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Adolescents' self-reported motor assessments may be more realistic than those of their parents

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1 People with low motor competence (LMC) are unable to perform many motor tasks with the
2 same level of proficiency as their peers. They experience difficulties in performing many
3 activities of daily living (ADLs) such as dressing and using eating utensils (Dunford et al., 2005).
4 This condition may be formally diagnosed as Developmental Coordination Disorder (DCD;
5 American Psychiatric Association [APA], 2013; Kirby et al., 2011) when all criteria in the
6 Diagnostic and Statistical Manual (fifth edition; DSM-5) are met. Some will outgrow the
7 condition (APA, 2013; Kirby et al., 2011), however between 50-70% of those identified during
8 childhood still experience motor difficulties into adolescence and adulthood (Purcell et al.,
9 2015).

10 The adolescent phase is thought to span from 12- to 22-years of age (Harter, 2012) and is
11 considered to be when an individual develops an independent identity separate to their parents
12 (Kroger, 2007). Therefore adolescence is an important time for those with LMC to receive
13 support as they face many social-emotional and physical challenges during this phase (Hill et al.,
14 2011; O'Dea and Connell, 2016) and may conceal their motor difficulties from their parents.
15 Unfortunately, many remain undiagnosed or unsupported for a number of reasons. Parents may
16 be unaware of the existence of the disorder or visit many health professionals before receiving a
17 diagnosis (Missiuna et al., 2006a). Other parents may place their concerns on the 'back burner'
18 as motor difficulties are able to be managed at home (Missiuna et al., 2006b) or their child is
19 given a different diagnosis due to symptoms being similar to other developmental disorders such
20 as Autism Spectrum Disorder (ASD), learning difficulties or Attention Deficit Hyperactivity
21 Disorder (ADHD; Kirby et al., 2007). Finally, adolescents with LMC may adopt coping
22 mechanisms that mask or hide their difficulties (Fitzpatrick and Watkinson, 2003), particularly

1 from their parents or peers in order to fit in (Hill et al., 2011). For example, many conceal
2 bullying or peer-victimization from their parents which may lead to less social opportunities and
3 lower levels of social support (Missiuna et al., 2008). The lack of peer support experienced by
4 some (O’Dea and Connell, 2016; Payne et al., 2013) may contribute to lower levels of self-worth
5 (Skinner and Piek, 2001) and associated internalizing behaviors (Cairney et al., 2013). The
6 recognition of motor difficulties by parents during adolescence would attract support in the
7 development of strategies to negotiate social-emotional challenges; (Skinner and Piek, 2001;
8 Rose et al., 2015; Payne et al., 2013) and improve life satisfaction and employment opportunities
9 as they enter adulthood (Kirby et al., 2013).

10 A parent’s awareness of their child’s level of motor skill competence may differ between
11 male and female children (Liong et al., 2015). This could be related to differences in social
12 expectations, physical activity preferences (Cairney et al., 2012) or skill proficiency. A
13 longitudinal study found age-related gender differences in motor skill proficiency (Barnett et al.,
14 2010). Proficiency of kicking, catching and throwing improved for males from childhood to
15 adolescence to a greater extent than females (Barnett et al., 2010). This could be related to
16 different social experiences as males tend to socialize more through vigorous ball-related
17 physical activities and competitive sports, whereas females are more likely to socialize during
18 sedentary activities such as talking with friends or shopping (Cairney et al., 2005; Lingam et al.,
19 2013; Hill et al., 2011; Payne et al., 2013). Consequently, movement difficulties experienced by
20 adolescent females may not be recognised by their peers or parents.

21 Some parents may realize their child has motor difficulties due to their poorer
22 performance and lower levels of participation in physical tasks or limited social interactions
23 (Cairney et al., 2005; Cairney et al., 2012). Many, however, have difficulties understanding their

1 child's motor delay which may cause feelings of uncertainty about their parenting and lower
2 levels of confidence in providing support (Barnett et al., 2013). Others may over assist by
3 completing daily tasks for their child (Missiuna et al., 2006b) or experience feelings of
4 helplessness when their young person refuses assistance (Kirby et al., 2011). Brown and Lane
5 (2014) found parents accurately reported their child's fine motor control and manual
6 coordination when compared to a performance based measure but were not able to accurately
7 identify issues in other domains such as upper-limb coordination. During adolescence, peer
8 comparisons become more important regardless of level of motor competence however among
9 those with LMC this may have a negative impact (Payne et al., 2013). Therefore, it is important
10 to consider the type of motor assessment tools designed for adolescents as parents may not fully
11 understand nor be aware of the personal challenges or school-based issues faced by their young
12 person (Hill et al., 2011; Pannekoek et al., 2012). Parents may be unaware that their adolescent
13 has LMC as many avoid sharing or revealing difficulties they experience regarding school-based
14 issues or interpersonal relationships with their parents (Gagnon-Roy et al., 2016). Alternatively,
15 some parents may simply think their son or daughter is non-sporty and not realise the level of
16 angst being experienced by them and the impact LMC can have on a range of health outcomes
17 (Missiuna et al., 2008). A parent who is aware of their child's motor competency may be able to
18 assist them in negotiating these personal and social difficulties (Kirby et al., 2011b). The
19 purpose of this study, therefore, is to compare a parent reported assessment of adolescent motor
20 competence and associated difficulties to self-reported assessment by the adolescent.

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Method

Study sample

The sample comprised 133 adolescent and parent dyads. The participants were recruited through personal contacts ($n = 6$), an adolescents movement clinic ($n = 4$) community sporting clubs [Australian Rules Football League (AFL, $n = 62$), netball ($n = 5$) and basketball clubs ($n = 4$)] and local schools [independent ($n = 47$) and government ($n = 5$)] over a two year period. The inclusion criteria for adolescents were; aged between 12 and 16 years, English as a first language, good linguistic and cognitive ability sufficient to comprehend questions, and no other diagnosed disability such as cerebral palsy, learning difficulties or muscular dystrophy. No inclusion criteria were specified for parents or guardians. Parents were asked if their adolescent had sufficient language and cognitive capabilities to comprehend the questions and if they had any other diagnosed disabilities. This project was approved by the Human Research Ethics Committee of the University of Notre Dame in Perth, Western Australia.

Measures

Motor competence.

Adolescents. The Adolescent Motor Competence Questionnaire (AMCQ; Timler et al., 2016) is a self-report measure of motor competence. The 26-item questionnaire was developed for adolescents between the ages of 12- to 18-years to examine the ecological (skill level in physical surroundings) presence of motor tasks and functional activities of daily living and was informed by the DSM-V criteria for DCD (APA, 2013). Responses are based on a 4-point Likert scale of Never (1), Sometimes (2), Frequently (3), and Always (4) resulting in a maximum score of 104; a higher score represents a higher motor competence. Concurrent validity of the

1 questionnaire was established against the McCarron Assessment of Neuromuscular Development
2 (MAND; $r = .49$, $p < .002$, proportion of agreement = 74%, sensitivity = 80%, specificity = 70%).
3 A score of 83 or below on the AMCQ indicates that motor difficulties may be present. This was
4 matched to the cut score for LMC on the MAND (Timler et al., 2016). The AMCQ has test re-test
5 reliability (intra-class correlation coefficients = 0.96), and internal consistency ($\alpha = 0.90$; Timler
6 et al., 2016) and can be completed in less than 10 minutes.

7 **Parents.** Parent reported adolescent motor competence was measured by the
8 Developmental Coordination Disorder Questionnaire-2007 (DCDQ'07; Wilson et al., 2009).
9 The DCDQ'07 is designed for parents of children 5- to 15-years-old. Parents are asked to
10 compare their child's motor performance to that of their child's peers. It consists of 15 items
11 which represent three subscales (Control During Movement, Fine Motor/Handwriting, and
12 General Coordination) and uses a 5 point Likert scale of Not at all like your child (1), A bit like
13 your child (2), Moderately like your child (3), Quite a bit like your child (4), and Extremely like
14 your child (5). A maximum score is 75. For children aged between 10- to 15-years-old, scores
15 below 57 indicate motor difficulties or suspected motor difficulties (Wilson et al., 2009).
16 Evidence of internal consistency ($\alpha = 0.95$) and concurrent validity ($r = 0.34$, $p = .001$) has been
17 established with an Australian adolescent sample (Pannekoek et al., 2012).

18 **Adolescent Impulsivity and Hyperactivity.**

19 As ADHD often co-occurs with DCD (Kirby et al., 2007), the Swanson, Nolan and Pelham-IV
20 (SNAP-IV Teacher and Parents Rating Scale; Gau et al., 2008) was used to screen for this
21 condition. The SNAP-IV is an 18-item norm-referenced checklist and uses a 4 point Likert scale
22 of: Not at all (0), Just a Little (1), Quite a bit (2), and Very Much (3). It consists of three

1 subscales (ADHD-Inattention, ADHD-Hyperactivity-Impulsivity and ADHD-Combined). The
2 score for each subscale is calculated, and the Average Rating per Item is compared to the 5%
3 cutoff scores. The scale has evidence of test-retest reliability (intra-class correlation coefficients
4 = 0.59~0.72), internal consistency ($\alpha = 0.88\sim 0.90$) and concurrent validity (Gau et al., 2008).

5 **Procedures**

6 This study employed a quantitative design. The AMCQ was used for the adolescent sample as it
7 is the only self-report motor competence measure available for this age range. The DCDQ'07 is
8 the most widely used and recognised parent-report measure for assessing motor competence. The
9 development of both questionnaires were informed by the DCD criteria outlined in the DSM
10 (fourth version, text Revision; DCDQ'07; fifth version; AMCQ) and contain similar items that
11 capture every day and sports based motor performance activities. Recruitment took place over a
12 two year period. Questionnaires and written consent forms were distributed to sporting clubs
13 and collected two weeks later (response rate 71/162 = 44%) . Depending on the school, the
14 questionnaires and consent forms were completed as hard copies or online. Schools that opted
15 for hard copies obtained written consent before the adolescents completed the AMCQ during an
16 allocated class (response rate 52/162 = 32%). The parent questionnaires (DCDQ'07 and SNAP-
17 IV) were sent home to be completed and returned to school the following day. Twenty-nine
18 parent questionnaires were not returned, however a high overall response rate was achieved
19 (adolescents response rate 133/162 = 82%, parents response rate 133/141 = 94%). Six schools
20 used the online version which enabled teachers and year group coordinators to email parents
21 about the study. Adolescents and parents ($n = 14$) were able to complete questionnaires and
22 online consent forms at a convenient time to them. It took adolescents 10 minutes, and parents

1 approximately 15 minutes to complete questionnaires. The overall response rate for returned
2 adolescent questionnaires was 39% (162/415). Of the 162 adolescent questionnaires returned,
3 only 133 parents also responded, thereby reducing the total sample included in the analysis to
4 133.

5 **Data Analysis**

6 SPSS version 23 (SPSS Inc., Chicago, IL, USA) was used to analyze the data. Descriptive
7 statistics were derived for the total sample, males and females. The data (AMCQ, DCDQ'07 and
8 SNAP-IV) were tested for normality and based on acceptable skewness and kurtosis values the
9 appropriate parametric tests were used. For the analysis only the Total DCDQ'07 score was used
10 and the SNAP-IV subscales were combined to group the sample into those with and without
11 ADHD for descriptive purposes. The sample was also grouped into high and low motor
12 competence based on the Total AMCQ (cut score ≤ 83) and DCDQ'07 (cut score ≤ 57) scores.
13 Case agreement calculations for the two groupings were derived. Pearson's correlation was used
14 to examine the relationship between the Total DCDQ'07 and AMCQ scores. Independent t-tests
15 were completed to examine differences between scores for male and female adolescents, mother
16 and father responses, hardcopy and online completion and those whose parents reported their
17 child did or did not have ADHD.

18 **Results**

19 Descriptive data for 133 pairs of adolescent (66.2 % males, $M_{age} = 14.49$ years, $SD = 0.794$, 12
20 to 16 years; 88 males, 45 females) and parent motor competence measures are reported in Table
21 1. A total of 103 mothers and 30 fathers participated in the study. Overall, males had higher
22 AMCQ scores compared to females. There were no significant differences between scores for

1 male ($M = 66.24, SD = 10.98$) and female adolescents ($M = 64.07, SD = 12.36; t(129) = .96,$
 2 $p = .303$) or questionnaire scores completed by fathers ($M = 68.67, SD = 7.53$) and mothers ($M =$

SNAP-IV measure	Non-ADHD 117 (89) M (SD)	ADHD 14 (11) M (SD)	Group P	
AMCQ	88.33 (10.43)	76.50 (13.84)	.007	64.58, $SD =$
DCDQ'07	67.33 (8.7)	49.29 (18.10)	.003	12.25; $t(131) =$ -1.73, $p = .096$

6 on the DCDQ'07.

7 Table 1.

8 *Descriptive statistics [M(SD)] for age, AMCQ, and DCDQ'07 measures for total sample, males*
 9 *and females.*

Measures	Total (N = 133) M(SD)	Males (n = 88) M(SD)	Females (n = 45) M(SD)	Gender p
Age	14.49 (.79)	14.44 (.80)	14.58 (.78)	.357
AMCQ	87.15(11.33)	89.68 (11.08)	82.20 (10.24)	.001
DCDQ'07	65.50 (11.46)	66.24 (10.98)	64.07 (12.36)	.303

10 AMCQ, Adolescent Motor Competence Questionnaire; DCDQ'07, Developmental Coordination Disorder Questionnaire, 2007;

11 SNAP-IV scores were derived for 131 of the 133 adolescents. Of these, 14 parents
 12 (10.7%; 10 males and 4 females) reported their child had some form of ADHD (Table 2). The
 13 data for these cases were retained in the study, as DCD is often diagnosed alongside ADHD
 14 (Kirby et al., 2007). There were no significant differences between hardcopy and online versions
 15 for the AMCQ scores ($p = .06$) or the DCDQ'07 ($p = .21$). Overall 114 hardcopy (85.7%)
 16 questionnaires and 19 online questionnaires (14.3%) were completed.

17 Table 2.

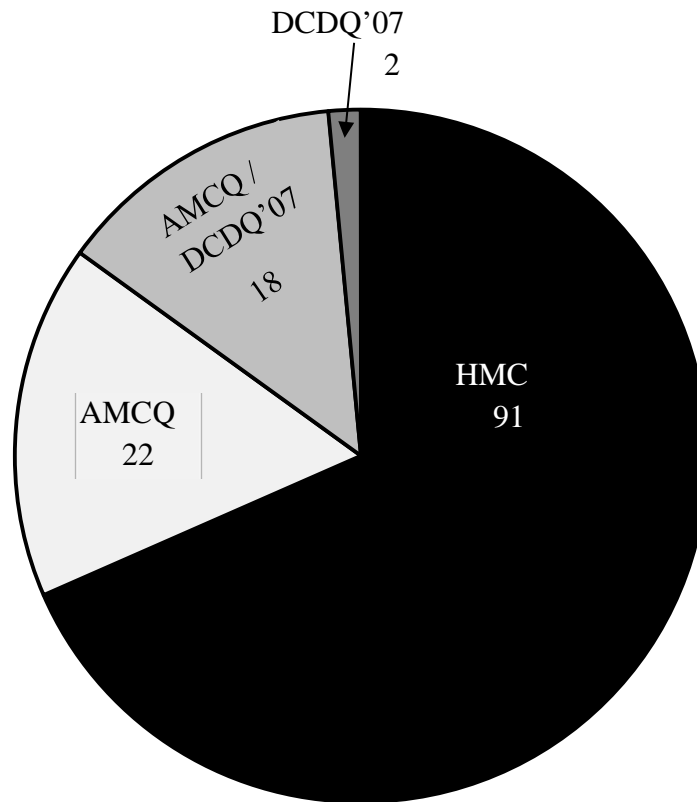
18 *Descriptive statistics [M(SD)] for SNAP-IV (N = 131) results between ACMQ and DCDQ07*

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SNAP-IV measure	Non-ADHD 117 (89) M (SD)	ADHD 14 (11) M (SD)	Group P 3 4
AMCQ	88.33 (10.43)	76.50 (13.84)	.007
DCDQ'07	67.33 (8.7)	49.29 (18.10)	.003 ⁵

6 SNAP-IV, Swanson, Nolan and Pelham-IV

7 There was a moderate positive correlation ($r = .56, p < .001$) between the Total AMCQ
8 and the Total DCDQ'07 scores. The overall proportion of agreement between the DCDQ'07 and
9 the AMCQ was 0.82 (Figure 1). This was primarily due to the high proportion of case
10 agreements for those with HMC ($n = 91$; 68.4% of sample). On the other hand, 42 cases were
11 identified with LMC by either the DCDQ'07 or the AMCQ. Of these, only 18 parent
12 (DCDQ'07) and adolescent (8 females and 10 males; AMCQ) dyads agreed. The AMCQ scores
13 identified more cases with LMC. Twenty two cases were identified by the AMCQ only and 2
14 cases by the DCDQ'07 only.



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2 N = 133, Proportion of agreement = 0.82

3 *Figure 1.*

4 The proportion of Agreement between these identified with LMC by the Adolescent Motor
5 Competence Questionnaire (AMCQ) and the Developmental Coordination Disorder
6 Questionnaire 2007 (DCDQ'07).

7 Overall a total of 20 (18 case agreements and 2 DCDQ'07 only) LMC cases were
8 identified by parents, 11 were male and 9 female. Whereas a total of 40 (18 case agreements,
9 and 22 AMCQ only) adolescents self-reported LMC, 18 were male and 22 were female. Most of
10 the 22 adolescents who were not identified by parents were female ($n= 14$).

1 clothing before school. In addition, parent's own physical activity level and the importance they
2 place on participation may affect their confidence when providing support to their child (Barnett
3 et al., 2013). Some adolescents may not want to share or acknowledge their LMC to their
4 parents due to personal frustrations which cause them to bottle up their emotions (Hill et al.,
5 2011) or lead to poor social support as a result of shying away from social or physical activity
6 participation (Fitzpatrick and Watkinson, 2003; O'Dea and Connell, 2016). Green and Wilson
7 (2008) found a low level of agreement between parent report (Developmental Coordination
8 Disorder Questionnaire, DCDQ) and self-report (Co-ordination Skills Questionnaire, CSQ)
9 motor skill assessments across a block of interventions. However, parents were only given the
10 opportunity to respond to specific motor skills whereas children were able to rank themselves
11 across a wider range of skills including ADLs (Green and Wilson, 2008).

12 In this study, more females than males self-reported with LMC. This is different from
13 the male:female ratio reported in the DCD diagnostic criteria (2:1; APA, 2013) and other studies
14 that have examined these gender differences (Cairney et al., 2013). This outcome could be due
15 to a number of factors. Females are less motivated to participate in team sports (Fredricks and
16 Eccles, 2005; Labbrozzi et al., 2013), prefer co-operative activities (Hands et al., 2015; Rose et
17 al., 2011) or place greater importance on ADLs. Consequently, their poor motor skills may be
18 less apparent or concerning to their parents. On the other hand, males place importance on sports
19 participation and physical activities as they value a chance to compete, to win and hang out with
20 their friends, compared to females who felt physical activities prevented them from doing the
21 things that they liked (Vedul-Kjelsås et al., 2012). For example, Vedul-Khelsas and colleagues
22 (2012) found physical fitness and self-perceptions among 11- to 12-year-olds differed, male
23 perceptions correlated with athletic competence whereas female perceptions were more closely

1 related to social acceptance. Females' also tend to place greater importance on close friendships
2 and emotional support as their self-esteem is affected by their degree of body satisfaction, self-
3 image, and appearance to a greater extent than males (Rose et al., 2011).

4 Another reason for the greater identification of males than females by parents may relate
5 to lower expectations of daughters' motor competence and placing less importance on their
6 physical activity participation (Cairney et al., 2012). Parents often have higher expectations of
7 boys' competence in physical tasks and consider sport as more important, compared to girls
8 (Fredricks and Eccles, 2005). We found that parents were more likely to place higher scores
9 ("extremely like your child") for their son's ball skill competence, running and jumping skills.
10 Similarly, Liong et al. (2015) also found parents were more able to accurately perceive their
11 son's (5 to 8 year-olds) level of object control skills. The higher participation in physical tasks
12 involving speed, strength and endurance by boys compared to girls (Cairney et al., 2005) makes
13 it easier for parents to observe and recognise level of motor competence in their sons as they tend
14 to participate regardless of their motor competence level. Parents' perceptions about their
15 adolescents motor skill competence may be influenced by gender-specific characteristics as
16 males are often viewed as strong, robust, autonomous and self-reliant compared to females who
17 are described as loving, loyal, and family orientated.

18 Assessing motor competence reliably can be challenging given developmental
19 fluctuations (improvements during adolescence and poorer coordination during adulthood;
20 (Hands et al., 2015), the range of skills (locomotion, object control and balance) considered to
21 accurately assess motor competence and the tendency to include gender biased items in tests of
22 motor skill (Hands and Larkin, 1997). This could be due the type of items typically included in
23 motor assessments which focus on tasks preferred by males such as ball skills or females being

1 less skilled in these activities (Hands and Larkin, 1997). The higher proportion of males
2 diagnosed in most studies with motor difficulties compared to females (APA, 2013; Cairney et
3 al., 2012) therefore, could also explain this gender bias.

4 Another factor that could account for the lack of congruency in identifying those with
5 LMC between the parent-report and self-report results is the questionnaire design. For example,
6 the DCDQ'07 asks parents to compare their child's motor ability against similar aged peers,
7 whereas the AMCQ asks adolescents to reflect on how their own coordination impacts
8 performance on motor-related activities (Timler et al., 2016; Wilson et al., 2009). The
9 DCDQ'07 was designed for a wider age range (5- to 15-year-olds) and therefore is more limited
10 with the type of ADLs that could be included (handwriting and scissor use; Wilson et al., 2009).
11 The AMCQ was designed for 12- to 18-year-olds and therefore includes more age-relevant items
12 relating to peer comparison, social interactions, participation (individual versus team sports;
13 Timler et al., 2016). The AMCQ also has a greater number of ADL items that are
14 developmentally appropriate such as flossing between teeth, putting on make-up, changing
15 clothes for physical education classes and getting ready to go out (Timler et al., 2016).
16 Consequently, the adolescents can respond to activities that are relevant for them as greater value
17 is placed on peer opinions and acceptance and looking presentable during this phase (Rose et al.,
18 2011). The items on the AMCQ enable females to have a greater voice and an opportunity to
19 report on their motor difficulties. The gender differences identified in this study suggest the
20 content of the assessments used by parents and adolescents need further exploration. Therefore
21 the findings from this study indicate that assessing adolescent motor competence is best
22 undertaken using a self-report rather than a parent report measure.

1 **Strengths and limitations**

2 There are a number of limitations and strengths of the current study. While the sample size was
3 adequate, generalization of the results to the broader Australian population is not possible due to
4 recruitment difficulties. Participants were drawn from a range of sources. In order to ensure an
5 adequate representation of adolescents with LMC, it was important not to over recruit
6 participants through sporting associations, which was the easiest way to access adolescents
7 outside school. As expected, significant differences in the Total AMCQ scores were found
8 between those recruited through sporting clubs ($M = 92.63, SD = 5.86$) compared to those
9 recruited elsewhere ($M = 82.64, SD = 12.71; t(105.40) = 5.98, p < .001$). This latter group
10 comprised adolescents attending a movement clinic as well as many community contacts. Fewer
11 females participated in the study which may be due to the recruitment process and the level of
12 interest in participating, however some interesting differences still emerged. The demographics
13 of the family and parents were not collected, which limited an exploration of environmental and
14 family dynamics. Further analysis could not be completed with the SNAP-IV data given the
15 small proportion of those identified with ADHD. The data were collected in two ways; online
16 and hardcopy surveys however this did not affect the results as no significant differences were
17 found for both the Total AMCQ and DCDQ'07 scores.

18 This study adds to previous literature published on the measurement of DCD and the
19 relevance of self-report compared to parent-report questionnaires. Adolescents are capable of
20 describing their own motor competence. The findings of this study highlight the importance of
21 age appropriate motor competence measures and the need for further research using adolescent
22 specific measures. The higher number of females identified with LMC in this study suggest that

1 future research should consider the girl:boy ratio of a DCD diagnosis (APA, 2013). It is possible
2 that gender biased items and measures being used to gather information about motor competence
3 are affecting results. It is important to provide adolescents with a voice at this critical phase of
4 development. During this phase they are trying to define their own personal identity and become
5 more independent from their parents. Providing them with an opportunity to identify their own
6 motor difficulties may be essential to helping find support or intervention program before they
7 enter adulthood.

8 **Conclusions**

9 Adolescents are aware of, and able to identify their level of motor competence in comparison to
10 their peers, whereas parents may not appreciate all aspects of their adolescent's experiences.
11 Self-report questionnaires, such as the AMCQ, may be more sensitive measures of motor
12 competence for this age group, especially among females. Further research involving interviews
13 with parents and their adolescent would gather more in-depth information of parent and child
14 differences in perceptions of motor ability. Education about the impact of LMC during
15 adolescence may build awareness and support among parents as well as teachers, practitioners
16 and health care professionals.

17 **Key findings:**

- 18 • Parents identified more males than females with LMC
- 19 • Females self-reported more LMC than males

20 **What this study adds:**

21 It may be more realistic for self-report motor assessments to be used for adolescents as they are
22 aware of their own capabilities.

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Research ethics

Ethical approval was obtained from the Human Research Ethics Committee of the University of All participants provided written informed consent.

Declaration of conflicting interests

The authors confirm that there is no conflict of interest.

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