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# Determinants of gross motor skill performance in children with visual impairments

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ABSTRACT

Children with visual impairments (CWVI) generally perform poorer in gross motor skills when compared with their sighted peers. This study examined the influence of age, sex, and severity of visual impairment upon locomotor and object control skills in CWVI. Participants included 100 CWVI from across the United States who completed the Test of Gross Motor Development II (TGMD-II). The TGMD-II consists of 12 gross motor skills including 6 object control skills (catching, kicking, striking, dribbling, throwing, and rolling) and 6 locomotor skills (running, sliding, galloping, leaping, jumping, and hopping). The full range of visual impairments according to United States Association for Blind Athletes (USABA; B3 = 20/200–20/599, legally blind; B2 = 20/600 and up, travel vision; B1 = totally blind) were assessed. The B1 group performed significantly worse than the B2 ($0.000 \leq p \leq 0.049$) or B3 groups ($0.000 \leq p \leq 0.005$); however, there were no significant differences between B2 and B3 except for the run ($p = 0.006$), catch ($p = 0.000$), and throw ($p = 0.012$). Age and sex did not play an important role in most of the skills, with the exception of boys outperforming girls striking ($p = 0.009$), dribbling ($p = 0.013$), and throwing ($p = 0.000$), and older children outperforming younger children in dribbling ($p = 0.002$). The significant impact of the severity of visual impairment is likely due to decreased experiences and opportunities for children with more severe visual impairments. In addition, it is likely that these reduced experiences explain the lack of age-related differences in the CWVI. The large disparities in performance between children who are blind and their partially sighted peers give direction for instruction and future research. In addition, there is a critical need for intentional and specific instruction on motor skills at a younger age to enable CWVI to develop their gross motor skills.



Children with visual impairments are developmentally behind their sighted peers in motor skill competence (e.g. Houwen, Visscher, Lemmink, & Hartman, 2009; Wagner, Haibach, & Lieberman, 2013). These lower performances may be caused in part by reduced opportunities to participate in physical activities (Holbrook, Caputo, Fuller, Perry, & Morgan, 2009; Kozub & Oh, 2004a, 2004b; Lieberman & MacVicar, 2003; Shapiro, Moffett, Lieberman, & Dummer, 2005), often resulting from a lack of knowledge on the part of physical educators on how to appropriately modify curriculum and equipment for the specific needs of this population (Conroy, 2012; Lieberman, Houston-Wilson, & Kozub, 2002; Perkins, Columna, Lieberman, & Bailey, 2013). By using modified equipment, children with visual impairments may participate in similar motor skills and activities with their sighted peers. Physical educators need not worry that using modified equipment will impair sighted

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children's performance, as it has been found that sighted children perform similarly with the modified equipment as they do with typical sports equipment (Lieberman, Haibach, & Wagner, 2014). In order to ensure appropriate instruction and guidance to teach gross motor skills, instructors must have knowledge about the specific personal attributes of the children with visual impairments such as age, gender, and level of visual impairment.

During typical child development, gross motor coordination gradually improves with increasing age (Butterfield, Angell, & Mason, 2012; Ulrich, 2000; Vandorpe et al., 2011); however, this may not occur in children with visual impairments and blindness. Unfortunately, the influence of age upon motor skill performance has not been well established in children with visual impairments. Two studies found no differences between younger and older children with visual impairments aged 8–13 years (Bouchard & Tetreault, 2000) and 6–13 years (Pereira, 1990), while another study (Gipsman, 1981) found better performances in older children (12–14 years) in comparison to younger children (8–10 years) who are blind on dynamic balance. Age effects were found for a manual dexterity task, finding progressively shorter times to complete the task for older children, but, this age effect was minimal for children who were blind (Reimer, Smits-Engelsman, & Siemonsma-Boom, 1999). Further research is necessary to establish a relationship between age and gross motor performances in children with visual impairments, as the only known research on a gross motor skill was on dart throwing, in which older children (14–21 years) were found to perform significantly better on a dart throwing task in comparison to younger children (7–14 years) who were blind (Joseph, 1984).

There is much research to support gender differences in sighted children for motor skill performances, in particular, object control skills such as throwing and striking (Barnett, van Beurden, Morgan, Brooks, & Beard, 2010; Butterfield & Loovis, 1998; Butterfield et al., 2012; Thomas & French, 1985). Research on gross motor skill gender differences in children who are blind, on the other hand, is scant, with only one known study examining gender differences in dart throwing finding boys outperforming girls (Joseph, 1984). Interventions for sighted children with a focus upon improving mechanics have yielded more significant benefits for girls than boys (Thomas, Michael, & Gallagher, 1994), indicating a lack of practice may be a large contributor to these gender differences. The most effective programs have emphasized the development of kicking, throwing, and striking since these skills tend to be lowest for girls in comparison to boys scores (Cooley, Oakman, McNaughton, & Ryska, 1997).

There is also limited research examining the influence of the severity of visual impairment upon motor skill performance. Much of such research has focused upon the level of visual impairment upon balance (Haibach, Lieberman, & Pritchett, 2011; Häkkinen, Holopainen, Kautianen, Sillanpää, & Häkkinen, 2006; Pereira, 1990; Johnson-Kramer, Sherwood, French, & Canabal, 1992; Ribadi, Rider, & Toole, 1987; Wyver & Livesey, 2003) finding mixed results. Leonard (1969) found no relationship between the level of visual impairment and performance on balance tasks, while Haibach et al. (2011), Pereira (1990), and Wyver and Livesey (2003) found better balance was related to increased residual vision. Several studies established a relationship between children and adolescents who are blind performing better than their sighted peers wearing blindfolds, revealing that the individuals who are blind adapt to their condition (Haibach et al., 2011; Johnson-Kramer et al., 1992; Ribadi et al., 1987); however, Häkkinen et al. (2006) did not find better balance in children who were blind in comparison to their blindfolded sighted peers. Weak results were also found for manual dexterity and severity of visual impairment indicating better performances for some tasks in children with low vision (Houwen, Hartman, & Visscher, 2008; Reimer et al., 1999; Wyver & Livesey, 2003) and no differences were found in regard to gross motor skills (Houwen, Visscher, Hartman, & Lemmink, 2007). Further research needs to be conducted in this area to establish a relationship between severity of visual impairment and gross motor skills in children.

## 1. Study aim and hypotheses

The aim of this study was to provide comprehensive research on gross motor skill performance in regard to age, gender, and level of visual impairment as defined by the United States Association of Blind Athletes (USABA). To examine these delays, we questioned whether there are differences in these three variables across the 12 fundamental motor skills assessed in the Test of Gross Motor Development Second edition (TGMD-II) (Ulrich, 2000). Considering that minimal research findings have been published in regard to fundamental motor skills in children with visual impairments, some of our assumptions were based upon research findings in sighted children; we hypothesized significant differences between (1) older and younger children, (2) boys and girls, and (3) children with varying levels of visual impairment.

## 2. Methods

### *2.1. Participants and recruitment*

A total of 100 children with visual impairments aged 6–12 years (mean age = 9.97 years; SD = 1.62; 61 boys: mean age = 9.92 years; SD = 1.51; 39 girls: mean age = 10.05 years; SD = 1.79) but no other disabilities were included in this cross-sectional study. Children with visual impairments (CWVI) were recruited from seven camps for CWVI across the United States (AK, AZ, CA, CT, MD, and NY) during the course of one summer. Within the study group, the full range of visual impairments according to United States Association for Blind Athletes (USABA; B3 = best corrected vision between 20/200 and 20/599, legally blind; B2 = best corrected vision between 20/600 and up, travel vision; B1 = totally blind) was assessed. Parents reported their child's visual acuity level obtained from their child's optometrist. Table 1 shows the distribution of participants among the study groups. Institutional Review Board approval was obtained from the two universities of the researchers prior to this study. Each participant and their parent agreed to participate by signing informed consent forms.