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Human Movement Science xxx (2015) xxx–xxx

Contents lists available at ScienceDirect

Human Movement Science

journal homepage: www.elsevier.com/locate/humov

Influences of gender and socioeconomic status on the motor proficiency of children in the UK

David Morley [a,*], Kevin Till [b], Paul Ogilvie [b], Graham Turner [c]

[a] *School of Education, Leisure and Sport Studies, Liverpool John Moores University, Liverpool, UK*
[b] *School of Sport, Leeds Beckett University, Leeds, UK*
[c] *Department of Sport, Health and Nutrition, Leeds Trinity University, Leeds, UK*

A R T I C L E I N F O

Article history:
Received 27 March 2015
Revised 22 May 2015
Accepted 27 August 2015
Available online xxxx

Keywords:
Motor proficiency
Children
Gender
Socioeconomic status

A B S T R A C T

As the development of movement skills are so crucial to a child's involvement in lifelong physical activity and sport, the purpose of this study was to assess the motor proficiency of children aged 4–7 years (range = 4.3–7.2 years), whilst considering gender and socioeconomic status. 369 children (176 females, 193 males, aged = 5.96 ± 0.57 years) were assessed for fine motor precision, fine motor integration, manual dexterity, bilateral co-ordination, balance, speed and agility, upper-limb co-ordination and strength. The average standard score for all participants was 44.4 ± 8.9, classifying the participants towards the lower end of the average score. Multivariate analysis of covariance identified significant effects for gender ($p < 0.001$) and socioeconomic status ($p < 0.001$). Females outperformed males for fine motor skills and boys outperformed girls for catch and dribble gross motor skills. High socioeconomic status significantly outperformed middle and/or low socioeconomic status for total, fine and gross motor proficiency. Current motor proficiency of primary children aged 4–7 years in the UK is just below average with differences evident between gender and socioeconomic status. Teachers and sport coaches working with primary aged children should concentrate on the development of movement skills, whilst considering differences between genders and socioeconomic status.

1. Introduction

Children's ability to perform movement skills develops at a prolific rate in the early years as they begin to acquire, refine and develop a range of gross and fine movement skills (Gallahue, Ozmun, & Goodway, 2012). The appropriate development of movement skills is regarded as a crucial platform for a child's participation in lifelong physical activity (Barnett, Van Beurden, Morgan, et al., 2009), although the exact nature of this relationship has been contested (Lai, Costigan, Morgan, et al., 2014). Furthermore, Seefeldt (1980) hypothesised that failure to develop a certain level of movement competence could result in a motor proficiency barrier, leading to a child's exclusion from a range of physical activities.

The development of reliable and validated tools that assess motor proficiency (the specific abilities upon which performance is built, e.g. agility, balance, co-ordination, running speed) has formed a cornerstone of motor development research for many decades. In most cases, motor proficiency assessment has involved the completion of tasks by participants and

* Corresponding author at: Liverpool John Moores University, IM Marsh Campus, Barkhill Road, Aigburth, Liverpool L17 6BD, UK.
E-mail addresses: d.m.morley@ljmu.ac.uk (D. Morley), k.till@leedsbeckett.ac.uk (K. Till), p.ogilvie@leedsbeckett.ac.uk (P. Ogilvie), g.turner@leedstrinity.ac.uk (G. Turner).

http://dx.doi.org/10.1016/j.humov.2015.08.022
0167-9457/

assessed in comparison to norm-referenced (compared to a normative group) quantifiable scores, or criterion-referenced against a set of pre-determined criteria (Cools, De Martelaer, Samaey, et al., 2008). Motor proficiency assessments are predominantly developed and validated for assessing children with motor impairments, suggesting that such assessments are of motor deficiency, rather than proficiency (Haywood & Getchell, 2005). Such assessments are also used as a way of measuring the impact of an intervention, predominantly involving a focus on improving children's movement competence and/or physical activity, on children's motor proficiency (Kirk & Rhodes, 2011).

The effect of gender on motor proficiency has been raised, with studies suggesting that girls develop fine motor skills at a faster rate than boys, and boys acquire certain gross motor skills earlier than girls (Bala & Katić, 2009). In research using the same assessment methods as used in this study, South African boys demonstrated overall motor proficiency superior to that of the girls and outperformed girls significantly in the upper limb and strength skills sub-items (Pienaar & Kemp, 2014). Paradoxically, other studies have reported no gender differences in motor proficiency (Milanese, Bortolami, Bertucco, Verlato, & Zancanaro, 2010), particularly in relation to younger children (Du Toit & Pienaar, 2002; Shala, 2009; Venetsanou & Kambas, 2011).

What is less commonly reported in the research literature is the relationship between motor proficiency and socioeconomic status (SES). A range of factors can be used to determine the SES of children. For example, the UK uses Indices of Multiple Deprivation (IMD) to measure SES within an area by postcode in terms of income, employment, health and disability, education, skills and training, barriers to housing and services and the living environment (Noble, McLennan, Wilkinson, et al., 2007). Studies in Australia have used similar indices of SES to explore FMS development of children in low-income communities, suggesting that such children start school developmentally delayed in FMS development (Okely & Booth, 2004), with early identification and targeted intervention seen as crucial in these environments if children are to be given the chance to catch up (Roeber, Tober, Bolt, et al., 2012). Other studies in Australia (Booth et al., 1999; Hardy, Reinten-Reynolds, Espinel, Zask, & Okely, 2012) have also highlighted an association between low movement competency and low SES, suggesting that Grade 2 (aged 7–8) and Grade 4 (aged 9–10) children had not mastered FMS expected at their stage of development. Whilst colleagues have presented some interesting findings from other Countries, this study adds further to our understanding of the field in that participants are younger, aged 4–7 years, and reside in a different country with its own social, political and cultural influences. Moreover, there is a general tendency to explore the relationship between motor proficiency and physical activity (Cohen, Morgan, Plotnikoff, et al., 2014) in understanding the influence of SES, rather than motor proficiency itself. This is not without cause as SES has been identified as a determinant of physical activity that can predispose, enable or reinforce physical activity behaviour (Inchley, Currie, Todd, et al., 2005).

There is a general shortage of research exploring motor proficiency of children in Europe, particularly within early years environments and this leads to a lack of normative data for cross-cultural uses of motor proficiency assessments (Cools et al., 2008). Furthermore, an understanding of how the development of motor proficiency is different for different children is even less understood. It is often assumed within schools that children have the prerequisite mastery of movement skills to be able to participate in organised and informal activities (Lubans, Morgan, & Cliff, 2010). However, with findings suggesting that organised physical activity within an institution such as a school is the most effective way to develop movement (Logan, Robinson, Wilson, et al., 2012), it is essential that we understand more about children's motor proficiency within this specific environment.

In the UK, there is a paucity of research that assesses the motor proficiency of children and determines the influences of gender and SES. Therefore, the purpose of this study was to assess children's motor proficiency across a number of primary schools (children aged 4–7 years) in the UK and to subsequently compare children's motor proficiency with gender and SES. Such findings would have serious implications for ensuring every child has access to lifelong pathways for participation in physical activity, as well as providing teachers and coaches appropriate information to be able to differentiate their practice effectively.

2. Methods

The research formed part of the 'Start to Move' research project (Youth Sport Trust (YST)/Bupa, 2014) and was funded by the YST/Bupa. The funding organizations played no role in any aspect of the research process and did not have the right to approve or disapprove of the publication.

2.1. Participants

Participants consisted of children ($n = 369$; females, $n = 176$; males, $n = 193$; aged 5.96 ± 0.57 years) from 14 primary schools in the North of England. Schools were randomly invited from a 'Start to Move' (Youth Sport Trust (YST)/Bupa, 2014) course delegate list, with 100% response rate. The ethics committee at Leeds Beckett University granted ethical approval. The Head teacher, teachers and parents provided consent, with informed assent provided by participants.

2.2. Procedure

Motor proficiency was assessed using the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition Brief Form (BOT-2 BF). All data collection was conducted during scheduled physical education classes, providing as naturalistic a setting as possible, in each of the participating schools. Gender, classified as male or female, and date of birth was collected for each participant. In addition, SES was calculated for each participating school by collecting United Kingdom's Indices of Multiple Deprivation (IMD). Each school's IMD was classified as low = below 10,894, medium = 10,895–21,788 and high as above 21,789. Therefore, 'low' IMD represented a lower SES than medium or high IMD. In the absence of individual participant postcode data, the IMD of the school provided the 'next-best' source of a participant's SES as a result of the use of 'catchment areas'. Catchment areas are determined by a number of factors including distance from home to school and are predominantly used to allocate places in oversubscribed schools. It can be assumed, given the existing population explosion at this age range (Department for Education (DfE), 2014a), that the majority of school places will be allocated to children within their catchment area (DfE, 2014b).

2.3. Measures

The BOT-2 BF was selected for its suitability to assess children with and without motor problems and strong test–retest reliability (Yoon, Scott, & Hill, 2006), as well as being a validated assessment instrument for motor proficiency for participants aged between 4 and 21 years of age (Bruininks & Oseretsky, 2010). The BOT-2 BF consisted of 12 measures of motor proficiency, which are categorised into sub-tests to assess fine motor precision, fine motor integration, manual dexterity, bilateral co-ordination, balance, speed and agility, upper-limb co-ordination and strength.

All the test items and sub-tests originated from the full assessment and were selected for "clinical utility, content coverage, and ease of administration" (Bruininks & Oseretsky, 2010). Test stations were established to allow multiple participant assessments, simultaneously. The child, guided by the examiner, determined whether a full or knee push-up was the most appropriate assessment of strength based on the pupil's performance in other areas, as per the BOT-2 BF manual (Bruininks & Oseretsky, 2010). A research team was collectively trained to administer the test, primarily through jointly observing participant performance of each element of the test. This training process was repeated until an analysis of the inter-observer reliability produced an interclass correlation coefficient of 1.00 ($n = 27$; 95% CI = 0.99–0.1.00), indicating excellent agreement between the responder's observations.

2.4. BOT-2 BF scoring

The standard score for each pupil was reached by converting the total points score (max = 72) to the standard score, using the gender-specific norms provided (Bruininks & Oseretsky, 2010). This took the child's age, gender and choice of strength assessment (push-up: full/ knee) into account when assessing their performance. Standard scores were classified as >70 = well above average, 60–69 = above average, 41–59 = average, 31–40 = below average, and <30 = well below average. Individual fine motor proficiency (items 1–7) and sub-section items (totals for fine motor precision/integration (items 1–4) and bilateral co-ordination (items 5–7)), and gross motor proficiency (items 8–12) were also calculated in relation to their raw score.

2.5. Statistical analysis

Data are presented as means and standard deviation (SD). Initial descriptive scores were calculated for the BOT-2 standard score and subsequent descriptive category. To compare the motor proficiency between gender and SES, mean and standard deviation scores were calculated for all elements of the BOT-2 motor proficiency assessment. A multivariate analysis of covariance (MANCOVA) test, with chronological age applied as the covariate, was used for comparisons between gender and SES. Chronological age was applied as a covariate to control for the relationships between age and motor proficiency and progress on the standardised scoring of the BOT-2, which doesn't class chronological age as a continuous variable and this was included within individual and sub-section scores.

Bonferroni pairwise comparisons were conducted to examine univariate effects between each dependent variable. All analyses were conducted with SPSS version 21.0 with significance levels set at $p < 0.05$. Effect sizes using partial eta squared (η^2) were calculated and interpreted as 0.01 = small, 0.06 = medium and 0.14 = large according to Cohen (1988).

3. Results

Table 1 shows the mean standard scores obtained in the BOT-2-BF and when classified into descriptive categories by gender and SES. The standard score for all participants was 44.4 ± 8.9 classifying the participants towards the lower end of the average group. On an individual level, most of the participants were classified in the average ($n = 241$; 65.3%) or below average ($n = 95$; 25.7%) categories. Of the remaining 33 participants, 18 scored well below average and 15 above average.

Table 1
Standard score for BOT-2-BF according to gender and SES.

			Well above average >70 (%)	Above average 60–69 (%)	Average 41–59 (%)	Below average 31–40 (%)	Well below average <30 (%)
Gender							
Males	193	44.9 ± 9.2	0 (0)	10 (5.2)	130 (67.4)	43 (22.2)	10 (5.2)
Females	176	43.8 ± 8.6	0 (0)	5 (2.8)	111 (63.0)	52 (29.6)	8 (4.6)
SES							
Low	108	43.4 ± 10.7	0 (0)	3 (2.8)	60 (55.6)	41 (40.0)	4 (3.6)
Medium	134	46.4 ± 7.4	0 (0)	4 (3.0)	102 (76.1)	26 (19.4)	2 (1.5)
High	127	43.1 ± 8.3	0 (0)	8 (6.3)	79 (62.2)	28 (22.0)	12 (9.4)

Table 2
Differences in motor proficiency by gender.

	Male Mean ± SD	Female Mean ± SD	Covariate Age	P	η^2
Fine motor					
Star	1.9 ± 0.5	2.1 ± 0.4	*	***	0.06
Line	1.7 ± 1.5	2.1 ± 1.7	***	*	0.01
Circle	4.0 ± 1.7	4.5 ± 1.5	**	**	0.02
Diamond	3.1 ± 1.7	3.0 ± 1.9	***	NS	0.00
Precision total	10.7 ± 3.6	11.7 ± 3.6	***	**	0.02
Manual dexterity	2.7 ± 1.3	2.9 ± 1.2	***	NS	0.01
Touch nose	3.2 ± 1.2	3.5 ± 1.0	***	*	0.01
Thumbs and finger	1.4 ± 1.2	1.6 ± 1.3	***	NS	0.00
Bilateral dexterity total	4.8 ± 1.8	5.1 ± 1.8	***	NS	0.01
Fine motor total	18.2 ± 5.0	19.8 ± 5.0	**	**	0.03
Gross motor					
Balance	2.5 ± 1.6	2.7 ± 1.5	***	NS	0.01
Speed and agility	2.3 ± 1.8	2.5 ± 1.8	***	NS	0.00
Catch	0.5 ± 1.0	0.2 ± 0.6	**	**	0.02
Dribble	1.9 ± 1.4	1.6 ± 1.4	***	**	0.02
Strength	2.2 ± 1.9	2.0 ± 1.9	***	NS	0.00
Gross total	9.3 ± 4.9	8.9 ± 4.3	***	NS	0.00
Total	30.1 ± 11.7	31.8 ± 11.1	***	NS	0.01

* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$.

Table 2 shows the gender differences in motor proficiency. MANCOVA demonstrated significant effects of chronological age ($F_{14,349} = 18.53$, $p < 0.001$, $\eta^2 = 0.46$) and gender ($F_{14,349} = 3.86$, $p < 0.001$, $\eta^2 = 0.14$). Using chronological age as a covariate, age was related to every element of the BOT-2 BF. When controlling for age, significant gender differences were identified for star, line, circle, precision total, touch nose, fine motor total, catch and dribble. Females outperformed males for all fine motor skills, whilst males outperformed females for catching and dribbling ability. Effect sizes for all variables were trivial to small except for the star, which were moderate.

Table 3 shows the differences in motor proficiency ability between high, middle and low SES children. MANCOVA demonstrated significant effects of SES ($F_{30,698} = 10.2$, $p < 0.001$, $\eta^2 = 0.314$). In relation to total score a significant large difference was identified with high and middle SES outperforming low SES. For fine motor skills, when controlling for age, significant differences between SES groups were identified for line, circle, precision total, manual dexterity and fine motor total. High SES significantly outperformed middle and/or low SES for each variable where significant differences were found. Low SES only significantly outperformed middle SES for line ability. Effect sizes demonstrated a large effect for line and manual dexterity with a moderate effect shown for fine motor total. For gross motor skills, when controlling for age, significant differences between high and low SES were identified for speed and agility, dribble, push up and gross total. High and middle SES outperformed low SES for speed and agility, push up and gross total with high and low outperforming middle SES for dribble performance. Large effect sizes were only identified for speed and agility.

Table 3
Differences in motor proficiency by SES.

	High (n = 106)	Middle (n = 127)	Low (n = 134)	P	η^2	Pairwise
Fine motor						
Star	2.0 ± 0.4	2.0 ± 0.4	1.9 ± 0.6	NS	0.01	
Line	2.6 ± 1.6	1.1 ± 1.2	2.0 ± 1.8	***	0.10	H > L > M
Circle	4.5 ± 1.5	4.4 ± 1.8	4.0 ± 1.6	*	0.02	H > L
Diamond	3.2 ± 1.7	3.1 ± 2.0	2.9 ± 1.5	NS	0.01	
Precision total	12.4 ± 3.6	10.6 ± 3.4	10.8 ± 3.7	**	0.03	H > M,L
Manual dexterity	3.5 ± 1.2	2.8 ± 1.1	2.3 ± 1.1	***	0.16	H > M > L
Touch nose	3.3 ± 1.0	3.2 ± 1.2	3.4 ± 1.2	NS	0.01	
Thumbs and finger	1.6 ± 1.2	1.6 ± 1.3	1.4 ± 1.3	NS	0.01	
Bilateral dexterity total	4.9 ± 1.6	5.2 ± 1.9	4.8 ± 1.8	NS	0.02	
Fine motor total	20.8 ± 5.0	18.6 ± 4.6	17.9 ± 5.1	***	0.06	H > L
Gross motor						
Balance	2.7 ± 1.5	2.6 ± 1.5	2.5 ± 1.5	NS	0.01	
Speed and agility	2.7 ± 2.0	2.9 ± 1.7	1.7 ± 1.5	***	0.13	H,M > L
Catch	0.4 ± 0.9	0.4 ± 0.8	0.3 ± 0.8	NS	0.00	
Dribble	2.0 ± 1.7	1.3 ± 1.0	2.0 ± 1.6	**	0.03	H,L > M
Strength	2.3 ± 1.8	2.2 ± 2.0	1.8 ± 1.6	**	0.02	H,M > L
Gross total	10.0 ± 5.0	9.4 ± 4.4	8.3 ± 4.4	**	0.04	H,M > L
Total	34.8 ± 13.8	32.7 ± 10.5	26.2 ± 8.2	***	0.16	H,M > L

* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$.

4. Discussion

The primary purpose of this study was to assess the motor proficiency of primary school (4–7 years) children in the North of England, with a secondary purpose of subsequently comparing children's motor proficiency according to gender and SES. To our knowledge, this is the first study to assess the motor proficiency of children aged 4–7 years, exploring the effect of gender and SES, in the UK. Overall, findings demonstrated that UK children performed below average to average on the BOT-2 BF motor proficiency assessment. When compared by gender, females outperformed males for fine motor skills, whilst males outperformed females for the gross motor skills of catching and dribbling. When SES was compared, high and middle SES significantly outperformed low SES for total, fine and gross motor skills.

The average standard score of this cohort (44.9) was on the average to below average boundary with 89.6% of participants' scores falling within this range. This potentially raises some concern as it indicates that approximately a quarter of 4–7 year olds in the current study score below average for motor proficiency. What is even more worrying about the low average score of participants is that the BOT-2 BF motor proficiency assessment tool is designed to assess motor deficiencies and therefore consists of basic tasks. These findings coincide with previous research findings worldwide that typically demonstrate average or below average motor proficiency in children (Okely & Booth, 2004; Sigmundsson & Rostoft, 2003), with few exceptions (Chow, Henderson, & Barnett, 2001).

Variation in motor proficiency of children from different countries has been previously reported (Adolph, Karasik, & Tamis-LeMonda, 2010), with influencing factors ranging from family expectations to the quality of stimulation at home (Hills, Anderson, & Byrne, 2011). Children's decline in motor proficiency has been supported elsewhere, although the impact of the general living environment has been evidenced as less important than changes in lifestyle activities on the movement behaviour of children (Kretschmer et al., 2014). In light of the reported variations in children's motor proficiency between different countries and evidence of the decline in the motor proficiency of children, it is important to understand reasons that may be impacting upon the motor proficiency of 4–7 year olds within the UK. One potential explanation for the low level of children's motor proficiency in this study is the recent shift in government policy with the dismantling of School Sport Partnerships and withdrawal of funding for the Physical Education and Sport Strategy in the UK (DfES, 2003; Bardens et al., 2012). Another reason could be the inadequate preparation of Primary school teachers to teach PE, with reports that a lack of specialist Physical Education subject knowledge remains a major weakness affecting the quality of Primary school provision (Ofsted, 2013). Whilst the impact of more recently introduced initiatives (DfE/Education Funding Agency, 2014) for Primary school Physical Education and sport are yet to be fully understood it remains imperative that teachers and coaches who are responsible for introducing young children to sport have an understanding of how to provide an environment where developing movement patterns and sequences can be nurtured and improved (Malina, 2012).

Given the limited research within this age-range of participants, previous research has highlighted the need to identify skill-specific differences in the mastery of movement skills, in order to adequately inform subsequent interventions and promote children's movement development effectively (Cools et al., 2008). In this vain, females in this study outperformed males for all fine motor skills, whilst males outperformed females for the elements of gross motor skills involving catching

Please cite this article in press as: Morley, D., et al. Influences of gender and socioeconomic status on the motor proficiency of children in the UK. *Human Movement Science* (2015), http://dx.doi.org/10.1016/j.humov.2015.08.022

and dribbling, as reported elsewhere (Bala & Katić, 2009; Sigmundsson & Rostoft, 2003) These differences could be attributed to stereotyped practices both within the school and home environments that support physical activity and play practices that facilitate the development of certain movement skills. This could relate, for instance, to gender influence on the selection of toys for play (Weisgram, Fulcher, & Dinella, 2014), with toys traditionally associated with boys being more likely to include sports equipment, whereas toys traditionally associated with girls were more likely to include dolls, fictional characters, and furniture, amongst other items (Pomerleau, Bolduc, Malcuit, & Cossette, 1990). Gender-biased play preferences might also contribute to the differences in motor proficiency, with boys playing more physical games than girls (Lindsey & Mize, 2001).

Interestingly, in the current study, effect sizes between genders demonstrated trivial to small differences in motor proficiency with results from the vast majority of subsets suggesting that the significant differences found in other studies were less prevalent within this age group, most notably strength (Pienaar & Kemp, 2014). In one of the rare UK studies, albeit with 7–10 year olds, a study by Duncan, Stanley, and Leddington-Wright (2013) reported no gender differences in motor proficiency when considered as total scores, but girls outperformed boys on the hurdle step and straight leg raise with boys outperforming girls on the trunk stability push-up. Other studies have reported varying and often conflicting perspectives on the significance of gender in motor proficiency when studying preschool children (Bala & Katić, 2009). Considering the trivial to small significance of gender differences, our results go some way to support the notion that the significance of the gender effect becomes more prominent as children age and biological diversity becomes pronounced (Barnett et al., 2009).

Empirical research has demonstrated a positive association between SES and FMS mastery (Cohen et al., 2014). Furthermore, the use of an ecological systems theory approach to understanding motor proficiency has yielded some interesting correlations between the child, family and environment, suggesting that early motor development is influenced by parental support and the child's immediate surroundings (Barnett, Hinkley, Okely, et al., 2013). Perhaps the most striking finding from this study is the strength of the relationship between SES and motor proficiency, with socially disadvantaged children having significantly lower motor proficiency than socially advantaged children. Specifically, socially disadvantaged children significantly underperformed, in comparison to socially advantaged children, on the majority of gross motor skill subsets apart from two (balance and catch). Other authors have reported similar general findings in their studies of children the same age as this study in other countries (McPhillips & Jordan-Black, 2007). Furthermore, the authors also established a correlation between motor deficit and reading attainment, suggesting that motor deficiency has more wide-ranging impact than solely inhibiting children in their full involvement in physical activity. As gross motor skill proficiency is a likely determinant of children's subsequent physical activity patterns, these findings suggest that this prevalence of motor deficiency could lead to a life of exclusion from physical activity for socially disadvantaged children.

5. Conclusions

Strengths of this study relate to the exploration of the large sample size drawn from a range of schools and the use of children from the UK as participants. Whilst other measurement instruments may have been deemed more suitable to assess typical motor development of the specific age range of participants in an educational setting, the breadth of skills coverage and number of detailed sub-elements deemed the BOT-2 BF the most appropriate measurement tool.

Whilst the relationship between the mastery of FMS and participation in physical activity remains inconclusive (Lai et al., 2014), there is sufficient evidence from longitudinal studies (Jaakkola & Washington, 2013) to suspect a relationship that consequently heightens the importance of movement in children's ability to access a range of physical activity experiences. The current findings suggest that teachers, sports coaches and physical activity specialists need to concentrate on movement-based approaches in their delivery and differentiate practice for different genders, particularly in the development of gross motor skills. Those responsible for the development of interventions in related fields need to be mindful of the motor deficits evidenced within this study and ensure they provide targeted and differentiated programs for socially disadvantaged children and female participants. Researchers have also suggested the need to further understand the movement ability of children in the wider constructs of the assessment of physical literacy within schools (Gublin, Collins, & Button, 2014) and involve teachers in the assessment of children's motor proficiency (Cools et al., 2008). Although this study has started to do this with UK primary school children, future developments are crucial if motor proficiency assessment is going to have a subsequent positive affect on the appropriate development of children's movement, over and beyond the relatively small-scale, cross-sectional, studies that currently exist.

6. Uncited reference

Goodway and Branta (2003).

Acknowledgements

Thank you to the staff and students responsible for the data capture and other members of the Start to Move project team for their thoughts and comments on initial thoughts around this manuscript. The Youth Sport Trust and Bupa funded this research.

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Please cite this article in press as: Morley, D., et al. Influences of gender and socioeconomic status on the motor proficiency of children in the UK. *Human Movement Science* (2015), http://dx.doi.org/10.1016/j.humov.2015.08.022