Physical activity levels of children with visual impairments during an adapted sports camp.

Abstract
The purpose of this study was to identify the physical activity (PA) levels of children and young people with visual impairments (VI) as they participated in closed and open skilled sports as part of a specially designed 1-week sports camp. Participants (N = 18; Girls = 6; Boys = 12; Mage = 13 years, 4 months) aged 9-19 years old possessed various levels of VI. Data were collected using Actigraph GM1 accelerometers and analysed using a one-way ANOVA. Findings suggest there was a significant effect of activity type on both intensity $F(1.7,28.94) = 9.86, p = .001, \eta^2_p = .37$ and time spent in moderate-to-vigorous physical activity (MVPA) $F(4,68) = 6.03, p < .001, \eta^2_p = .26$. The findings of this study support the continued implementation of both closed and open skill-orientated disability sports as a means to reaching recommended MVPA levels for children and young people with VI.

Keywords: Adapted physical activity, disability sport, goalball, beep baseball, accelerometers.
Introduction

Worldwide, over the last two decades one of the major health concerns is the lack of physical activity (PA) for individuals with disabilities. Recommendations published by the United States Department of Health and Human Services (USDHHS, 2008), the Council of the European Union (CEU 2013), and the World Health Organization (WHO, 2010) call for children and youth between the ages of 5-17 to accumulate 60 minutes of moderate-to-vigorous physical activity (MVPA) daily. However, given these recommendations, children with and without disabilities in many countries around the world continue to fall short in terms of achieving these goals. Issues related to PA and sport, or lack thereof (inactivity), are particularly relevant for children with disabilities as research suggests these individuals noticeably fall behind their nondisabled peers in terms of engagement and opportunity and as a result are at a higher risk for developing sedentary lifestyle patterns (Cook, Li, & Heinrich, 2015; Hinckson & Curtis, 2013; U.S. Department of Health and Human Services, 2010).

In order to maintain health and better quality of life for persons with disabilities physical activity has been shown to have many positive effects (Bloemen, et al., 2015; Murphy & Carbone, 2008). Yet, several studies have shown that individuals with visual impairments (VI) in particular have significantly low levels of PA (Augestad & Jiang, 2015; Houwen, Hartman, & Visscher, 2009; Kozub & Oh, 2004; Lieberman, Byrne, Mattern, Watt & Fernández-Vivó, 2010; Lieberman & McHugh, 2001; Longmuir & Bar-Or, 2000). As many as one-third of individuals with VI lead sedentary lifestyles (Longmuir & Bar-Or, 2000) and adolescents with VI engage in fewer activities than their same age non-VI peers (Kroksmark & Nordell, 2001). These findings highlight the fact that individuals with VI may be at elevated risk for health-related illnesses attributed to inactivity and low fitness as well as a
compromised quality of life. This is particularly alarming when one takes into consideration that energy requirements for activities of daily living increase as vision loss increases due to less efficient movement in individuals with VI (Kobberling, Jankowski, & Leger, 1989). Another issue is that individuals with VI who lack motivation to engage in PA may become dependent members of society who rely on others for success in navigating the community (Lieberman, et al. 2010).

One way in which to improve PA engagement for children with VI is through well planned and effective physical education (PE) experiences early in life and during adolescence (Lieberman, Robinson, & Rollheiser, 2006). In these settings, individuals with disabilities may obtain opportunities to improve physical activity, acquire motor skills, develop physiological systems, improve affective behaviours, and increase social skills (Cooper & Quatrano, 1999). Sports such as goalball may be considered an effective option to improve motor skills in children with VI (Çolak, Bamaç, Aydin, Meriç, & Ozbek, 2004). While there are many options for physical educators to choose physical activities for individuals with disabilities, games can often be broken down into two types of sporting activities, disability sport and adapted sport; both comprised of open and closed skills. Disability sport (DePauw & Gavron, 2005) consists of games from a sport perspective that are created specifically for persons with disabilities and can be highly competitive. Examples include sports like wheelchair basketball versus basketball or blind football/soccer versus regular football/soccer; also referred to as 5-a-side football (Tindall, McMahon, Wilson, & Foley, 2013). Adapted sport (Winnick, 2011) encompasses disability sport but differs slightly in its approach. From this perspective activities and sports are modified to allow for the unique needs of individuals with disabilities. For example, again using the sport of soccer, games can be modified for children with VI through the
equipment used (e.g., type of ball that uses sound or size of goals), dimensions of the playing area, rules of the game, and/or and number of players on the pitch. Additionally, adapted sports may be conducted in integrated settings in which persons with and without disabilities may interact together. While there is some debate over the terminology used, adapted sport is preferred for many reasons primarily for its consistency with terminology used in adapted physical education (APE) and adapted physical activity (APA) as well as its focus on modifications to sport and not a person’s disability, to name a few (Winnick, 2011). In the context of this study, the term ‘disability sport’ will be used throughout. Within disability sport (and sport in general) there are both open and closed skills both determined somewhat by a level of predictability. Closed skills are performed in a relatively stable and predictable environment where the participants’ response can be planned or self-paced. Open skills are performed in an environment that is noticeably unpredictable and externally paced (Buck, Lund, Harrison, & Blakemore-Cook, 2008). Examples of closed skills are such things as hitting a ball off a batting tee, shooting a free throw, swinging a golf club, bowling, and gymnastics. Examples of open skills are those required in riding a mountain bike through the woods, hitting a pitch in softball/baseball, playing badminton/tennis, or engaging in martial arts. These particular activities involve consistent movement of players as well as objects through space at different speeds and angles.

At present, according to systematic reviews conducted by Furtado, Allums-Featherston, Lieberman, and Gutierrez (2015) and Haegele and Porretta (2015) numerous studies have been conducted examining PA interventions for children and youth with VI. From these reviews, researchers noted there was still a scarcity of research in this area, predominantly on the effectiveness of interventions to reach
recommended MVPA levels as well as PA levels of specific sports for youth with VI. In order to address these areas in greater detail, measuring PA among individuals with VI has been an issue of concern. When conducting research on PA for individuals with VI it is important to have accurate and reliable measuring instruments. Self-reports have been questioned in terms of validity and accuracy and have been replaced by new computerized monitors such as talking pedometers, (Beets, Foley, Tindall, & Lieberman, 2007; Lieberman, Stuart, Hand, & Robinson, 2006), heart rate monitors, and accelerometers (Cervantes & Porretta, 2013; Eston, Rowlands, & Ingedew, 1998; Morelli, Foley, Columna, Lieberman, & Folmer, 2010; Morelli, Foley, Lieberman, & Folmer, 2011; Kozub, Oh, & Rider, 2005). Of the aforementioned methods, accelerometry has the ability to provide an estimate of energy expenditure while having little to no interference to the participant. As a field based measure accelerometers can be conveniently used in PA research in many different environments (Trost, 2001). Therefore, the purpose of this study was twofold; 1.) To determine the activity counts and percent of time spent in MVPA of children and youth with VI as they engage in both closed and open skilled disability sports; and 2.) To determine if any significant differences occur between the different disability sports.

**Methods**

**Participants**

Youth aged 9-19, who attended a week long summer sport camp specifically designed for children and youth with VI, participated in this study. From camp applications completed by their parents, those individuals who reported as having no orthopaedic impairment, mobility impairment, and/or hearing impairment were pre-identified and recruited (N=24). One month prior to attending camp, letters were sent by mail to
parents/guardians of the pre-identified participants inviting them to take part in the study. Of the 24 recruited, 23 volunteered to participate. Of these individuals, data from five participants were not used in the study (Figure 1). Final analysis included six girls (B1 = 2, B2/3 = 4) and 12 boys (B1 = 11, B2/3 = 1). The visual classifications were based on the International Blind Sports Association (IBSA) classification system (ISBA, 2012). These classifications are determined using the eye with better visual acuity, whilst wearing best optical correction using spectacles or contact lenses, and/or visual fields which include central and peripheral zones. The classifications are further defined as follows: B1 = visual acuity poorer than a Logarithm of the Minimum Angle of Resolution (LogMAR) score of 2.6; B2 = visual acuity ranging from a LogMAR score of 1.5 to 2.6 (inclusive) and/or visual field constricted to a diameter of less than 10 degrees; and B3 = visual acuity ranging from a LogMAR score of 1.4 to 1.0 (inclusive) and/or visual field constricted to a diameter of less than 40 degrees (ISBA, 2012).

**Procedures**

Upon arrival at camp participants were paired with a coach/counsellor (1:1 ratio) and assigned to one of four groups (each comprised of 12-14 children) which are determined by age. Prior to the participants arriving at camp, each counsellor experienced a day and a half orientation which focused on working with youth with VI and blindness. Though the camp offered seven physical activities for the campers only five were chosen based on the appropriateness of using accelerometry to measure physical activity: beep baseball, goalball, gymnastics, judo, and athletics (also referred to ‘track and field’). Excluded from the list were: tandem cycling and swimming. During the week long camp, children experienced each activity 3-4 times (approximately 45 minutes per lesson) rotating to different activities throughout the
day. Each activity lesson was prepared by a team of three APE teachers and would be considered typical for a school setting with 15-20 minutes of skill development and 20-25 minutes of game or skill related activity (Winnick, 2011). Additionally, the lessons were reviewed by a second team of APE professionals for appropriateness of both content and developmental level; giving suggestions on ways to modify the lesson if needed. Teachers and lesson reviewers were not informed about the purpose of the study to limit biasing the lessons to produce more MVPA opportunities than originally planned.

**Instrument**

Physical activity intensity was measured by the Actigraph GM1 accelerometer (Actigraph, Pensacola, FL) which has been shown to be an appropriate measure of PA in youth (Puyau, Adolph, Vohra, & Butte, 2002). Prior to the study all accelerometers were tested and calibrated. To insure accuracy of the physical activity time delineations, researchers synchronized their watches with the computer in which the accelerometers were linked and maintained. At the end of the study all accelerometers were checked for consistency to insure data integrity. Accelerometers were placed in a pouch on a belt and sealed. A research assistant attached the belts to participants every morning between 7-8am and retrieved them in the evening between 7-8pm. Care was taken to assure each person wore the accelerometer on the small of their back (Chen, et al., 2003). Participants and their coaches/counsellors were prompted to do location checks of the accelerometer at the start and midway through each lesson. Additionally, research assistants randomly checked on placement of the accelerometers throughout the day to ensure adequate position of the monitors.

**Analysis**
Data consisted of the lesson session only and were downloaded from the accelerometers onto a PC that contained a Windows-based operating system using ActiLife software v3.2.11. Data files were then exported into a Microsoft Excel spreadsheet and extracted using both the camp schedule and the personal observation records of the research assistants. Data were analysis using SPSS v10 for Windows. A visual inspection of graphic representations of the data indicated it met the assumptions of a normal distribution. A one way repeated measure of ANOVA was used to determine if a difference existed between the five activities. Alpha was set a priori at .05; Post Hoc analysis used a Bonferroni adjustment for pairwise comparisons. Data are reported in Activity Counts per Minute (ACm), (per one minute epoch) and Percent of Time spent during the lesson in MVPA (% MVPA) (Welk, Corbin, & Dale, 2000). The use of the one minute epoch is consistent with other physical activity research on youth with visual impairments (Cervantes & Porretta, 2013). Based on research conducted by Dowda, Pate, Sallis, & Freedson (1997) cut-off points for MVPA were calculated using the following age-adjusted formula:

\[ \text{METs} = 2.757 + (0.0015 \times \text{counts/min}) - (0.08957 \times \text{age}) - (0.000038 \times \text{counts/min} \times \text{age}) \]

This is one on the most commonly used formulas in physical activity research in youth (Cain, Sallis, Conway, Van Dyck, & Calhoon, 2013) and provides consistency with other studies. Means are reported with standard deviations in parentheses.

**Results**

In the comparison of raw activity counts (see Figure 2), Mauchly’s test indicated that sphericity has been violated, \( \chi^2(9) = 45.52, p<.001 \). To adjust the degrees of freedom, Huynh-Feldt estimates of sphericity were used (\( \varepsilon = .43 \)). The results suggest there was a significant effect of activity type on PA intensity levels \( F(1.7,28.94) = 9.86, p =.001, \eta^2_p = .37 \). Planned contrast between each activity revealed no significant
differences in activity counts were observed between gymnastics (M=1342.6 ± 722.5 ACm), athletics (M=1030.7 ± 359.1 ACm) and judo (M=765.4 ± 264.8 ACm). However, gymnastics had significantly higher intensity levels than goalball (747 ± 239.8 ACm) with a mean difference between the two of 595.6 ACm p =.04, 95% CI (14.6, 1176.7) and beep baseball (690.4 ± 292.7 ACm) with a mean difference between the two of 652.2 ACm p =.02, 95% CI (79.1, 1225.4). Similarly, athletics had significantly higher intensity levels than goalball with a mean difference between the two of 283.7 ACm p =.02, 95% CI (27.6, 539.9) and beep baseball with a mean difference between the two of 340.3 ACm p =.001, 95% CI (131.4, 549.2).

In the comparison of percent of lesson time in MVPA (see Figure 3) there was no violation of sphericity as the results suggest there was a significant effect of activity type on time spent in MVPA levels F(4,68) = 6.03, p <.001, η²_p = .26. Planned contrast between individual activities revealed that no significant differences in percent of time spent in MVPA were observed between gymnastics (M=26.4 ± 13.5 % MVPA), athletics (M=23.6 ± 10.5% MVPA), judo (M=17.9 ± 10.9 % MVPA), and goalball (M=18.4 ± 13.7 % MVPA). Gymnastics had significantly higher MVPA percentages than beep baseball (M=13.9 ± 9.8 % MVPA) with a mean difference between the two of 12.5 % MVPA p =.008, 95% CI (2.5, 22.4). Similarly, athletics had significantly higher MVPA percentages than beep baseball with a mean difference between the two of 9.6 % MVPA p <.001, 95% CI (4, 15.3).

Discussion

The purpose of this study was to determine the activity counts and percent of time spent in MVPA of children and youth with VI as they engage in both closed and open skilled disability sports and to conclude if any significant differences occurred between the different disability sports. As noted earlier, research suggests that
individuals with VI display lower levels of PA than their sighted peers (Augestad & Jiang, 2015; Houwen, et al, 2009; Kozub & Oh, 2004; Lieberman, et al., 2010; Lieberman & McHugh, 2001; Longmuir & Bar-Or, 2000). As such, it can be surmised that individuals with VI tend to have a higher risk for health-related illnesses attributed notably to inactivity and lower fitness levels. Based on the results of this study there appears to be significant differences in intensity levels between certain activities as measured by raw accelerometer counts. What is interesting is that the differences did not group by type of sport, but instead were grouped by skill type; specifically, closed vs. open skilled sports. This was something not originally considered in the initial planning of the study. Closed skilled sports are often individual individually-oriented sports such as athletics or gymnastics whereas open skilled sports include an interaction of some sort, often with others, which require participants to react to such as goalball, judo, and beep baseball. According to the mission statement of the camp, primary goals are to empower young people with VI to be physically active, have fun, and be productive members of their schools, towns, cities, and communities. However, a crucial, yet less publicised goal of the camp is to improve the health and well-being of participants by achieving a minimum of 50% MVPA across each sport. However, when the raw counts were converted into percent of time in MVPA, with the exception of beep baseball, open skilled sports were generally lower than the closed skilled sports.

As the intensity level data indicated, closed sports such as gymnastics and athletics lent themselves well to the 1:1 situations at the sports camp where coach/counsellors were utilized. Here, campers could engage with the activity at a quicker rate than they could with open skilled sports. It was apparent that sports necessitating interaction with others such as goalball, beep baseball and judo had
limits to the intensity on the activity as measured by raw accelerations. This may be the result of participants being cautionary while interacting in close proximity to other novice campers. The instructional time was high, and much of it was spent feeling the courses and mats and learning about basic components of the skills as children and youth with VI take longer to learn the basic components of skills as opposed to their sighted peers (Withagen, Vervloed, Janssen, Knoors, & Verhoeven, 2010). Findings from Withagen and colleagues (2010) concluded that children who are congenitally blind and have no additional impairments master roughly 94% of the tactile tasks they encounter. From a PA perspective, once the sport is learned and understood then the pace of engagement can move at a faster pace; similar to closed skilled sports that utilize a 1:1 instructional environment. Without the basic components understood it would not be pedagogically sound or fair to move at a fast rate when taking part in open skilled sports.

Conclusions

Students with visual impairments (VI) should be introduced to all sports, games, and activities. Lifetime activities such as tandem biking, running, goalball, swimming, wrestling, judo, and bowling should be included as well. The results of this study suggest that individually-oriented closed skills lend themselves well to increased physical activity. Open sports that are more group orientated in nature must be taught methodically and slowly to ensure active participation in the future. It is extremely important to take the time necessary to ensure the child or young person knows the dimensions of the playing area, terminology used, and positions related to the sport being introduced before the unit starts. This can be done by the physical education teacher, the paraeducator, the special needs assistant, the learning support assistant, adapted physical education specialist, a teacher of the visually impaired, or the
orientation and mobility specialist. The goal of each lesson plan of having over 50% of the time in activity was never achieved in any of the five activities. This would suggest that it may be more complicated to get youth with visual impairments into MVPA levels during early instructional phases on learning a new sport or activity. Consequently, knowing this may assist current and future physical education and adapted physical education teachers to obtain a better understanding of programming choices should they encounter students with VI in their classes. This study, nonetheless, was limited in that participants were at the beginning to intermediate skill levels in most activities. Thus, activity levels for students with advanced skill levels may not have the same outcome. With this in mind, the following recommendations are made for future studies to either corroborate or contradict the findings of this work:

1. This study should be replicated with students who possess a wider spectrum of skill levels; beginner, intermediate and advanced performers.

2. While the participants of this study were between the ages of 9-19, additional studies should focus on specific age groups that operate at similar developmental levels physically. Also, future studies should consider utilizing more participants and possibly consider differences in males and females.

3. Additional studies with a similar design should examine the activity/intensity levels of students with VI as they take part in other disability/adapted activities or sports.

4. Additional studies with a similar design should be conducted in both physical education and adapted physical education settings as students with VI participate in activities and/or sports. Doing so would allow for a comparison
of activity/intensity levels in both a specialized setting (sport camp) versus a
more traditional setting (PE class).

5. Analysis should be made of students’ activity/intensity levels over a longer
period of time. In this study, data for the participants was collected
periodically over the course of roughly one week. A longer period of time
may reveal different data trends and conclusions.

6. Lastly, motivation, or lack thereof, of students to be active at a moderate-to-
vigorous level as they engage in disability/adapted sport or activity is another
variable that could add significant value to this subject area.
References


