$. The IBM SPSS version 25 software had been used to analyze the data.

Table 1 Anthropometric Characteristics of Male and the Female Participants

	Male (n=7)	Female (n=7)
Age in years	5.29±2.14	6.43±3.26
Height (cm)	101.70±10.31	101.96±18.31
Weight (kg)	22.57±2.91	25.57±5.97

Table 1 above shows the anthropometric characteristics of the males and females between the subjects' age, height, and weight. The mean age of the male participants analyzed was 5.29±2.14. Meanwhile, the mean age of the female participants was 6.43±3.26. Besides that, the mean height of the male participants was 101.70±10.31, while 101.96±18.31 for the female participants. Next, the mean weight of the male participants was 22.57±2.91, while the female participants were 25.57±5.97.

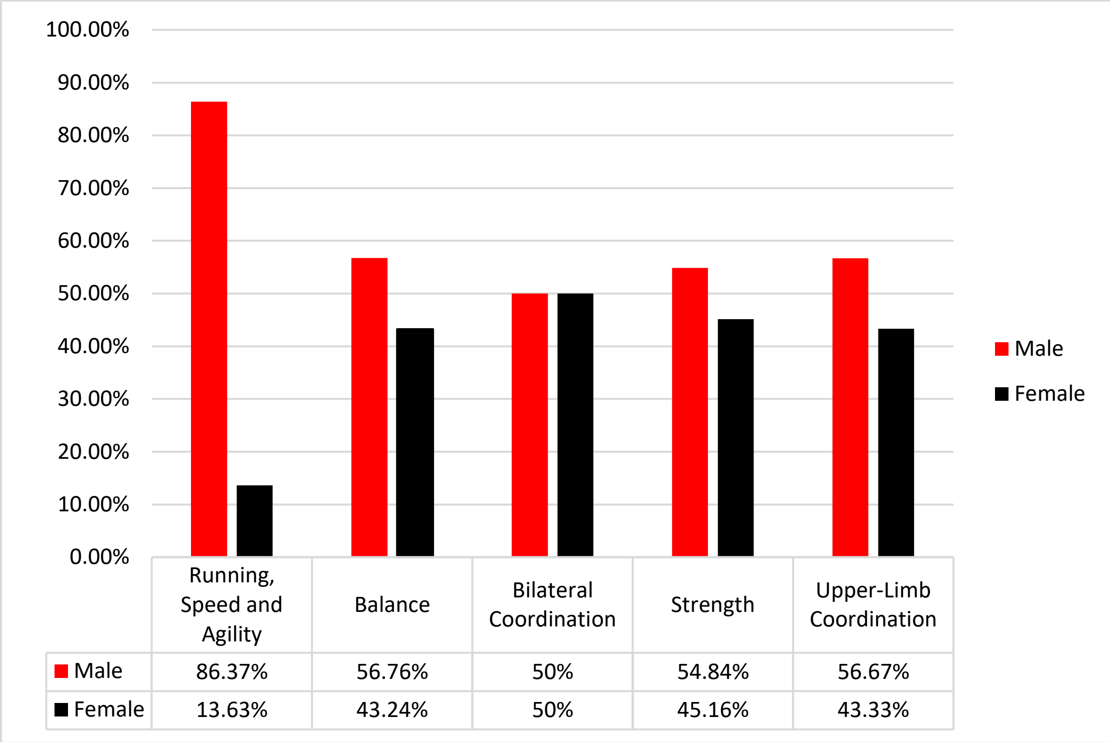

Figure 1 Percentage of total score in Gross Motor Skills Test

Figure 1 shows the percentage of the Gross Motor Skills Test scores. It can be concluded that male participants scored a higher point in the running, speed, and agility subtest with 86.37% than female participants, 13.63%. In the balance subtest, male participants also get a higher score of 56.76% than females, with 43.24%. For bilateral coordination, the percentage is equal which the score is 50% for each group. For the strength subtest, the male participants got better points than female participants, with 54.84% than 45.16%. Lastly, for upper-limb coordination, male participants also got a higher point of 56.67% than female participants with 43.33%.

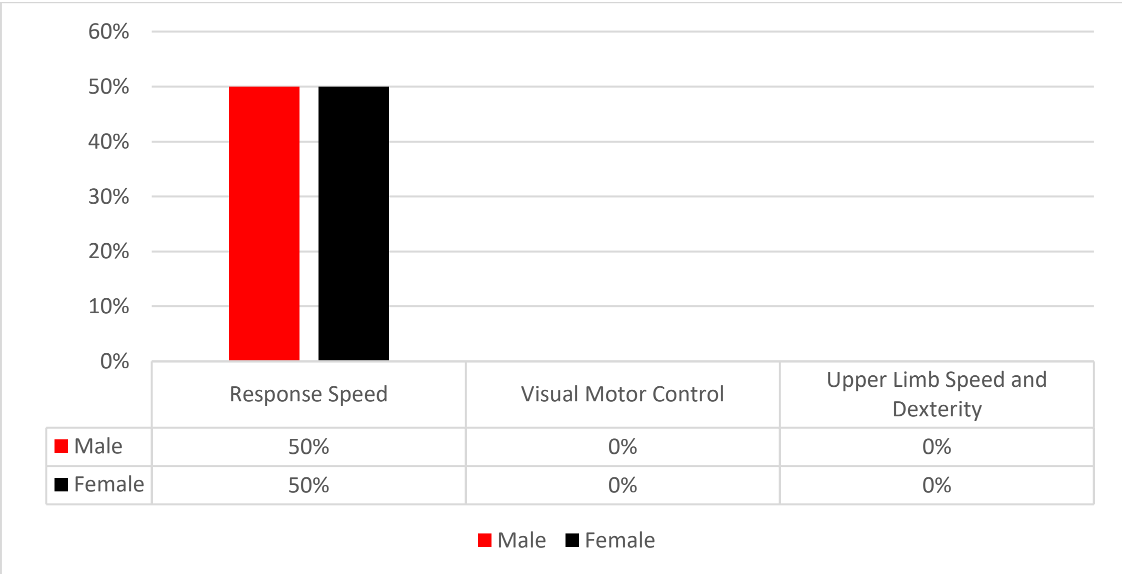

Figure 2. Percentage of total score in Fine Motor Skills Test

Figure 2 shows the percentage of the Fine Motor Skills Test scores. It can be concluded that male and female participants get an equal score of 50% in the response speed subtest. In visual-motor control and upper limb speed and dexterity, male and female participants also get an equal score of 0%.

Table 2 Mann-Whitney data for Gross and Fine Motor Skills Test

Variables	Gender	Mann-Whitney	Mean Rank	Sum of Ranks	*p*-value
Gross motor skills	Male	1.00	10.86	76.00	0.002
	Female		4.14	29.00	
Fine motor skills	Male	24.50	7.50	52.50	1.000
	Female		7.50	25.50	

From table 2 above, the gross motor skills score was higher in males than females. A Mann-Whitney test indicated that this difference was statistically significant, $U(N_{Male}=7, N_{female} = 7), = 1.00, p=0.002$. On the other hand, the fine motor skills showed higher in males compared to the females. However, a Mann-Whitney test indicated that the difference of fine motor skills score between gender was not statistically significant, $U(N_{Male}=7, N_{female} = 7), = 24.50, p=1.00$.

Table 3 Mann-Whitney data for Subtest Running, Speed and Agility, Balance, Bilateral Coordination, Strength, Upper Limb Coordination

Variable	Gender	Mann-Whitney	Mean Rank	Sum of Ranks	p-value
Running, Speed, and Agility	Male Female	2.500	10.64 4.36	74.50 30.50	0.004
Balance	Male Female	9.500	9.64 5.36	67.50 37.50	0.035
Bilateral Coordination	Male Female	24.500	7.50 7.50	52.50 52.50	1.000
Strength	Male Female	6.500	10.07 4.93	70.50 34.50	0.010
Upper Limb Coordination	Male Female	15.000	8.86 6.14	62.00 43.00	0.193
Respond speed subtest	Male Female	24.500	7.50 7.50	52.50 52.50	1.000
Visual-motor control subtest	Male Female	24.500	7.50 7.50	52.50 52.50	1.000
Upper-limb speed and dexterity subtest	Male Female	24.500	7.50 7.50	52.50 52.50	1.000

Table 3 above reported that males have the highest results compared to females. However, the different results are significant only for running, speed, agility, balance, and strength. A Mann-Whitney test indicated a statistically significant difference in running, speed, and agility between gender, $U(N_{Male}=7, N_{female} = 7), = 2.50, p=0.004$. In addition, a Mann-Whitney test indicated a statistically significant difference in balance between gender, $U(N_{Male}=7, N_{female} = 7), = 9.50, p=0.035$. Finally, a Mann-Whitney test indicated a statistically significant difference in strength between gender, $U(N_{Male}=7, N_{female} = 7), = 6.50, p=0.010$.

There are non-significant results reported for bilateral coordination, upper limb coordination, respond speed subtest, visual-motor control subtest, and upper-limb speed and dexterity subtest. A Mann-Whitney test indicated a statistically non-significant difference in bilateral coordination between gender, $U(N_{Male}=7, N_{female} = 7), = 24.50, p=1.000$. A Mann-Whitney test indicated a statistically non-significant difference in upper limb coordination between gender, $U(N_{Male}=7, N_{female} = 7), = 15.00, p=0.193$. In addition, there is a Mann-Whitney test indicated a statistically non-significant difference in response speed subtest between gender, $U(N_{Male}=7, N_{female} = 7), = 24.50, p=1.000$. A Mann-Whitney test indicated a statistically non-significant difference in visual-motor control subtest between gender, $U(N_{Male}=7, N_{female} = 7), = 24.50, p=1.000$. Finally, a Mann-Whitney test indicated a statistically non-significant difference in Upper-limb speed and dexterity subtest between gender, $U(N_{Male}=7, N_{female} = 7), = 24.50, p=1.000$.

DISCUSSION

To the authors' information seeking, no or very limited studies have investigated the test-retest reliability of the BOT-2 SF in youth with DS. One study by Wuang and Su (2009) seek the reliability of the BOT-2 CF in youth (ages 4 to 12 years old) with various causes of intellectual disabilities with the reliability ranging from 0.88 to 0.99. Additionally, the total score had an ICC of 0.99, indicating excellent reliability. The current study has shown that the male participants with DS had a better gross motor skills test than the female participants with DS but the fine motor skills test, shows there are no differences between both genders. For each subtest, the male participants expose better results than the female participants in the running, speed and agility subtest, balance subtest, strength subtest, and upper-limb coordination subtest. While for the bilateral coordination subtest, response speed subtest, visual-motor control, and upper-limb speed and dexterity, the findings in the current study show no difference between the male and female participants with DS. But compared to the age of the participants in the current study which are between 5 to 6 years old, the average age of the participants in this past study was 17.7 years old, which may have influenced motor skills, as older youths may have performed better on the BOT-2 SF when compared to younger individuals. Additionally, the level of intelligence of the participants was not evaluated in the both past and the current study, and therefore, the authors cannot determine if this factor impacted the assessment results (Nocera, Wood, Wozencroft & Coe, 2021).

For the gross motor skills test, the male participants with DS show better results than the female participants because in childhood and adolescence, and this is true with the past study that shows the males are generally more active than the female participants (Booth at el., 2016). Motor skills that involve skill outcomes, such as time, distance, power, or number of success for any activity and also focus on how the skill is performed (Burton & Miller, 1998)

For subtest running, speed, and agility, participants with DS can do the test because running was the extension of walking and they were executed the skills at early of development phase so that they can be performed well in running. In the study, it was reported that among the gross motor skills examined, running is the easiest since 60% of children would master this skill at age of 4 to 5 (Seefeldt & Haubenstricker, 1982).

Next, the development of the ability to balance the body among infants and children was a subject of considerable interest in the literature, beginning with a preliminary study (Figura, Cama, Capranica, Guidetti, & Pulejo, 1991). In this subtest, the male participants performed well than the female participants but, not at par with the able-bodied children. Same as able-bodied children. for bilateral coordination, jumping was a fundamental movement that occurs when the body is projected into the air by the force generated in one or both legs and the body lands on one or both feet (Payne, 2005). The past study did indicate that for the balance subtest, the intraclass correlation coefficients (ICC) for walking on a line (0.76) were much higher than the task of standing on a balance beam on one leg (0.10). The second task is more difficult in terms of balance and skill level, whereas walking online is a similar task to the type of walking that the participants do regularly. The low ICCs may simply be a function of the lack of exposure or practice of the participants in those particular tasks.

In the strength subtest, if the size and strength of motor skills are important, the males can have an advantage over the females because of their long limbs and have more muscular. (Thomas & French, 1985). Thus, it may be assumed that the males could have advantages an outcomes-based or product-oriented assessment may not favor the biological strength and size advantage of males as much in childhood. Then, for upper-limb coordination, catching involves "the use of hands to stop a tossed object" (Gallahue & Ozmun, 1998). It was an act of getting some object on the air by hand and arms after soaring the something object.

Other than that, for fine motor skills, the current study shows that is are no difference between the male and the female participants. The fine motor skills requiring eye-hand coordination, laterality, and visual-motor control were among the most advanced in these children (Connolly & Michael, 1986). In BOT-2 fine motor skill consists of response speed, visual-motor control, and upper-limb speed and dexterity.

For subtest response speed, the current study also shows the same outcome where both gender also has difficulty performing well. The major reason for the deficits in this area can be attributed to the characteristics of the slowness of reaction in children with DS (Magath & Berkson, 1960). This subtest required quick movements by the participants in addition to demanding hand-eye coordination. The current study also exposes the subtest visual-motor control and upper-limb speed and dexterity, both gender facing difficulty to perform the test because of the slower visual-motor control problems in them. The children with DS were less accurate in controlling movements than their age-equivalent peers (Davis & Scott Kelso, 1982). At the age of 5 years, the motor skill development of the child with DS is approximately two years behind that of the child without Down syndrome, and the performs many activities at 50% to 70% below the normal rate (Connolly & Michael, 1986). When comparing with the study by Tun, Aye & Kin (2021) using the Test of Gross Motor Development Second Edition (TGMD-2) for Children with Down syndrome also show the inter-rater reliability ICC for locomotor and object control raw scores were 0.94 and 0.95 which signified high or excellent reliability. The results of this study were similar to previous studies that were conducted with different study populations such as TDC, children with visually impaired (VI), and Intellectual disabilities (ID). All of these studies had excellent inter-rater reliability. An important limitation to the current study that should be noted is the small sample size and it is difficult to be recruited. Despite these limitations, the results of the current investigation demonstrate that this assessment is a reliable measurement tool for this population. All of the children enrolled in the current study appeared to be able to understand from the explanation and follow the directions for the BOT-2. Therefore, these findings may not be generalizable to all individuals with DS. Additionally, since normative data for this population have not been established, future research should develop standards specific to this population to better classify motor deficiencies.

CONCLUSION

This study was conducted to measure motor skills proficiency among children with DS at the Down Syndrome Association of Malaysia. The BOT-2, which is often used in a variety of settings, maybe a feasible assessment tool. Individuals who have disabilities may be similar to able-bodied individuals who are chronological younger. Many individuals who have disabilities have a short attention span and problems with complicated directions. Often, they cannot reliably test each other, even if the test lends itself to it because they don't count accurately nor are not good judges of properly executed performances. The development of fundamental motor skills is one of the primary goals of physical education programs. Fundamental motor skills do not develop automatically. Although certain fundamental motor skills evolve with growth and maturation, they are age-related, not age determined. Mature and advanced movement forms have resulted from instruction and practice. The results of this investigation suggest that the BOT-2 can be applied in the research setting to assess the motor proficiency of youth with DS. Future studies should emphasize DS children with a specific focus on a certain aspect of gross motor and fine motor proficiency with fitness elements.

RECOMMENDATIONS

Some recommendations can be outlaid in the current study such as a) these individuals need a special program that can make them exhibit better coordination of movement in fundamental motor skills such as gross and fine motor skills. The imbalance of both motor skills can contribute to deficits in their fundamental movement skill performance; b) the activity for children with Down syndrome at school or foundation also must be focused on how to overcome their weaknesses. For example, using the result of the current study, the teacher should know which part that their student cannot exhibit well and then the teacher can program or create an activity that can develop their weakness and can attract them to join further; c) The involvement of the children in sporting activity also is important. The sporting activity can influents the improvement and the development of gross motor skills. The lack of ability to perform fundamental motor skills competently was a constraint to the development of more advanced skills, and subsequently the comfortable participation in a wide range of sports, recreation, and leisure pursuits.

REFERENCES

Abdullah, N.M., Tumijan, W., Parnabas, V., Shapie, M.N.M., Mohamed. M., Hamid, N.A & Ahmad. A (2015) in S.I. Ismail et al. (eds.), *Proceedings of the 2nd International Colloquium on Sports Science, Exercise, Engineering and Technology 2015 (ICoSSEET 2015)*, DOI 10.1007/978-981-287-691-1_22.

Alesi, M. & Battaglia, G. (2019).Motor development and Down syndrome. *In InternationalReview of Research in Developmental Disabilities*, Lanfranchi, S., Ed.; Academic Press: Cambridge, MA, USA, Volume 56, pp. 169–211.

Bittles, A. H., Bower, C., Hussain, R., & Glasson, E. J. (2007). The four ages of Down syndrome. *European Journal of Public Health*, 17(2), 221-225.

Booth, M., Okely, A., Denney-Wilson, E., Hardy, L., Yang, B., & Dobbins, T. (2004). *NSW Schools Physical Activity and Nutrition Survey (SPANS) 2004-Summary Report*. Retrieved from Broadhead, G. D., & Bruininks, R. H. (1982). Childhood Motor Performance Traits on the Short Form Bruininks-Oseretsky Test. *Physical Educator, 39*(3), 149-155.

Burton, A.W. & Miller, D.E. *Movement Skill Assessment*; Human Kinetics: Champaign, IL, USA, 1998. Bruininks, R. H., & Bruininks, B. D. (2005a). Bruininks-Oseretsky test of motor proficiency (2nd ed.). Minneapolis, USA: Pearson Assessments.

Bruininks, R.H. & Bruininks, B.D. (2005). *Bruininks-Oseretsky Test of Motor Proficiency*, 2nd ed.; AGS Publishing: Circle Pines, MN, USA.

Capio, C. M., & Rotor, E. R. (2010). Fundamental movement skills among Filipino children with Down syndrome. *Journal of Exercise Science & Fitness*, 8(1), 17-24.

Connolly, B. H., & Michael, B. T. (1986). Performance of retarded children, with and without Down syndrome, on the Bruininks Oseretsky Test of Motor Proficiency. *Physical Therapy*, 66(3), 344-348.

Davis, W. E., & Scott Kelso, J. (1982). Analysis of "invariant characteristics" in the motor control of Down's syndrome and normal subjects. *Journal of Motor Behavior*, 14(3), 194-211.

Diaz, K.M. (2020). Physical activity and sedentary behavior among us children with and without Down syndrome. The National Survey of Children's Health. *Am. J. Intellect. Dev. Disabil*, 125, 230–242.

Esposito, P.E.; MacDonald, M.; Hornyak, J.E. & Ulrich, D.A. (2012).Physical activity patterns of youth with Down Syndrome. *Intellect. Dev. Disabil*, 50, 109–119.

Figura, F., Cama, G., Capranica, L., Guidetti, L., & Pulejo, C. (1991). Assessment of static balance in children. *J Sports Med Phys Fitness, 31*(2), 235-242.

Fox, B., Moffett, G.E., Kinnison, C., Brooks, G. & Case, L.E. (2019). Physical activity levels of children with Down Syndrome. *Pediatr. Phys. Ther*, 31, 33–41.

Gallahue, D. L., Ozmun, J. C., & Goodway, J. (2006). *Understanding motor development: Infants, children, adolescents, adults*: Boston.

Kazemi, M., Salehi, M., & Kheirollahi, M. (2016). Down syndrome: current status, challenges, and future perspectives. *International Journal of Molecular and Cellular Medicine*, 5(3), 125.

Kennedy, J., Brown, G.T. & Chien, C. (2012). Motor skill assessment of children: Is there an association between performance-based, child-report, and parent-report measures of children's motor skills? *Physical & Occupational Therapy in Pediatrics*,32(2): 196–209.

Lam, M.Y., Rubin, D.A., White, E., Duran, A.T. & Rose, D.J.(2018). Test-retest reliability of the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition for youth with Prader-Willi syndrome. *Ann. Phys. Rehabil. Med*, 61, 355–357.

Lubans, D. R., Morgan, P. J., Cliff, D. P., Barnett, L. M., & Okely, A. D. (2010). Fundamental movement skills in children and adolescents. *Sports Medicine, 40*(12), 1019-1035.

Lucas, B.R., Latimer, J., Doney, R., Ferreira, M.L., Adams, R., Hawkes, G., Fitzpatrick, J.P., Hand, M., Oscar, J., Carter, M., et al. (2013). The Bruininks-Oseretsky test of motor proficiency-short form is reliable in children living in remote Australian Aboriginal communities. *BMC Pediatr*, 13, 135.

Nocera, V.G., Wood, A.P., Wozencroft, A.J. & Coe, D.P.(2021). The Test-Retest Reliability of the Bruininks–Oseretsky Test of Motor Proficiency-Short Form in Youth with Down syndrome—A Pilot Study. *Int. J. Environ. Res. Public Health*, 18, 5367. https://doi.org/10.3390/ ijerph18105367.

Magath, T. B., & Berkson, J. (1960). Electronic blood-cell counting. *American Journal of Clinical Pathology, 34*(3), 203-213.

Murray, J. & Ryan-Krause, P. (2010). Obesity in children with Down syndrome: Background and recommendations for management. *Pediatr. Nurs*, 36, 314–319.

Ogden, C.L., Carroll, M.D., Lawman, H.G., Fryar, C.D., Kruszon-Moran, D., Kit, B.K. & Flegal, F.M. (2016).Trends in Obesity Prevalence among Children and Adolescents in the United States, 1988–1994 through 2013–2014. *JAMA*, 315, 2292–2299.

Palomba, A., Perez, D., & Tafuri, D. (2020). Evaluating the quality of life in people with Down Syndrome: a literature review. *Sport Science*, 13, Suppl 1: 52-57.

Payne, R. (2005). Special Education Teacher Shortages: Barriers or Lack of Preparation? *International Journal of Special Education, 20*(1), 88-91.

Rimmer, J.H., Yamaki, K., Davis, B.M., Wang, E. & Vogel, L.C.(2011). Obesity and overweight prevalence among adolescents with disabilities. *Prev. Chronic Dis*, 8, A41.

Rimmer, J.H., Yamaki, K., Lowry, B.M.D., Wang, E. & Vogel, L.C. (2010). Obesity and obesity-related secondary conditions in adolescents with intellectual/developmental disabilities. J. *Intellect. Disabil. Res*, 54, 787–794.

Ruiz-González, L., Lucena-Antón, D., Salazar, A., Martín-Valero, R. & Moral-Munoz, J.A.(2019). Physical therapy in Down syndrome: Systematic review and meta-analysis. *J. Intellect. Disabil. Res*, 63, 1041–1067.

Shields, N., Plant, S., Warren, C., Wollersheim, D., & Peiris, C. (2018). Do adults with Down syndrome do the same amount of physical activity as adults without disabilities? A proof of principle study. *Journal of Applied Research in Intellectual Disabilities*, 31(3), 459-465.

Spiegel, A. N., Steffens, K. M., Rynders, J. E., & Bruininks, R. H. (1990). The early motor profile: Correlation with the Bruininks-Oseretsky test of motor proficiency. *Perceptual and Motor skills, 71*(2), 645-646.

Styles, M.E., Cole, T.J., Dennis, J. & Preece, M.A. (2002). New cross-sectional stature, weight, and head circumference references for Down's syndrome in the UK and Republic of Ireland. *Arch. Dis. Child*, 87, 104–108.

Seefeldt, V., & Haubenstricker, J. (1982). Patterns, phases, or stages: An analytical model for the study of developmental movement. *The Development of Movement Control and Coordination*, 309, 318.

Thomas, J. R., & French, K. E. (1985). Gender differences across age in motor performance: A meta-analysis. *Psychological Bulletin*, *98*(2), 260.

Tun, M.T., Aye, T., & Khin, M.T. (2021). Inter-rater reliability of the Test of Gross Motor Development Second Edition (TGMD-2) for Children with Down syndrome: A Pilot Study. *J. Asi. Reha. Sci*, 4(3): 39-46.

Ulrich, D. A. (2013). The test of gross motor development-3 (TGMD-3): Administration, scoring,, and international norms. *Spor Bilimleri Dergisi*, 24(2), 27-33.

Villarroya, M. A., González-Agüero, A., Moros-García, T., de la Flor Marín, M., Moreno, L. A., & Casajús, J.A. (2012). Static standing balance in adolescents with Down syndrome. *Research in Developmental Disabilities*, 33(4), 1294-1300.

Whitt-Glover, M.C., O'Neill, K.L. & Stettler, N. (2006).Physical activity patterns in children with and without Down syndrome. *Pediatr. Rehabil*, 9, 158–164.

Wuang, Yee-Pang, & Su, Cheng-Yng. (2009). Reliability and responsiveness of the Bruininks–Oseretsky Test of Motor Proficiency-Second Edition in children with intellectual disability.*Research in Developmental Disabilities*, 30, 5, 847-855.

Yochman, A., Ornoy, A., & Parush, S. (2006). Co-occurrence of developmental delays among preschool children with attention-deficit-hyperactivity disorder. *Developmental Medicine & Child Neurology*, 48(6), 483-488.