Pertanika J. Soc. Sci. & Hum. 28 (3): 2465 - 2475 (2020)

SOCIAL SCIENCES & HUMANITIES

Journal homepage: http://www.pertanika.upm.edu.my/

Fundamental Motor Skills Proficiency in Children with Down Syndrome

Wan Hazree Wan Zakaria[1]*, Hosni Hasan[1] and Noor Azila Azreen Md Radzi[2]

[1]Faculty of Sport Science & Recreation, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia
[2]Faculty of Sport Science & Recreation, Seremban Campus, Universiti Teknologi MARA, 70300 Seremban, Negeri Sembilan, Malaysia

ABSTRACT

Subsets of motor skills proficiency are evaluated based on bilateral coordination, balance, running speed and agility, upper-limb coordination and strength. This study was designed to determine the correlation of motor skills proficiency subsets among children with Down syndrome. Thirty-three participants (N = 33, 23 boys and 10 girls) aged 4–12 years underwent selected motor skills proficiency subtests of the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition, Short Form. The measurements included synchronised jumping in place on same side, synchronised tapping of feet and fingers on same side, walking forward on a line, standing on one leg on a balance beam with eyes open, one-legged stationary hop, dropping and catching a ball with both hands, dribbling a ball with alternating hands, knee push-ups, and sit-ups. Running speed and agility were found to be moderately correlated with upper-limb coordination ($r = 0.36$, $p < 0.05$). There was no significant relationship between gross motor composite of body control (bilateral coordination subtest and balance subtest) and gross motor composite of strength (running speed and agility subtest, and strength subtest). The motor skills proficiency parameters identified in this study will influence the motor development of children with Down syndrome and therefore, a goal-directed conditioning program can be prepared for their motor progression.

Keywords: Children with down syndrome, motor function, motor skills proficiency, physical performance

ARTICLE INFO

Article history:
Received: 26 April 2019
Accepted: 6 April 2020
Published: 25 September 2020

E-mail addresses:
whee182@yahoo.com (Wan Hazree Wan Zakaria)
hosnihasan@uitm.edu.my (Hosni Hasan)
azila_azreen7172@ns.uitm.edu.my (Noor Azila Azreen Md Radzi)
*Corresponding author

ISSN: 0128-7702
e-ISSN 2231-8534

INTRODUCTION

Down syndrome (DS) is a medical anomaly characterised by three copies of chromosome 21 (Pitetti et al., 2013). It is highly associated with delayed developmental milestones especially in the motor skills development (Gupta et al., 2011; Volman et al., 2007; Wang & Ju, 2002). Physical activities involving extensive motor skills such as jumping, influences the developmental milestones of children with DS. Standing broad jump is an example of a locomotive fundamental movement skill (FMS), a building block of an active lifestyle for individuals (Gallahue et al., 2006).

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. Focusing only on the motor control system of the musculoskeletal system, the delayed motor development among children with DS is attributed to joint hyperextensibility and muscle hypotonia (Capio & Rotor, 2010; Haley, 1986, 1987; Rast & Harris, 1985; Wang & Ju, 2002) or specifically poor hip abductors and knee extensors (Mercer & Lewis, 2001; Pitetti et al., 2013).

In healthy children, Jiang et al. (2017) reported that static balance, dynamic balance, proprioception, and gross motor development level of locomotor skills and object control skills increased with age. However, children with DS have different development of motor skills. The performance of most motor tasks during early childhood favour boys over girls due to biological and environmental causes as reported in the meta-analysis study of gender differences in motor performance (Thomas & French, 1985). The endocrine system, physical development, and a child's perception of gender role determines their performance on motor tasks.

Motor developments are analysed using extensive performance instruments with functional relevance to the test content. Referring to the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2) (Bruininks & Bruininks, 2005a), motor skills proficiency is categorised 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). Psychometric studies of the BOT-2 instrument were conducted according to focused parameters (Brown, 2019; Carmosino et al., 2014; Venetsanou et al., 2009). Hasan et al. (2012) did a study on gross motor development in Malaysia using a different study instrument; the Test of Gross Motor Development-2 (TGMD-2) (Ulrich, 2000), which tested locomotor skills and object control skills in children with DS. Subtests of motor skills proficiency such as bilateral coordination, balance, running speed and agility, upper-limb coordination, and strength contribute to the standing broad jump movement framework.

There is limited research analysing the motor skills proficiency in children with DS. Previous studies done on a subset of children demonstrated that they performed poorly on motor skills proficiency (Bellows et al., 2017; Hasan et al., 2012; Westendorp et al., 2011), including balance, object control skills (Bellows et al., 2017), and locomotor skills (Hasan et al., 2012; Westendorp et al., 2011). Bellows et al. (2017) measured the motor skills proficiency of typical developing children with low socioeconomic status, Hasan et al. (2012) examined the motor development of children with DS, and Westendorp et al. (2011) analysed the motor competence of children with learning disabilities. In terms of gender comparison, Hasan et al. (2012) reported that although there was a strong correlation between locomotor skills and object control skills, there was no significant difference between boys and girls with DS in object control skills and locomotor skills. On the contrary, there was significant difference between typical developing boys and girls in upper-limb coordination (object control skills) and running speed and agility (locomotor skills) (Duger et al., 1999). However, Duger et al. (1999) found no significance difference between genders on other motor skills proficiency subsets such as balance, bilateral coordination and strength.

This study placed emphasis on motor skills proficiency assessment among children with DS using Bruininks-Oseretsky Test of Motor Proficiency, Second Edition, Short Form, (BOT-2-SF) (Bruininks & Bruininks, 2005a), and explored the descriptive analysis and correlation of motor skills proficiency subsets to identify the key areas of their delayed motor developmental milestones. It is crucial to establish FMS or early motor functions to master further dynamism of motor behaviour. Apart from environmental conditions, the interactions between the motor functions and the biology of individual, such as gender, also affect motor development (Gallahue et al., 2006). Therefore, gaining more research evidence related to fundamental motor development in children with DS would also improve the index of the study instrument.

The purpose of this study was to assess the motor skills proficiency subsets among children with DS aged 4–12 years in the Klang Valley using BOT-2-SF. The difference of genders and their correlation with motor skills proficiency subsets were also investigated.

METHODS

This is a cross-sectional study and the procedures of this study was approved by the Research Ethics Committee of Universiti Teknologi MARA (600-IRMI (5/1/6)).

Participants

Thirty-three participants consisting of children with DS (N = 33); aged between 4 to 12 years old were selected from institutions for DS in the Klang Valley. Twenty-three boys with DS with the mean age of 9.54 ± 2.27 years old and 10 girls with DS with the mean age of 8.35 ± 2.94 years old were recruited for this study. The sample size corresponded to previous local studies of Hasan et al. (2012) and Teng (2012). The recruited participants healthy (no chronic diseases), with body mass index (BMI) in the normal or underweight category, as calculated through the formula of participant's weight in kilogram divided by the square of height in meters (de Miguel-Díez et al., 2003). The recruited boys with DS had a mean BMI of 17.73 ± 2.50 kg/m^2, whilst the girls with DS had a mean BMI of 17.76 ± 4.25 kg/m^2. The selected children with DS acknowledged their involvement in the study with prior active consent from their parents or guardians. They also screened with the Physical Activity Readiness Questionnaire for Children (PAR-Q) (Limerick University Department of Physical Education and Sport Sciences, n.d).

Instrumentation

The performance measurements used were selected subtests of BOT-2-SF in accordance to the test guidelines. These consisted of nine motor skills proficiency tests; the evaluation of body control composite of bilateral coordination subtest (synchronised jumping in place on same side, and synchronised tapping of feet and fingers on same side), body control composite of balance subtest (walking forward on a line and standing on one leg on a balance beam with eyes open), gross manual control composite of upper-limb coordination subtest (dropping and catching ball with both hands, and dribbling ball with alternating hands), strength and agility composite of running speed and agility subtest (one-legged stationary hop), and strength and agility composite of strength subtest (knee push-ups and sits-up). The study was equipped with apparatus such as table, chair, paper tape, balance beam, tennis balls, mat, and measuring tape.

Procedures

The performance measurement testing was organised into five stations according to the subtests: Station 1 (bilateral coordination subtest), Station 2 (balance subtest), Station 3 (running speed and agility subtest), Station 4 (upper-limb coordination subtest), and final base is Station 5 (strength subtest).

The testers were individuals who had conducted both the familiarisation process and evaluation of the performance measurements on the study participants. The tester's evaluation process of the study instrument was crosschecked prior to the testing. The familiarisation process of skill demonstrations and verbal instructions were standardised according to the Administration Easel of the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (Bruininks & Bruininks, 2005b). Each participant was evaluated through nine performance measurement tests, and expected to spend about an hour to complete all five stations.

RESULTS

The performance measurement outcomes were assessed through the selected BOT-2-SF subtests. In determining group effect, the effect size, *Cohen d,* of the analysed gender groups were calculated for each dependent variable in accordance to Thalheimer and Cook (2002). The effect size is described as small if $d \geq 0.2 < 0.5$, moderate if $d \geq 0.5 < 0.8$, and large if $d \geq 0.8$ (Cohen, 1988). Correlation analysis between the motor skills proficiency subsets were measured using Pearson correlation coefficient, *r*. The correlation coefficient is described as small if $r \geq 0.10 \leq 0.29$, medium if $r \geq 0.30 \leq 0.49$, and large if $r \geq 0.50 \leq 1.0$ (Cohen, 1988).

Descriptive Categories of Motor Skills Proficiency

The descriptive ratings of the participants' performance are presented in Table 1. The total score was the summation of the scores of the BOT-2-SF subtests (bilateral coordination, balance, running speed and agility, upper-limb coordination, and strength). Table 1 shows that most participants performed below average in the performance measurements of BOT-2-SF subtests and only 38.2% of them managed to achieve the best performance at the average level.

Comparison Between Genders on the Motor Skills Proficiency Subsets

The gender difference on the motor skills proficiency subsets is shown in Table 2. The results of this study showed that there was no statistical significance between the performance of boys and girls with DS in the subtests of BOT-2-SF (bilateral coordination, balance, running speed and agility, upper-limb coordination, and strength). Gender difference on motor skills proficiency subsets of gross motor composites is shown in Table 3. There was also no statistical significance between the performance of boys and girls with DS in the assessment of BOT-2-SF gross motor composite of body control and gross motor composite of strength and agility. All motor subtests and gross motor composites had moderate effect sizes except strength subtest and body control composite, which had small sizes respectively for gender groups. The bilateral coordination subtest had a relatively small effect size (Cohen, 1988).

Table 1
Descriptive ratings for participants (N = 33)

Total scale score point	Descriptive category	Total	Percentage (%)
45–55	Well-Above Average	0	0
34–44	Above Average	0	0
23–33	Average	12	38.2
12–22	Below Average	21	61.8
1–11	Well-Below Average	0	0

Table 2

The gender frequency distribution of the subtests of BOT-2-SF (N_{Total} = 33)

	Boys with DS, N = 23		Girls with DS, N = 10		Cohen *d*
	M±SD	Min-Max	M±SD	Min-Max	
BC	4.26±0.96	3–7	4.55±1.08	3–7	0.14
BA	7.48±1.34	3–8	6.91±1.32	4–8	0.53[b]
RS	3.13±1.71	0–6	2.00±1.48	0–5	0.58[b]
UC	4.52±3.09	0–8	2.60±2.27	0–8	0.67[b]
ST	3.65±1.58	2–7	3.00±1.33	2–6	0.44[c]

Note: BOT-2-SF: Bruininks-Oseretsky Test of Motor Proficiency, Second Edition, Short Form; M: mean; SD: standard deviation; BC: bilateral coordination; BA: balance; RS: running speed and agility; UC: upper-limb coordination; ST: strength. Effect sizes were calculated by dividing the mean difference between boys and girls by the pooled standard deviation of both groups. Pooled standard deviation was calculated as the square root of the pooled estimate of the population variance.

$[\ SD^2 = ((N_{Boy} - 1) \text{ x } SD_{Boy}) + ((N_{Girl} - 1) \text{ x } SD_{Girl}) / (N_{Boy} + N_{Girl})]$

[a] Cohen *d* value ≥ 0.8 indicates a large effect size

[b] Cohen *d* value ≥ 0.5 < 0.8 indicates a moderate effect size

[c] Cohen *d* value ≥ 0.2 < 0.5 indicates a small effect size

Table 3

The gender frequency distribution of the BOT-2-SF gross motor composite of body control, gross motor composite of strength and agility (N_{Total} = 33)

	Boys with DS, N = 23		Girls with DS, N = 10		Cohen *d*
	M±SD	Min-Max	M±SD	Min-Max	
BC	11.74±1.71	7–15	11.20±1.40	8–13	0.34[c]
SA	6.78±2.04	2–11	5.20±2.44	3–11	0.75[b]

Note: BOT-2-SF: Bruininks-Oseretsky Test of Motor Proficiency, Second Edition, Short Form; M: mean; SD: standard deviation; BC: body control; SA: strength and agility.

[a] Cohen *d* value ≥ 0.8 indicates a large effect size

[b] Cohen *d* value ≥ 0.5 < 0.8 indicates a moderate effect size

[c] Cohen *d* value ≥ 0.2 < 0.5 indicates a small effect size

Correlation Within Motor Skills Proficiency Subtests of BOT-2-SF and Correlation Between Gross Motor BOT-2-SF Composite of Body Control and Composite of Strength and Agility

The correlation between the subset of motor skills proficiency is shown in Table 4. Only the upper-limb coordination subtest had a positive moderate association with the running speed and agility subtest (r = 0.36, $p < 0.05$) and there was no significant relationship between other motor skills proficiency subsets. Comparison between the association of gross motor composite body control and composite strength and agility showed that there was no significant relationship between the composite of body control and composite of strength and agility (r = 0.16)

Table 4

Bivariate correlations between BOT-2-SF subtests of bilateral coordination, balance, running speed and agility, upper-limb coordination, and strength (N = 33)

	BC	BA	RS	UC
BA	-0.06			
RS	-0.24	0.27		
UC	-0.17	0.18	**0.36***	
ST	-0.03	0.20	-0.01	0.28

*$p < 0.05$

Note: BOT-2-SF: Bruininks-Oseretsky Test of Motor Proficiency, Second Edition, Short Form; BC: Bilateral coordination; BA: Balance; RS: Running speed and agility; UC: Upper-limb coordination; ST: Strength.

DISCUSSION

This study served to determine two objectives: (i) to compare the subsets of motor skills proficiency in 23 boys and 10 girls with DS; (ii) to investigate the relationship between motor skills proficiency subsets in the motor skills proficiency development of children with DS.

More than half of the participants had below average results. They scored poorly on all motor subtests; bilateral coordination (M = 4.30 ± 0.98), balance (M = 7.27 ± 1.35), running speed and agility (M = 2.85 ± 1.68), upper-limb coordination (M = 3.94 ± 2.97), and strength (M = 3.45 ± 1.52). These motor skills proficiency results were in agreement with studies done by Hasan et al. (2012), Bellows et al. (2017), and Westendorp et al. (2011). Hasan et al. (2012), who had assessed the gross motor development of 30 children with DS aged 3–10 years demonstrated that 60% of the participants did not achieve average level of gross motor development of TGMD-2, including poor performance on locomotor skills (M = 6.03 ± 3.34) and average performance on object control skills (M =

9.60 ± 3.63). Using BOT-2, Bellows et al. (2017) who did a longitudinal study, found that typical developing children with low socio-economic status scored significantly low on balance (p = 0.016, N = 226), with upper-limb coordination (p < 0.001, N = 227) at the baseline, and even after a two-year follow up. The mean score of balance for all participants (N = 175) and the upper-limb coordination of the control group (N = 66) were significantly lower than the normative sample ($p \leq 0.001$). In a different study, 104 children with learning disabilities scored significantly lower on TGMD-2 of locomotor skills (M = 37.7 ± 4.4, p < 0.001) and object control (M = 34.7 ± 5.6, p < 0.001) (Westendorp et al., 2011).

The poor prevalence of motor performance in this study confirms poor or delayed motor development milestone in children with DS. Their low score in strength, balance and bilateral coordination suggested that the children had muscle hypotonia and poor coordination. The results reflected their disordered musculoskeletal system with low muscle tone and symmetry, laxity of tendons, and instability of articulations on their delayed motor development (Malak et al., 2015). It also reported that the poor motor development was due to the delayed in the development of the motor control system of central nervous system. Therefore, it is thought that these resulted in the psychomotor development delayed although children with DS are often scored by psychologist as being within the mild to moderate range of mental impairment (Malak et al., 2013).

The insignificant finding on gender performance on the selected BOT-2-SF motor subtests and BOT-2-SF gross motor composite was supported by Hasan et al. (2012). There was also no significant relationship between gender and locomotor skills (p = 0.70, N_{Boy} = 16, N_{Girl} = 14), and object control skills (p = 0.96, N_{Boy} = 16, N_{Girl} = 14) (Hasan et al., 2012). Our findings demonstrate the insignificant biological factor on motor performance among the study participants, and imply that environmental factor may play a larger role in motor development. A local study on predominantly Malay-Malaysian women with DS, ranging 1-40 years old with median age 12.7, attained menarche at median age of 12.18 years old (Yaacob et al., 2012). Therefore, the effect of endocrinology on motor development in children with DS is inconclusive. However, environmental factors such as physical conditioning or intervention may play a role in motor progression.

The correlation between running speed agility and upper-limb coordination found in this study had been further validated by Hasan et al. (2012) and Westendorp et al. (2011). Hasan et al. (2012) found a strong positive association between locomotor skills (running speed and agility) and object control skills (upper-limb coordination) (r = 0.608, p = 0.00) when he and colleagues assessed the gross motor development of children with DS. Westendorp et al. (2011) demonstrated a positive relationship between locomotor skills and object control skills (r = 0.27, p < 0.01) among children with learning disability. Our finding of the correlation between running speed and agility with upper-limb coordination signifies the importance of functional skills integration of skill-handling while maintaining body stability and space orientation. The functional skills of stability, locomotor skill, and object control skill involve multiple body segments orientation and kinematics dynamic during the performance. Therefore, the correlation of motor skills proficiency subsets proved that functional skills integration was required in the dynamics of motor development of children with DS. The absence of correlation among other motor skills proficiency subtests and gross motor composites may be due to the group analysis of this study, as the composite comparison annotates the individual's strengths and weaknesses (Bruininks & Bruininks, 2013).

One of the limitations in this study was that the sample size was small, which might have prevented BOT-2 from providing a more in-depth motor proficiency assessment corresponding to age and gender. Secondly, as the data collection was gathered from the instrument's scores, maximum performance may not be attainable. For instance, ball dribbling without alternating hands was sufficient to be given a passing score. Previous motor proficiency studies faced similar problems when using similar methods of data collection (Castetbon & Andreyeva, 2012). This study estimates had not fully conformed to the study instrument protocol, due to the resources available. Therefore, the formal descriptive category of study instrument produced was not in conformance to formal data reporting of BOT-2-SF and the selected performance measurements were not framed according to the standard assessment of BOT-2-SF.

CONCLUSIONS

This study was conducted to measure motor skills proficiency among children with DS in the Klang Valley. Most of the children (61.8%) were lacking in motor competency. Boys and girls with DS showed no significant differences in motor proficiency. There was a positive relationship between upper-limb coordination, running speed and agility. With complementary data, a goal-directed developmental conditioning could be developed for the motor progression of children, especially with DS. Future research should emphasise on the gross motor training of DS children with specific focus on strength proficiency with element of longitudinal progression-conditioning protocol.

ACKNOWLEDGMENTS

The authors would like to thank Universiti Teknologi MARA for the study grant of *Geran Inisiatif Penyeliaan* (600-IRMI 5/3/ GIP (019/2018) in funding this research. They would like to extend their gratitude to the organisations involved in the success of this study, particularly *Persatuan Sindrom Down Malaysia*, Kiwanis Down Syndrome Foundation, *Persatuan Kebajikan Anak-Anak Istimewa Selangor* (ORKIDS), and *Persatuan Kanak-Kanak Istimewa Hulu Langat*.

REFERENCES

Bellows, L. L., Davies, P. L., Courtney, J. B., Gavin, W. J., Johnson, S. L., & Boles, R. E. (2017). Motor skill development in low-income, at-risk preschoolers: A community-based longitudinal intervention study. *Journal of Science and Medicine in Sport*, *20*(11), 997-1002.

Brown, T. (2019). Structural validity of the Bruininks-Oseretsky test of motor proficiency–Second edition brief form (BOT-2-BF). *Research in Developmental Disabilities*, *85*, 92-103.

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. (2005b). *Bruininks-Oseretsky test of motor proficiency: Administration easel* (2nd ed.). Minneapolis, USA: Pearson Assessments.

Bruininks, R. H., & Bruininks, B. D. (2013). *BOT2: Bruininks-Oseretsky test of motor proficiency: Complete form sample report.* [Sample Case]. Retrieved Jun 21, 2017, from https://images.pearsonclinical.com/images/Assets/BOT-2/BOT-2_Complete_Form_Sample_Report.pdf

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.

Carmosino, K., Grzeszczak, A., McMurray, K., Olivo, A., Slutz, B., & Jayne, C. (2014). Test items in the complete and short forms of the BOT-2 that contribute substantially to motor performance assessments in typically developing children 6-10 years of age. *Journal of Student Physical Therapy Research, 7*(2), 32-43.

Castetbon, K., & Andreyeva, T. (2012). Obesity and motor skills among 4 to 6-year-old children in the United States: Nationally-representative surveys. *BMC Pediatrics*, *12*(1), 28.

Cohen, J. (1988). *Statistical power analysis for the behavioural science* (2nd ed.). New York, USA: Academic Press.

de Miguel-Díez, J., Villa-Asensi, J. R., & Álvarez-Sala, J. L. (2003). Prevalence of sleep-disordered breathing in children with Down syndrome: Polygraphic findings in 108 children. *Sleep*, *26*(8), 1006-1009.

Duger, T., Bumin, G., Uyanik, M., Aki, E., & Kayihan, H. (1999). The assessment of Bruininks-Oseretsky test of motor proficiency in children. *Pediatric Rehabilitation*, *3*(3), 125-131.

Gallahue, D. L., Ozmun, J. C., & Goodway, J. (2006). *Understanding motor development: Infants, children, adolescents, adults* (7th ed.). New York, USA: McGraw-Hill.

Gupta, S., Rao, B. K., & Kumaran, S. D. (2011). Effect of strength and balance training in children with Down's syndrome: A randomized controlled trial. *Clinical Rehabilitation*, *25*(5), 425-432.

Haley, S. M. (1986). Postural reactions in infants with Down syndrome: Relationship to motor milestone development and age. *Physical Therapy*, *66*(1), 17-22.

Haley, S. M. (1987). Sequence of development of postural reactions by infants with Down syndrome. *Developmental Medicine & Child Neurology*, *29*(5), 674-679.

Hasan, H., Abdullah, N. M., & Suun, A. (2012). The assessment of gross motor skills development among Down syndrome children in Klang Valley. In *2012 IEEE Symposium on Humanities, Science and Engineering Research* (pp. 217-221). n.p.: IEEE. doi: 10.1109/SHUSER.2012.6268854

Jiang, G. P., Jiao, X. B., Wu, S. K., Ji, Z. Q., Liu, W. T., Chen, X., & Wang, H. H. (2017). Balance, proprioception, and gross motor development of Chinese children aged 3 to 6 years. *Journal of Motor Behaviour*, *50*(3), 343-352.

Limerick University Department of Physical Education and Sport Sciences (n.d.). *Physical Activity Readiness Questionnaire (PAR-Q) for children*. Retrieved September 21, 2017, from https://www.ul.ie/pess/research-ethics/par-q

Malak, R., Kotwicka, M., Krawczyk-Wasielewska, A., Mojs, E., & Samborski, W. (2013). Motor skills, cognitive development and balance functions of children with Down syndrome. *Annals of Agricultural and Environmental Medicine*, *20*(4), 803-806.

Malak, R., Kostiukow, A., Krawczyk-Wasielewska, A., Mojs, E., & Samborski, W. (2015). Delays in motor development in children with Down syndrome. *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research*, *21*, 1904-1910.

Mercer, V. S., & Lewis, C. L. (2001). Hip abductor and knee extensor muscle strength of children with and without Down syndrome. *Paediatric Physical Therapy*, *13*(1), 18-26.

Pitetti, K., Baynard, T., & Agiovlasitis, S. (2013). Children and adolescents with Down syndrome, physical fitness and physical activity. *Journal of Sport and Health Science*, *2*(1), 47-57.

Rast, M. M., & Harris, S. R. (1985). Motor control in infants with Down syndrome. *Developmental Medicine & Child Neurology*, *27*(5), 682-685.

Teng, S. L. (2012). *Effect of balance and posture control intervention on gross motor development of Down syndrome children in Federal Territory of Kuala Lumpur* (Doctoral thesis). Available from Universiti Putra Malaysia Institutional Repository (UPMIR). (Record No. FPP 2012 16)

Thalheimer, W., & Cook, S. (2002). *How to calculate effect sizes from published research articles: A simplified methodology*. Retrieved February 15, 2019, from http://www.bwgriffin.com/gsu/courses/edur9131/content/Effect_Sizes_pdf5.pdf

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

Ulrich, D. A. (2000). *TGMD 2–test of gross motor development examiner's manual* (2nd ed.). Austin, USA: Pro-ED.

Venetsanou, F., Kambas, A., Aggeloussis, N., Fatouros, I., & Taxildaris, K. (2009). Motor assessment of preschool aged children: A preliminary investigation of the validity of the Bruininks–Oseretsky test of motor proficiency–short form. *Human Movement Science*, *28*(4), 543-550.

Volman, M. J., Visser, J. J., & Lensvelt-Mulders, G. J. (2007). Functional status in 5 to 7-year-old children with Down syndrome in relation to motor ability and performance mental ability. *Disability and Rehabilitation*, *29*(1), 25-31.

Wang, W. Y., & Ju, Y. H. (2002). Promoting balance and jumping skills in children with Down syndrome. *Perceptual and Motor Skills*, *94*(2), 443-448.

Westendorp, M., Hartman, E., Houwen, S., Smith, J., & Visscher, C. (2011). The relationship between gross motor skills and academic achievement in children with learning disabilities. *Research in Developmental Disabilities*, *32*(6), 2773-2779.

Yaacob, N., Nasir, N. M., Jalil, S. N., Ahmad, R., Rahim, N. A. R. A., Yusof, A. N. M., & Ghani, N. A. A. (2012). Parents or caregiver's perception on menstrual care in individuals with Down syndrome. *Procedia - Social and Behavioral Sciences*, *36*, 128-136.