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Short Communication

Fundamental movement skills: Where do girls fall short? A novel investigation of object-control skill execution in primary-school aged girls

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ABSTRACT

Fundamental movement skill (FMS) proficiency is positively associated with a range of health outcomes, and is a predictor of lifelong participation in physical activities and sport. Yet low FMS proficiency levels in children prevail, particularly among girls performing object-control skills (e.g., kicking, catching). To identify where girls require the most support and inform future teaching resources and interventions, this cross-sectional study investigated proficiency levels of object-control skills and their specific performance components (subskills) in girls; and aimed to determine whether patterns in subskill mastery were evident in girls from two different developmental stages. This study included 153 girls (aged 4–12 years; mean age = 7.7, SD = 1.8) from the Hunter Region, Australia. Six object-control skills were video-assessed using the Test of Gross Motor Development (TGMD-2, TGMD-3); overall skill proficiency levels and mastery levels of subskills were determined. In summary, < 5% (of the total group, 4–8 years or 9–12 years) demonstrated mastery or advanced skill level in the strike, stationary dribble, overhand throw or kick. Mastery levels were also poor for the majority of the 24 subskills, with mastery levels below 40% for the total group for 17 of the 24 subskills. Deficiencies in specific subskills were evident in the preparation, action and recovery phases of the six object-control skills. Only 6 of the 24 subskills mastery levels were significantly higher in the older age-group. Our investigation provides new evidence that may be useful for practitioners and researchers looking to support the optimal development of FMS proficiency among girls.

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1. Introduction

Fundamental movement skills (FMS) have been described as the building blocks for movement, and form the foundation for many of the specialized movement skills needed to participate successfully in sport and physical activity (Gallahue and Ozmun, 2006). As FMS do not generally develop naturally, the skills need to be learned, practised and developed (Gagen and Getchell, 2006). Childhood is a critical time for FMS development as recent reviews have found FMS proficiency to be positively associated with a range of health, fitness and academic outcomes, participation in organised sports and sustained engagement in physical activity (Hardy et al., 2012; Jaakkola et al., 2015; Lubans et al., 2010; Stodden et al., 2014; Stodden et al., 2008).

FMS have been commonly categorized as locomotor skills (e.g., running, jumping, hopping) and object-control skills (e.g., catching, throwing, kicking) (Haywood and Getchell, 2009). The motor learning

literature outlines that most children (girls and boys) are developmentally capable of mastering all FMS by Grade 4 (approximately 10 years old) through the provision of developmentally appropriate activities and equipment, appropriate visual demonstrations of skills, instruction and feedback, a variety of relevant, enjoyable and challenging practice activities, and a positive learning environment (Gallahue and Ozmun, 2006). Alongside these environmental factors, biological factors impacting girls and boys can also influence the rate at which FMS are mastered by boys and girls alike (Gallahue and Ozmun, 2006). Globally, young people are also failing to perform FMS to their expected developmental capability. For example: in Ireland only 11% of 12–13 year olds achieved either mastery or near mastery for nine FMS (O'Brien et al., 2016); in New Zealand < 40% of children 5–13 years old mastered the kick, throw or strike (Mitchell et al., 2013); less than a quarter of children aged 6–9 years old in Hong Kong achieved mastery across 12 FMS (Pang and Fong, 2009); in the UK a large proportion of

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10–11 year old children rated as non-proficient in overall FMS competency levels (Fowweather, 2010); and in Singapore the majority of children aged 6–9 years old score ‘below average’ or ‘poor’ on both locomotor and object control skills (Mukherjee et al., 2017). These studies also demonstrate that boys generally outperform girls in FMS assessments; of concern is that 14%, 38% and 34% more Australian boys (in Grade 6) demonstrate advanced skill levels in object control skill such as the catch, kick and over-arm throw (respectively), than their female peers (Hardy et al., 2017).

Researchers have attempted to explain the vast differences between sexes, especially in throwing, with some researchers suggesting that environmental and socio-cultural factors explain why boys generally outperform girls at object-control skills (as boys generally spend more time participating in different ball games and gross motor activities that utilise and develop these skills) (Pate et al., 2004). This hypothesis is supported by Hyde (2005), who reviewed the extensive meta-analyses evidence relating to sex differences and reported that males and females are alike on most psychological variables at all ages (Hyde, 2005) - implying that differences in motor abilities in children are influenced by the learning environment. On the contrary and given that sex differences occur very early in life, other researchers claim that sex differences, especially in throwing, cannot simply be attributed differential experiences, and that innate psychological capacities relating to spatial targeting may influence performance in girls and boys (Watson, 2001). Consequently, low FMS proficiency levels and sex-differences in performance levels highlight the need for further investigation into FMS proficiency in young people (especially girls).

The prevalence of FMS mastery among Australian children and adolescents is also very low (Hardy et al., 2017). In a recent national physical literacy report card, where an ‘A’ represented the highest score (81–100% mastery), Australian children received a D (21–40% mastery) for ‘movement skills’ (Active Healthy Kids Australia, 2016). This rating was based on assessments of both locomotor (sprint, vertical jump, side gallop and leap) and object-control (kick, over-arm throw and catch) skills, of Grade 6 children. Of further concern, Australian girls consistently demonstrate poorer FMS proficiency than boys, particularly for object-control skills. For example, only 14% of Australian girls have mastered the kick and over-arm throw upon entering secondary school, compared to 52% and 53% of boys (respectively) (Hardy et al., 2017). However, there have been no studies reporting the specific components of individual object-control skills that girls may be proficient or deficient, or whether these vary by age. In order to maximize learning experiences for girls, it is important that researchers not only identify FMS component mastery levels, but that evidence-based and age-appropriate FMS programs are developed that specifically target areas of need (Hardy et al., 2012).

Therefore, the aims of this paper were 1) to determine mastery levels of six common object-control skills; 2) to examine overall and individual subskill mastery levels; and 3) to determine whether subskill mastery rates varied in girls from two different developmental stages.

2. Materials and methods

2.1. Study design

Guided by the STROBE statement this investigation reports baseline data from a randomized controlled trial which evaluated an intervention designed to improve physical activity levels in fathers and their pre-adolescent daughters. In total, 153 daughters (mean (SD) age = 7.4 (1.6) years, range 4–12 years) were recruited from the broader Newcastle region, NSW, Australia (Morgan et al., under review). Families were eligible if the father or male guardian lived with his daughters at least 3 days per week. All FMS data were collected prior to randomization.

2.2. Assessment measures

Ethics approval for the study was provided by the University of Newcastle's Human Research Ethics Committee. Assessments occurred in January 2015 by trained researchers.

2.2.1. Measurement of fundamental movement skill (FMS)

Girls' FMS competency was assessed using the standardized object-control skill protocols described in the *Test of Gross Motor Development* (TGMD-2 and TGMD-3) (Ulrich, 2000; Valentini et al., 2016). This validated assessment was designed to measure the gross motor functioning in children aged 3–10 via the assessment of 3–5 key skill components for each FMS (Ulrich, 2000; Valentini et al., 2016). After watching a demonstration of each skill, girls were individually filmed (on an iPad) performing two attempts of the kick, catch, dribble, overhand throw, two-handed strike (TGMD-2), and underhand throw (TGMD-3). The performance components of each skill were scored as present (“1”) or absent (“0”) for both trials by independent coders. Scores for each trial were summed to give total component scores, which were then added to give total skill scores. Aligning with the methods used by Cliff and associates (Cliff et al., 2012), the proportion of girls exhibiting mastery were calculated (defined as exhibiting all skill components during both trials, e.g., kick = 8/8) and advanced skill proficiency (defined as exhibiting ‘all’ or ‘all but one component’ during both trials, e.g., catch $\geq 5/6$) for each skill. Given that low FMS competency levels prevail among Australian children (especially in girls) despite increased efforts to target this issue in the past decade, our research team took a novel approach by investigating what specific aspects of object-control skills are problematic for girls, and reported sub-skill mastery. Included in Table 2 are the TGMD performance criteria for each of the six object-control skills tested. The six skills were selected due to their inclusion in the Australian health and physical education curriculum and their relevance to a wide variety of sports commonly played by children in Australia. The skills were categorized as either power skills (strike, kick and overhand throw) or control skills (stationary dribble, underhand throw, catch) for this study. The TGMD-2 was used for all but one object-control skill, with the TGMD-3 used for the underarm throw, as it was a new inclusion to the assessment tool (replacing the underarm roll).

2.3. Statistical analysis

The statistical analyses were conducted in IBM SPSS Statistics for Windows (Version 20) (SPSS, INC 2010, IBM Company, Armonk, NY). Overall mastery rates for each skill subcomponent are presented as counts and percentages. Chi-square tests were used to determine if significant differences in subskill mastery existed between girls in the ‘infant’ (4–8 years) and ‘primary’ (9–12 years) school stages. To account for the multiple analyses, the alpha was adjusted with a Bonferroni correction and the significance level was set at $p < 0.001$.

3. Results

The mean (SD) ages of girls was 7.7 years (SD 1.8) with 22% of girls meeting daily physical activity recommendations of 12,000 steps/day (Tudor-Locke et al., 2011). Based on estimates from the SEIFA Index of Relative Socio-economic Advantage and Disadvantage (Australian Bureau of Statistics, 2011) (1 = most disadvantaged, 10 = most advantaged), girls were represented from socio-economic postal areas (3–4 = 24%, 5–6 = 42%; 7–8 = 17%; 9–10 = 17%). Results were analysed based on the schooling stage of participants and on the two levels of Primary School that exists in Australian schools (Infants: Kindergarten to Grade 2 = ages 4–8; Primary: Grade 3–6 = aged 9–12) given that object-control skills are typically taught, learned, practiced and developed from Kindergarten to Grades 2, and explored, practised and applied in different contexts during Grades 3–6 within the

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