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The Importance of Fundamental Motor Skill Proficiency for Physical Activity in Elementary School Age Females

Liens entre la maîtrise des habiletés motrices fondamentales et le niveau d'activité physique chez des filles de l'élémentaire

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Abstract

This study examined the relationship between fundamental motor skills and physical activity in 6-9 year old females (n=25). Motor proficiency was assessed with the Test of Gross Motor Development-2 and physical activity was measured for 7 days with time-stamped pedometers. Participants took an average of 10573.4 steps per day and had motor skills that were below what would be expected for their age. Locomotor skills were positively associated with physical activity during the weekday (r=.487, p=.013) and during the after-school period of 3-6pm (r=.431, p=.032). Given the results, physical education teachers should capitalize on the school day, as well as after-school programming, as a time to improve both the motor skills and physical activity levels of young female students in order to lay the foundation for an active, healthy life.

Résumé

Cette étude s'intéresse aux liens entre les habiletés motrices fondamentales et le niveau d'activité physique chez des filles de 6 à 9 ans (n=25). Les habiletés motrices de ces filles ont été évaluées en ayant recours au Test du développement moteur global -2 et la mesure du niveau d'activité physique a été réalisée sur une période de 7 jours au moyen de pédomètres horodatés. Les résultats démontrent que les participantes faisaient 10 573,4 pas par jour en moyenne et que

leurs habiletés motrices étaient inférieures aux attentes habituelles pour ce groupe d'âge. L'étude a aussi établi des liens positifs entre les habiletés locomotrices et le niveau d'activité physique les jours de semaine (r=.487, p=.013) et pendant la période de la journée comprise entre 15 h à 18 h (r=,431, p=,032). Ces résultats indiquent que les enseignantes et enseignants d'éducation physique devraient profiter au maximum de la journée d'école et de la période qui suit la fin des classes pour aider les filles à perfectionner leurs habiletés motrices et à accroître leur niveau d'activité physique de manière à jeter les assises d'une vie saine et active.

Introduction

Recent research has demonstrated that Canadian children are extremely inactive with only 9% of boys and 4% of girls meeting the Canadian physical activity guidelines of 60 minutes, or 12,000 steps, of moderate to vigorous physical activity (MVPA) per day (Colley et al., 2011; Colley, Janssen, & Tremblay, 2012). Although these low rates of physical activity are alarming for both genders, particular attention should be paid to the fact that regardless of age, the evidence indicates that females are consistently less active than males (Colley et al., 2011; Hinkley, Salmon, Okely, Hesketh, & Crawford, 2012; Sallis, Prochaska, & Taylor, 2000; Tucker, 2008). Unfortunately, there is a poor understanding as to why the physical activity levels of females are lower than males.

It is well documented that females have high dropout rates in sport, physical education and recreational activity as they reach adolescence, which negatively impacts their overall physical activity levels (Pfeiffer et al., 2006; Sallis et al., 2000; Sallis, Prochaska, Taylor, Hill, & Geraci, 1999; Troiano et al., 2008). These high drop-out rates may help to explain the low rates of physical activity as young females' transition to adolescence. However, females engage in less activity than their male counterparts even before adolescence. Hinkley and colleagues (2012) measured the physical activity of 703 children aged 3-5 years with accelerometers and found that females spent significantly less time in light, moderate, and total physical activity than their male counterparts even in the preschool years. Similarly, a systematic review of physical activity in preschool-aged children revealed that of the 18 articles reporting sex differences in physical activity levels, 16 found female preschoolers to be less active than males (Tucker, 2008). These studies indicate that sport and physical activity drop-out rates in early adolescence may not be the only culprit in the low levels of overall physical activity of females, as females are less active than males from as early as the preschool years. Both males and females become less active as they get older; however, because females are consistently less active than males to begin with, it is possible that these declines in physical activity with age may have an incrementally larger impact on females (Colley et al., 2011; Hinkley et al., 2012). A recent study by Hinkley and colleagues (2012) objectively measured physical activity in 3-5 year old children and found that both genders spent 12% less time being active with each additional year of age. Unfortunately, this trend continues beyond the preschool years. Recent research found that the time Canadian females spent in MVPA each day significantly decreased from 58 minutes at 6-10 years of age, to 47 minutes at 11-14 years, and 39 minutes at 15-19 years of age (Colley et al., 2011). Furthermore, they found that females engaged in an average of 47 minutes of MVPA each day across these three age bands, which was significantly less than the males who engaged in an average of 61 minutes of MVPA each day (Colley et al., 2011). It is evident that females engage in significantly less physical activity than males, physical activity declines with age, and the trend starts very early and continues through adolescence.

Changing physical activity behaviour is a challenge, due in part to how many factors influence physical activity including, but not limited to, access to facilities, socio-economic status, and transportation (Sallis et al., 2000); many of these factors are not easily modifiable through interventions. Fundamental motor skills (FMS) are the basic movement skills that are essential to the future acquisition of the more complex skills required in games, dance, sports, gymnastics, and recreational physical activities and are core components to physical education curricula at the elementary school level (Lubans, Morgan, Cliff, Barnett, & Okely, 2010; Stodden et al., 2008). Recent research indicates that proficiency in FMS is positively associated with physical activity (Fisher et al., 2005; Lloyd, Saunders, Bremer, & Tremblay, 2014; Lubans et al., 2010; Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006). For example, Lloyd and colleagues (2014) conducted a 20-year follow-up study of the long-term association between motor skills at age 6 and physical activity at age 26. They found that in females, overall motor skill proficiency at 6 years of age was positively related to leisure time physical activity at 26 years of age (Lloyd et al., 2014). Research has also indicated that school-age females with poor locomotor skills are twice as likely to be inactive than their more proficient peers (Hardy, Reinten-Reynolds, Espinel, Zask, & Okely, 2012). We propose that proficiency in FMS is one of the most important predictors of physical activity in children because it is modifiable (Logan, Robinson, Wilson, & Lucas, 2012; Lubans et al., 2010). A recent meta-analysis indicates that FMS can be improved through intervention (Logan et al., 2012), whereas socioeconomic status, for example, is not likely to change. It is important that all children develop proficiency in FMS at a young age in order to lay the foundation of skills necessary for a physically active life, which is important to maintain a healthy weight, improve psychological well-being, and decrease the risk of developing chronic conditions such as hypertension, diabetes, osteoporosis, and cardiovascular disease (Janssen & LeBlanc, 2010; Warburton, Nicol, & Bredin, 2006). However, the literature is consistent in finding that females have less proficient FMS than males (Hardy et al., 2012; Spessato, Gabbard, Valentini, & Rudisill, 2012). For instance, Hardy and colleagues (2012) examined the motor skills of 6917 children and youth in grades 2-10 and found that regardless of age, females were much more likely to demonstrate low competency in both locomotor and object control skills than males. Similarly, Hume et al. (2008) objectively measured the motor proficiency of 248 children 9-12 years of age. Results indicated that the males exhibited higher total motor skill scores and object control proficiency scores than the females; however, there were no significant differences in locomotor proficiency scores between the sexes (Hume et al., 2008). Spessato and colleagues (2012) examined gender differences in regard to motor proficiency in a large sample of 1248 children 3-10 years of age. Results indicated that the males outscored the females in both object control and locomotor skills as measured by the Test of Gross Motor Development-2 (Spessato et al., 2012). Thus, it appears that females, on average, have poorer motor skills and are less physically active than their male counterparts (Colley et al., 2011; Hardy et al., 2012; Hume et al., 2008; Spessato et al., 2012).

There is a critical need to increase physical activity for all children, particularly for females. Given the evidence linking FMS proficiency and physical activity in children, the low levels of physical activity exhibited by females, and the poor FMS proficiency found in females, the purpose of this study was to examine the strength of the relationship between motor skills and physical activity in 6-9 year old females. This information may be beneficial in providing evidence to direct physical education teachers to further promote FMS development and physical activity in young females.

Method

Sample

Children were recruited through advertisements placed in 15 local community centres and recreation facilities within an urban centre, as part of a larger project. A total of 28 females 6-9 years of age consented to the study and completed the testing. No participants withdrew from the study after giving consent; however, 3 did not return their pedometers, which excluded them from the analysis for this study. Therefore, the current sample consists of 25 females between 6-9 years of age. Participants were predominately Caucasian (76%) and from middle-to-high income families. Data collection took place in a multi-purpose room at a Canadian University in an urban centre between June 2011 and August 2012. The University's Research Ethics Board for studies involving human subjects approved all procedures, and parental written informed consent and child assent were obtained for all participants prior to the onset of the study.

Measurements

Height and weight were directly measured and BMI was calculated using the International Obesity Task Force (IOTF) cut-off points for children and youth (Cole, Bellizzi, Flegal, & Dietz, 2000). Motor proficiency was assessed using the Test of Gross Motor Development-2 (TGMD-2) (Ulrich, 2000). The TGMD-2 is composed of 12 items in two subtests (locomotor and object control) and is designed for children 3-10 years of age. All motor skill assessments were video-taped and later scored for accuracy. Inter-rater reliability was established at 89% agreement on the scoring of the video-taped assessments.

Physical activity was assessed for 7 days using a time-stamped pedometer (Omron Pocket Pedometer Model Number HJ-720ITC). Pedometers are a reliable tool for assessing physical activity and are simple to use (Tudor-Locke, Williams, Reis, & Pluto, 2002). Furthermore, the Omron HJ-720ITC pedometer has demonstrated accuracy and reliability under various conditions with adults and has been successfully used in a childhood population (Holbrook, Barreira, & Kang, 2009; Pabayo et al., 2012). The OMRON pedometers have a 41 day built-in memory which increases the reliability of the data by not having to rely on self-report. The hourly time-stamp function was able to give an accurate depiction of what time of day the steps were taken. All children were instructed to wear the pedometer on their right hip from the time they got up in the morning until they went to bed at night with the exception of water activities (i.e. swimming and bathing). There was an equal representation of participant's who wore the pedometer during either the summer or winter in order to account for any potential seasonal effects on physical activity levels.

Statistical Analysis

Descriptive characteristics (mean, standard deviation) were calculated on all variables. The raw pedometer data was screened for the following criteria: between 1000 and 30000 steps taken per day and at least three valid days of data (Tudor-Locke et al., 2005). Data from all 25 participants met these criteria. One participant did not have any weekend data; therefore, there is only acceptable weekend data on 24 of the participants. A daily pedometer wear time was calculated for each individual. Pedometer time on was documented as the hour that steps were first recorded in the morning and time off was recorded as the hour after the last step counts were recorded (i.e. if the last steps were taken between 9-10pm, time off was recorded as 10pm). Individual wear times were used to calculate the average weekday and weekend wear times for

the complete sample. The daily average step count was calculated as the average number of steps taken each day (24 hour period) during the 7-day period that pedometers were worn. Average weekend steps were the average number of steps taken over the 24 hour period on both Saturday and Sunday. Average weekday steps were calculated as those taken Monday to Friday over the 24 hour period. Weekday steps were further broken down in to four time periods: morning (6-9am), daytime (9am-3pm), after-school (3pm-6pm), and evening (6pm-12am) for analyses. Pearson product moment correlation analysis was conducted to examine the relationships between physical activity variables (total steps, steps/day, steps/time of day) and motor proficiency. All statistical tests were performed using SPSS version 19.

Results

A total of 25 females between 6-9 years of age completed all components of this study and are included in the results. The average TGMD-2 scores are reported to demonstrate the females' level of motor proficiency. Pedometer step counts for the sample indicate the physical activity levels, by time of day, for our young participants. Lastly, the correlations between motor skills and physical activity levels help us to understand the relationship between these variables within our sample. Descriptive characteristics and TGMD-2 scores of the sample are presented in Table 1.

Table 1. Descriptive characteristics and TGMD-2 scores for the complete sample (n=25).

Variable (units)	Mean	SD
Age (months)	93.6	16.2
Height (cm)	125.6	9.5
Weight (kg)	27.0	8.1
BMI (kg/m^2)	16.8	2.6
TGMD-2 Locomotor raw score (0-48)	38.9	4.3
TGMD-2 Locomotor standard score (0-20)	8.8	2.2
TGMD-2 Object control raw score (0-48)	31.4	6.7
TGMD-2 Object control standard score (0-20)	8.0	2.6
TGMD-2 Gross Motor Quotient (46-160)	90.4	10.4

Pedometer data for the complete sample (n=25) is presented in Table 2. One participant did not wear her pedometer on the weekend; thus, the weekend pedometer data only includes 24 participants. Pedometers were worn for an average of 13 hours and 54 minutes on weekdays compared to 13 hours and 8 minutes on weekend days ($t(23)=1.922$, $p=0.067$).

Table 2. Overall, weekday, and weekend pedometer step counts for the complete sample.

Physical Activity Time Frame	Average Steps		Average Steps per Hour	
	Mean	SD	Mean	SD
Overall (Monday-Sunday; 24 hour period)	10573.4	2505.0	440.6	104.4
Weekday (Monday-Friday; 24 hour period)	11541.3	2852.9	480.9	118.9
Weekday Morning (Monday-Friday; 6-9am)	961.5	606.0	320.5	202.0

Weekday Day-Time (Monday-Friday; 9am-3pm)	5643.9	2100.2	940.7	350.0
Weekday After School (Monday-Friday; 3-6pm)	2584.5	805.8	861.5	268.6
Weekday Evening (Monday-Friday; 6pm-12am)	2306.2	1347.6	384.4	224.6
Weekend (Saturday-Sunday; 24 hour period)	8049.2	3170.7	335.4	132.1

Participants were significantly more active on weekdays (11541.3 steps per day) than on weekend days (8049.2 steps per day; t(23)=5.224, p=<.000). Correlations between TGMD-2 scores and pedometer step counts are presented in Table 3.

Table 3. Select correlations of motor skills and physical activity for the complete sample.

TGMD-2 Variable	Average Steps per Hour	r	p value
Locomotor standard score	Overall (Monday-Sunday; 24 hour period)	.435	.030
Locomotor standard score	Weekday (Monday-Friday; 24 hour period)	.487	.013
Locomotor standard score	Weekday Morning (Monday-Friday; 6-9am)	-.287	.165
Locomotor standard score	Weekday Day-Time (Monday-Friday; 9am-3pm)	.404	.045
Locomotor standard score	Weekday After School (Monday-Friday; 3-6pm)	.431	.032
Locomotor standard score	Weekday Evening (Monday-Friday; 6pm-12am)	.270	.192
Locomotor standard score	Weekend (Saturday-Sunday; 24 hour period)	.223	.295
Object control standard score	Overall (Monday-Sunday; 24 hour period)	-.076	.719
Object control standard score	Weekday (Monday-Friday; 24 hour period)	-.029	.889
Object control standard score	Weekday Morning (Monday-Friday; 6-9am)	-.273	.187
Object control standard score	Weekday Day-Time (Monday-Friday; 9am-3pm)	.071	.737
Object control standard score	Weekday After School (Monday-Friday; 3-6pm)	.174	.406
Object control standard score	Weekday Evening (Monday-Friday; 6pm-12am)	-.153	.466
Object control standard score	Weekend (Saturday-Sunday; 24 hour period)	-.158	.462

Discussion

The purpose of this study was to examine the relationship between FMS and physical activity in 6-9 year old females. The results demonstrate the importance of locomotor skill proficiency for participation in physical activity in young females, particularly on weekdays. Previous studies clearly indicate that females have low levels of physical activity and poor FMS (Colley et al., 2011; Hardy et al., 2012; Hinkley et al., 2012; Hume et al., 2008; Spessato et al., 2012). It is important to understand the relationship between these variables in order to inform future research and school-based interventions aimed at improving both FMS and physical activity in young females.

A positive relationship between FMS and physical activity levels has previously been demonstrated, where children who have more proficient motor skills are more likely to engage in physical activity (Lloyd et al., 2014; Lubans et al., 2010). Our results indicate that proficiency in locomotor skills is positively related to weekday physical activity in 6-9 year old females. Although the ways in which this increased activity is achieved are unknown, it is possible that females who are more proficient in locomotor skills such as running, jumping, and skipping may be more likely to engage in active play and physical activities during physical education, their free time at recess, and after-school on weekdays. Proficiency in object control skills was not related to physical activity in this study even though previous research has found that proficient

object control skills in childhood are related to physical activity in adolescence (Barnett, Morgan, Van Beurden, Ball, & Lubans, 2011; Barnett, Van Beurden, Morgan, Brooks, & Beard, 2009). One possible explanation for the lack of association in our study may be attributed to females not choosing to participate in activities that require object control skills (i.e. baseball, basketball, football), many of which may not be considered gender-appropriate for young females (Hardin & Greer, 2009; Koivula, 2001). It is also possible that a lack of proficiency inhibits females from engaging in activities that require object control skills; thus, limiting their opportunity to develop these skills. However, more research is needed into the factors that may promote or inhibit object control skills in young females. Given the positive relationship between locomotor proficiency and physical activity in this study, physical education teachers should provide young females with ample opportunity to develop their locomotor skills through skill-based activities and instruction, including activity stations and skill-appropriate games, so that they have the motor proficiency required to engage in physical activity.

A recent emphasis has been placed on engaging children in physical activity during the after-school period (Lytle et al., 2009). This is a time of day when it is thought that children have the actual time to be active and participation in physical activity after-school has been linked to increased physical activity throughout the rest of the day (Mota, Santos, & Ribeiro, 2008; Sallis et al., 2000). A recent investigation of Canadian children's daily patterns of physical activity found that the after-school period of 3-5pm was the second most active time of the day, second only to lunch time, and that females were less active than males at each of these time points (Garriguet & Colley, 2012). Furthermore, Sallis and colleagues (1999) found that the use of afternoon time for sports and physical activities was positively associated with overall physical activity levels in females in grades 4 through 12. To our knowledge, this is the first study to include time of day as a factor when examining the relationship between physical activity and motor skill proficiency in females. Our results indicate that locomotor skill proficiency is positively related to weekday physical activity between 3-6pm in the females in our study. Given the positive relationship between locomotor skills and after-school physical activity participation, and the importance of the after-school period for overall physical activity levels (Sallis et al., 1999), improving the motor skills of young females may translate into increased overall physical activity. Teachers, school administrators, and recreation programmers could target the after-school period, in addition to the school-day, as an ideal time to provide young females with skill instruction and opportunities to be physically active in a non-competitive atmosphere.

Motor skill proficiency was found to be below what is expected for age among the participants in this study; this finding is consistent with previous literature (Hardy et al., 2012; Spessato et al., 2012). Why young females have poor motor skills is not well understood and could be the result of many factors; one possible factor is that there may be fewer opportunities for young females to practice these skills from a young age due to the gender norms associated with many sports and physical activities (Hardin & Greer, 2009; Koivula, 2001). However, it is also possible that a lack of motor skill proficiency is one of the driving forces behind the decision, by young females and their parents, to not participate in physical activity. Research indicates that children with poor motor skills often have negative experiences with physical activity, resulting in their withdrawal from the activity (Bouffard, Watkinson, Thompson, Dunn, & Romanow, 1996; Wall, 2004). Thus, it is possible that females are not engaging in physical activity due to negative experiences and a lack of confidence in their ability. For instance, females who are not proficient in running or throwing may not participate in activities requiring

those skills to avoid negative or failure experiences. By withdrawing from physical activity, females may also lose any opportunity for future skill development, which may contribute to further delays in their motor skills. In order to prevent physical activity drop-out due to lack of skill, it is critical that females receive motor skill instruction, and participate in skill based physical activities at a young age. It could also be beneficial for physical education teachers to provide a positive atmosphere where the focus is on skill development through activity stations, obstacle courses, and active games, rather than competition in traditional sports. Encouraging females to be engaged in physical education classes, activities at recess, and after-school programming, may promote physical activity and help with skill development.

Current Canadian physical activity guidelines state that children should be participating in 60 minutes of MVPA each day (Tremblay et al., 2011) and recent evidence indicates that children should be taking approximately 12,000 steps per day in order to meet this guideline (Colley et al., 2012). Our results indicate that the females in this study were not sufficiently active to meet these guidelines, regardless of the day of the week and this finding is consistent with larger, nationally representative samples of children (Colley et al., 2011). Participants in this study were more active on weekdays, when they were in school, than on weekends; and motor skill proficiency was not related to physical activity during the weekend. Weekends should provide children with more discretionary leisure time to be physically active because they are not in school during the day; yet children are consistently not active during the weekend (Garriguet & Colley, 2012). It is possible that children choose to spend their leisure time involved in more sedentary activities, such as watching television and playing video games, during this time (Sallis et al., 2000). Because children are more active on weekdays, more research is needed to investigate which factors are most important for promoting physical activity on the weekend, and whether skills learned in school will transfer to weekend activities, to help children meet the physical activity guidelines every day of the week. Creating a change in physical activity behaviour requires a multi-faceted approach; however, we propose that one strategy to increase physical activity on weekends is for the entire family to engage in skill based physical activities together, such as rollerblading, playing catch, or going to the park, because research indicates that when parents are active, their children are more likely to be active (Moore et al., 1991). Helping young females to develop their motor skills, through direct instruction in physical education, and enjoy physical activity, through non-competitive games and alternative activity options, at school may also provide them with the skills and confidence to choose to be physically active on their own time during the evenings and weekends.

As with all studies, there are limitations to these findings. The first limitation is the small sample. A larger sample would make the results more generalizable and add strength to the study. Despite a small sample size, significant relationships were still found between motor skill proficiency and physical activity, including during the after-school period, making it an area worthy of further investigation. A second limitation is that participants in this study were recruited through advertisements posted in recreational facilities. Therefore, our sample may not be representative of the general population of 6-9 year old females as those families attending recreational facilities likely have the time, resources, and interest to be more active than others. Given this limitation, the fact that our sample still had overall poor motor skills and low levels of physical activity emphasizes the need for intervention in these areas for all young females.

Previous research indicates that young females have poor motor skills and are physically inactive (Colley et al., 2011; Hardy et al., 2012; Hinkley et al., 2012; Hume et al., 2008; Spessato et al., 2012). This study examined the relationship between motor skill proficiency and physical

activity levels of a small sample of 6-9 year old females and the results indicate that locomotor proficiency is positively related to physical activity in the young females in this study. We propose that direct motor skill instruction, through activity stations, obstacle courses, and alternative group and individual sports, in physical education is one potential way to improve both motor skill proficiency and physical activity levels in females, and should be further investigated. The positive relationship between locomotor proficiency and physical activity is also present during the after-school period; this may provide an ideal time to implement additional school-based motor skill interventions for young females. Future research and early elementary school physical education curriculums should specifically target the motor skills of young females in order to provide them with the skills required to live a healthy, active life.

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