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Early childhood fundamental motor skills: visual impairments and non-visually impaired

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Abstract

The purpose of this study was to test fundamental motor skills (FMS) in young children with visual impairments (VI) and non-VI children. This study used a cross-sectional design, descriptive-analytic with purposive sampling. Children without VI showed higher locomotor skills (M= 21.38, SD= 6.69) when compared to children with VI (M= 9.70, SD= 3.09). Children without VI showed higher ball skills (M = 18.74, SD = 6.54) when compared to children with VI (M = 5.23, SD = 5.44)). For locomotor skills there was a significant effect on vision (F=17.55, p=.014, η2=.31). For children with VI, birth control (n=7) performed higher (M=10.33, SD=10.54) compared to non-birth VI (n=3; M 4.02, SD=2, 73). For ball skills there was a significant effect on vision (F=21.99, p<0.001, η2=.56). For children with VI, congenital VI (n=7) performed higher (M=6.73, SD=6.69) than non-congenital blind (n=3; M=2.05, SD=1.01). Non-blind children show higher levels of FMS when compared to children with VI. The children with VI in this sample exhibited profound developmental delays requiring further investigation and future intervention.

Keywords: *Visual Impairments, locomotor skills, ball skills, fundamental motor skills.*

INTRODUCTION

Fundamental motor skills (FMS), usually classified as means of motion (eg running, one leg jump, and jumping) and ball skills (eg, throwing, catching and kicking), are also known as “building blocks” for more advanced motion patterns, participation physical activity, as well as sports and games (Clark & Metcalfe, 2002). Learning FMS must be at an early age because it is a crucial time (Brian, Pennell, Taunton, et al., 2019). If children do not learn FMS at an early age, it will result in delays in the development of gross motor skills (Solihin et al., 2020; Widyawan, 2020), may have difficulty trying to learn FMS at a later date (Brian, Pennell, Taunton, et al., 2019; Clark & Metcalfe, 2002). Delays in FMS at an early age often result in persistent developmental delays over time from

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early childhood to adolescence (Robinson et al., 2015). Developmental delay, which lasts into adolescence, can have a negative and recurring effect with health-enhancing behaviors such as physical activity (Stodden et al., 2008), makes individuals with developmental delays more susceptible to hypokinetic diseases (eg, type 2 diabetes, metabolic syndrome, etc.).

Unlike age, socioeconomic status and location, the presence of documented persons with disabilities increases the risk of delays in the development of FMS in early childhood (Brian, Taunton, et al., 2019), regardless of the type of disability (Kim et al., 2016; Taunton et al., 2017). However, children with visual impairments (VI), including those who are blind or have low vision, often show severe developmental delays (<5th percentile) with FMS (Haegele et al., 2015), which is often much deeper than peers without disabilities (Wagner et al., 2013). Interestingly, gender and age did not tend to influence the FMS of young people with VI; However, the degree of vision almost always plays a role (Brian, Pennell, Haibach-Beach, et al., 2019). Often, as vision improves, so do FMS (Brian et al., 2020; Brian, Pennell, Haibach-Beach, et al., 2019; Brian et al., 2018).

In order to understand the nuances of how vision affects the development of FMS, we must first explore the often-debated views surrounding the way motor skill learning occurs. The development and learning of motor skills is not age dependent (Nagarkatte & Oley, 2018). From a dynamic systems and constraint theory perspective (Nagarkatte & Oley, 2018), learning motor skills is the result of dynamic and transactional interactions between the three constraints: tasks, environment, and organisms. Theoretically, to maximize motor skill learning, organisms need to experience developmentally appropriate tasks that accommodate functional and structural constraints in a given environment. After experiencing developmentally appropriate tasks, the motor control system will then self-regulate to create the movement patterns necessary for motor competence. Without positive learning experiences, or opportunities

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to practice FMS, individuals will not learn FMS naturally as a result of time. (Brian et al., 2017, 2018; Gagen & Getchell, 2006; Shmuelof et al., 2012). However, it is possible that children with VI have difficulty learning FMS because they do not experience opportunities to do what they develop in a safe and positive environment (Widyawan et al., 2020; Widyawan & Sina, 2021).

Given that children with VI are especially at risk of experiencing difficulties with FMS, which may have further health consequences in the future, it is important to better understand how FMS of young children with VI develop compared to their non-VI peers. Furthermore, this is the first test of the FMS of young children with VI. Thus, this data can provide insight into the potential development of adolescents with VI and provide recommendations for timing of interventions, if necessary. Therefore, researchers tested basic motor skills in young children with VI and non-VI. Researchers hypothesized that children with VI will show much lower locomotor abilities and ball skills than non-VI children.

METHOD

This study used a cross-sectional design, descriptive-analytic with purposive sampling. The total sample was 25 people (male= 12; female= 13) including children aged 3–5 years (M_{age}4,32 year, SD= 0,52; Sundanese= 15; Javanese= 7; Batak= 3) from a school with special needs in the city of Serang, Banten Province.

Association for Blind Athletes classification scale as a grade for visually impaired persons. B1 is the lowest visual acuity level, B2 is the visual acuity level is 20/600, B3 is 20/600 to 20/200 is the sharpness level, and B4 is the highest level.

TGMD-3 (Ulrich, 2019) features strong psychometric properties for children between the ages of 3 years to 10 years and 11 months. TGMD-3 includes 13 FMS divided into two separate subscales. The locomotor subscale contains six skills, which include running, sliding, galloping, skipping, hopping, and jumping. The ball skills subscale contains seven skills, which include dribbling, two-hand strike, one-hand strike, kicking, throwing, tossing, and catching. Each locomotor and ball skill displays between 3 and 5 essential elements of individual skill performance. During trials of the skills being assessed, the trained coder gives the child a score of 1 if the critical element is present and 0 if the critical element is not present. A child then receives a raw skill score ranging between 0 and 8 points for each locomotor skill and 0 and 10 points for each ball skill. The sum of each raw skill score on each subscale provides the child's overall subscale score. For locomotor skills, a total skill score of 46 points and a ball skill of a total of 54 points. The total raw score for the assessment ranges from 0 to 100. The raw score can then be converted to a percentile rating for normative reference using the conversion table in the manual (Ulrich, 2019).

TGMD-3 has been tested for psychometric properties by experts (Brian, et al., 2018). Internal consistency ω=0,89–0,95, strong inter-rater reliability= 0,91–0,92, convergence with TGMD-2 (r=0,96), and a good fit model, χ2 (63)=80,10, p=0,072, ratio χ2/df=1,27, root mean error squared approximates=0,06, comparative match index =0,97. Furthermore, they also examined the content and face validity of the TGMD-3 modification (Brian et al., 2018). For an example of the TGMD-3 modification for children with VI, refer to (Brian et al., 2018).

Researchers chose purposive sample in schools with special needs in Serang City. All groupings of ethnicity, sex, and age occur because of convenience. Researchers obtained institutional review board approval from STKIP Situs Banten. Parents and research subjects gave written consent. All tests were carried out in March. Researchers recorded a video of each TGMD-3 trial which was scored and retroactively coded a sample.

Researchers assessed all children without VI following the standard TGMD-3 procedure (Ulrich, 2019) and make use of modifications and procedures for children with VI where appropriate (Brian et al., 2018). The researcher first demonstrates each skill. Participants complete a practical trial. If necessary, the research follows the structure and modification from

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least to most recommended by (Brian et al., 2018). After that, the children completed two score trials for each skill.

Researchers coded the TGMD-3 test and made sure all coders achieved inter-rater reliability at or above 90% as the “gold standard” for coders before coding current samples. After coding, perform inter-rater reliability secondary in 30% of the coded sample. Appraisers achieved inter-rater reliability of 88,2% across 30% of the sample.

Prior to formal analysis, the researcher tested all statistical assumptions including linearity, multicollinearity, univariate / multivariate outliers, normality, and homogeneity. Next, performed a descriptive analysis (mean/SD) for TGMD-3 scores across locations for the ball and locomotor skills subscale (Table 1). Furthermore, for descriptive purposes, converting all raw scores to percentile rankings using the conversion tables in the TGMD-3 manual (Ulrich, 2019). Next, use raw scores, and perform MANCOVA for locomotor and ball skills after controlling for gender and age. Gender and age were not significant, so they were excluded from the model. Researchers followed up with MANOVA to explore differences in locomotor and ball skills.

RESULTS

Locomotor scores and ball skills were moderately correlated ($r = 0.67$, $p = 0.002$) which guaranteed the use of MANOVA (Hair et al., 2018). There is a linear relationship assessed by a scatter plot. There is no univariate outlier as assessed by the inspection of a boxplot. There is no multivariate outlier as assessed by the Mahalanobis distance ($p>.001$). Locomotor scores and ball skill were normally distributed as assessed by Shapiro – Wilk's test ($p>.05$). There is homogeneity of the covariance matrix as assessed by the Box's M test ($p=.404$). There is a homogeneity of variance as assessed by Levene's test ($p>.05$).

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Table 1 Descriptive Analysis of the TGMD-3 Score

Total sample (N = 25)	LM raw scores, M (SD)	BS raw scores, M (SD)	LM percentile rank	BS percentile rank
Not VI (n = 15)	21.38 (6.69)	18.74 (6.54)	Ke-50	Ke-37
VI (n = 10)	9.70 (3.09)	5.23 (5.44)	Ke-9	Ke-2

VI = visual impairment; LM = locomotor; BS = ball skills.

The children's locomotor skills ranged from 0,00 to 37,00 (M=17,72, SD=10,22) out of a total likelihood of 46 points. Non-VI children show higher locomotor skills (10,00-37,00; M=21,38, SD=6,69; persentil ke-50; Table 1) when compared to children with VI (0,00-28,00; M=9,70, SD=3,09; persentil ke-9; Tabel 1). There is a significant effect on vision (F=17,55, p=,014, η2=,31). For children with VI, congenital (n=7) performed higher (M=10,33, SD=10,54) compared to the VI is not innate (n=3; M 4,02, SD=2,73).

Kids ball skills ranged from 0,00 to 28,00 (M = 14,79, SD = 9,03) out of a total possible 54 points. Non-VI showed higher ball skills (8,00-28,00; M=18,74, SD=6,54; 37th percentile; Table 1) when compared to children with VI (0,00-16,00; M=5,23, SD=5,44; persentil ke-5; Tabel 1). There is a significant effect on vision (F=21,99, p<0,001, η2=.56). For children with VI, congenital (n=7) performing higher (M=6,73, SD=6,69) compared with no congenital VI (n=3; M=2:05, SD=1:01).

DISCUSSION

All samples, regardless of degree of VI, exhibited true developmental delays (e.g., 5-25th percentile) or were at risk of developmental delay (e.g., 37th percentile) in ball skills. For locomotor skills, non-VI children (as a group) showed no developmental delay (50th percentile) while blind children showed developmental delays (see Table 1). The prevalence of developmental delay in this study is not surprising. Early childhood may experience impairment in FMS (Brian, Pennell, Taunton, et al., 2019). This means that the FMS of children today are significantly lower than the FMS of children 20–35 years ago (Brian, Pennell, Taunton, et al., 2019). In addition, the presence of a documented disability often increases the risk of developmental delays in early childhood (Brian, Pennell, Haibach-Beach, et al., 2019). Thus, the severe

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tardiness presented by children with VI is consistent with previous studies covering different types of disabilities (Brian, Pennell, Taunton, et al., 2019) and very worrying.

Children in this sample, for the most part, had severe developmental delays (for example, the 5th percentile) or were at risk of being delayed (for example, greater than the 30th percentile). FMS are very important for the development of the child as a whole. FMS are not only concerned with health-enhancing physical activity behaviours for children without VI (Robinson et al., 2015) and children with VI (Brian, Pennell, Haibach-Beach, et al., 2019) but another aspect of the child's overall health. FMS are related to self-perception (Robinson & Goodway, 2009), social-emotional development (Cummins et al., 2005), executive function (Aadland et al., 2017), school readiness (Chang & Gu, 2018), and literacy (Macdonald et al., 2018). If children have delays in FMS, it is likely that these delays have cascading effects in various aspects of the child's development and will continue to increase over time.

Present-day children, including those in this sample, were more likely to show delays with FMS than those at other times in history (Brian, Pennell, Taunton, et al., 2019). Recent data conclude that VI adolescents show a high prevalence of stagnant development (Brian et al., 2021). On hold development refers to a halt in development for a domain, such as gross motor skills, where changes are expected to occur over time (Brian et al., 2021). Obviously, developmental delays occur in young children with VI with a larger deficit which is a trend for those with VI after birth. Intervention, which is especially effective for children with VI (Brian et al., 2020) it is necessary to occur immediately at signs of developmental delay. Perhaps early childhood intervention needs to be undertaken for all children, through some form of PE, in a universally designed early childhood environment. However, further research is needed.

CONCLUSION

Non-visually impaired children show a higher level of basic motor skills when compared to children with visual impairments. The children with visual impairments in this sample exhibited profound developmental delays requiring further investigation and future intervention. This finding is new because no previous literature reports on the level of basic motor skills of children with visual impairments at an early age. Although the findings fill a gap in the literature, future research should recruit larger samples for greater generalizability.

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