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Cleaton, M.A.M, Tal-Saban, M., Hill, E.L., & Kirby A. (2021; published online June 2021) Gender and age differences in the presentation of at-risk or probable Developmental Coordination Disorder in adults. *Research in Developmental Disabilities, 115*.

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Abstract

Background: Developmental Coordination Disorder (DCD), also called Dyspraxia, is a common Neurodevelopmental Disorder (NDD) that affects motor coordination with a marked impact on both academic and day-to-day living activities. It is increasingly clear that NDDs such as Attention-Deficit/Hyperactivity Disorder and Autism Spectrum Disorder may present differently in males and females, resulting in underdiagnoses of women and girls. Aims: To consider age and gender differences in the presentation of at-risk and probable DCD. Methods and Procedures: A sample of 1,476 adults aged 16-60 years were surveyed online using the Adult DCD Checklist.

Outcomes and Results: Women with at-risk (n=186,16.6%) or probable DCD (n=643, 56.6%) reported significantly greater gross motor and non-motor difficulties and significantly greater impact on activities and participation, whereas men with at-risk (n= 58,16.3%) or probable (n=177,49.9%), DCD reported significantly greater fine motor difficulties. Emerging adults (aged 16-25 years) with at-risk (n=65,14.3%) or probable (293,64.3%) DCD reported significantly greater fine motor and non-motor difficulties than adults (aged 26-60+ years) with at-risk (n=179,17.5%) or probable (n=518, 50.8%) DCD.

Conclusions and Implications: Both age and gender differences were found in the presentation of at-risk and probable DCD in adults. This may have implications for the development of future DCD assessment tools and for the training of front-line staff who may encounter individuals with DCD throughout their lives, including teachers, doctors and employers' Human Resources and Occupational Health staff.

What this paper adds?

This paper describes the world’s first investigation of potential gender and age differences in the presentation of Developmental Coordination Disorder (DCD). It adds to our understanding of DCD in adults. It demonstrated both age and gender differences in DCD presentation. Specifically, women may experience greater gross motor and non-motor difficulties and greater impact on their activities and participation than men. Additionally, men may experience greater fine motor difficulties.

Emerging adults (aged 16-25 years) may experience greater fine motor and non-motor difficulties and greater impact on their activities and participation than adults (aged 26-60 years). However, emerging adults and adults appear to experience similar levels of gross motor difficulties. This research illustrates that gender differences in the presentation of Neurodevelopmental Disorders (NDDs) extend beyond Attention-Deficit/Hyperactivity Disorder and Autism Spectrum Disorder. It has implications for the development and validation of DCD screening and diagnostic instruments. It also has implications for the development of diagnostic and support pathways for children and adults with DCD.

Keywords

Developmental Coordination Disorder; Dyspraxia; adult; gender; age; emerging adulthood

1 Introduction

1.1 Developmental Coordination Disorder

Developmental Coordination Disorder (DCD), also called Dyspraxia, is aNeurodevelopmental Disorder (NDD) characterised by an impairment of motor coordination with a marked impact on both academic and day-to-day living activities (APA, 2013). DCD prevalence rates in UK schoolchildren have been estimated at 5-6% (Lingam, Hunt, Golding,Jongmans, & Emond, 2009). DCD is recognized more often in boys than in girls (APA, 2013).

Children with DCD typically have difficulties with self-care tasks, including using feeding utensils and dressing, as well as difficulties in school, for example with handwriting or team sports (College of Occupational Therapists, 2013). As the child with DCD matures, greater challenges arise from increased demands placed on them (Tal-Saban & Kirby, 2018). These challenges may result in lowered self-esteem and greater social isolation (Poulsen, Ziviani, Cuskelly, & Smith, 2007), increasing problems with peer relationships and reduced social participation (Dewey, Kaplan, Crawford, & Wilson, 2002; Gagnon-Roy, Jasmin, & Camden, 2016), resulting in lower quality of life (Wuang, Wang, & Huang, 2012).

Approximately 70% of children with DCD continue to exhibit significant motor difficulties through adolescence and into adulthood (Losse et al.,1991). Despite this, the diagnostic criteria for DCD predominantly describe its childhood symptoms (APA, 2013). Recent international guidelines have introduced specific recommendations regarding adolescents and adults with DCD (Blank et al., 2019); however, such research is still in its infancy.

Emerging adulthood (16-25 years) is the important stage bridging adolescence and adulthood, where the individual is still dependent on parents whilst learning to become a separate individual. Arnett (2000) described it as a distinct period of identity exploration. Experiences at this stage may influence individuals' future mental health (Schulenberg, Sameroff, & Cicchetti, 2004).

Adolescents, emerging adults and adults with DCD may present differently compared to children because of improved skills, professional intervention and/or the ability to adapt or avoid situations and tasks that they find challenging. Adults with DCD may avoid playing ball sports in favour of swimming or gym workouts; they may record information by computer rather than by handwriting; they also have greater opportunity to choose their friends and leisure activities (Tal-Saban & Kirby, 2019). However, the evidence demonstratesthat some adults with DCD continue to exhibit motor difficulties (Cousins & Smyth, 2003; Tal-Saban, Ornoy, & Parush, 2014b). Handwriting difficulties often persist and new difficulties may manifest while learning new skills such as driving (Kirby, Edwards, & Sugden, 2011). Adults with DCD are also more likely than typically-developed adults to exhibit low mood, depression and anxiety and report lower satisfaction with their quality of life (Hill & Brown, 2013; Hill, Brown, & Sorgardt, 2011; Kirby, Williams, Thomas, & Hill, 2013).

1.2 Gender biases in Neurodevelopmental Disorder diagnosis

It is increasingly clear that there are gender biases in the diagnosis of some NDDs. When children with ADHD are studied, the ratio of boys to girls ranges from 2:1 to 9:1 in clinical and 2:1 to 3:1 in epidemiological samples (Nussbaum, 2012). However, adult samples show approximately equal proportions (Nussbaum, 2012). One possible explanation is that the current diagnostic criteria have been developed in predominantly male samples, so many diagnostic instruments may not generalise to females (Nussbaum, 2012). Alternately, females may be missed as they often have the predominantly inattentive ADHD subtype, which is usually less disruptive and obvious to others (APA, 2013) than the combined and predominantly hyperactive/impulsive subtypes common in males (Biederman et al., 2002; Gershon, 2002).

There may be similar biases against identifying females with ASD. Commonly used estimates state that for every female with ASD there are four males (APA, 2013). However, high-quality studies that screen for ASD have shown the ratio is closer to 1:3 (Loomes, Hull, & Mandy, 2017). Females with ASD may superficially present like their typically-developing peers, by having more ‘typical’ interests (Hiller, Young, & Weber, 2014), by mimicking social interactions without necessarily understanding them (Dean, Harwood, & Kasari, 2017;Lai et al., 2017), by leveraging their higher levels of social motivation (Sedgewick, Hill, Yates, & Pickering, 2016) for making and maintaining friendships (Dean et al., 2014; Head, McGillivray, & Stokes, 2014; Sedgewick et al., 2016) and by having fewer repetitive behaviours (Harrop, Gulsrud, & Kasari, 2015; Mandy et al., 2012; Van Wijngaarden-Cremers et al., 2014). As a result, some of the instruments used to diagnose ASD may have a male bias (Adamou, Johnson, & Alty, 2018; Murray et al., 2017; Wilson et al., 2016).

Referral biases in ADHD and ASD have long-term health and well-being implications for females at all ages.: The consequent decrease in access to support may risk damaged self-perception, anxiety, and stress (Allely, 2019; Hull et al., 2017). It may also leave these females vulnerable to sexual abuse (Bargiela, Steward, & Mandy, 2016).

Evidence also suggests potential gender biases in DCD diagnosis. However, there has been little exploration of this issue. One UK prevalence estimate found that, among 7- to 8-year-old children systematically tested for motor difficulties, there were 1.7 boys for every girl with DCD or probable DCD (Lingam et al., 2009). However, a more recent nationwide poll by the Dyspraxia Foundation suggests that, among children with a DCD *diagnosis*, the boy-to-girl ratio is approximately 3:1 (McCarthy, 2015). Historically, the literature indicates greater gender biases, even when cohorts were screened as part of the study. For example, a 1992 Swedish study of 409 7-year-old children reported ratios of 7.3:1 for severe DCD and 4:1 for moderate DCD (Kadesjö & Gillberg, 1999).

As with other NDDs, early identification of DCD is equally important in females and males, in order to provide support and reduce the risk of cumulative adversity. Gender-related challenges reported to particularly impact teenagers and young women with DCD include using personal hygiene products such as tampons, applying makeup and choosing clothes (McCarthy, 2015). However, the late or missed diagnosis of females with DCD also has wider implications, including increased risk of depression and anxiety from personal and interpersonal stressors, as described in the ‘Environmental Stress Hypothesis’ (Cairney, Rigoli, & Piek, 2013). Moreover, DCD is associated with reduced cardiorespiratory fitness (Cairney, Veldhuizen, King-Dowling, Faught, & Hay, 2017) and increased risk of obesity (Cairney et al., 2010).

Whilst it is unclear whether early diagnosis can prevent these associations, interventions that focus on enabling everyday activities have been shown to significantly improve quality of life for children with DCD (Mandich, Polatajko, & Rodger, 2003). As interventions are often provided only to individuals with a diagnosis (Maciver et al., 2011), any gender biases in DCD diagnosis risk impairing girls’ quality of life and long-term mental and physical health.

1.3 Aims

This study aimed to describe age and gender differences in presentation of at-risk and probable DCD in adults who thought that they had motor and/or coordination difficulties or knew that someone else thought so. Given the increasing evidence of underdiagnosis of females with NDDs and the negative long-term impact of failing to support those with NDDs from an early age, it is important to understand whether symptom presentation differs between males and females with DCD. To date, no studies have specifically investigated whether there are gender-based or other biases in the presentation or diagnosis of DCD.

2 Methods

2.1 Participants

Given the limited large-scale data sources available, the current study surveyed a large sample comprised of self-report data from emerging adults and adults. To this end, volunteers aged 16+ years were recruited and screened for probable and at-risk DCD using the Adult DCD Checklist (ADC). There are two parts to the ADC asking about childhood and present symptoms. The scoring requires a minimum score in childhood contributing to the overall score to be at risk or probable of DCD. Inclusion criteria were as follows: a) the participant thought that they had motor and/or coordination difficulties or knew someone else thought so and b) was aged 16 years or older.

The study included 1,634 participants who answered both the background information questionnaire and the screening tool (described below). The background questionnaire asked about the presence of other diagnoses. The following groups were excluded from the study: those who reported having Visual Impairment, Cerebral Palsy, Huntington's Chorea, Multiple Sclerosis, Parkinson's Disease and/or a history of head injury, Traumatic Brain Injury or Stroke (*n* = 102) and those whose date of birth indicated they were aged under 16 years (*n* = 11). Additionally, transgender individuals (*n* = 18) and individuals aged over 60 years (*n* = 37) were excluded due to small group sizes. Therefore, 1,476 were included. Note that some individuals met more than one exclusion criterion.

2.2 Procedure

Participants were recruited online using a convenience sampling method.The study was advertised through social media (Twitter and LinkedIn) and, the last author' professional contacts (via LinkedIn). Additionally, the Dyspraxia Foundation (a UK charity) passed on recruitment information to their adult members. Participants completed the questionnaire and screening tool online via the XXX system (average time: 30 minutes). Participants whose answers indicated 'at risk of 'or 'probable' DCD were given practical guidance and referred to relevant support groups.

All procedures complied with the Code of Ethics of the World Medical Association (Declaration of Helsinki and amendments) for experimentsinvolving humans. Ethical approval for secondary data analysis was given by the Research Ethics Committee, Department of Psychology at XXX University. All participants provided written informed consent to participate and for their anonymized data to be used for research purposes.

2.2.1 XXX System

The ADC was administered online via the XXX system, a person-centered, computer-based, modular screening and assessment system created by XXX company (REF-XXX1). Users provide consent upon entering the system, then view a short video outlining the purpose of completion and highlighting the accessibility features (including voiced question-and-answer options, a zoom-in function and the ability to change the text and background colour). Modules are thus highly accessible to individuals with NDDs such as DCD and Dyslexia,who may have difficulties reading or completing a handwritten form, resulting in greater consistency in test delivery. Next, the user completed a 'background information' questionnaire and the ADC. Both require minimal IT skills and minimal or no typing. If difficulties were identified on the ADC, the system automatically provided the participant with personalised, practical support strategies.

2.3 Instruments

2.3.1 The Adult Developmental Coordination Disorder Checklist (ADC)

The ADC is an adult self-report screening tool for DCD, developed and tested in UK and Israeli populations (Kirby, Edwards, Sugden, & Rosenblum, 2010). It consists of ten items regarding past childhood symptoms (Section 1) and 30 items regarding current symptoms (Section 2), each scored using a four-point Likert scale ('Rarely', 'Occasionally', 'Often' or 'Always'). Section 1 includes questions such as 'As a child, did you find playing team games, e.g. football, netball, rounders, rugby, difficult?' and 'As a child, did you have difficulty writing as fast as your peers?'. Section 2 includes questions such as 'Do you currently avoid hobbies that require good coordination?' and 'Do you currently have difficulties withorganising/finding things in your own room/home?' Overall, the 40 items meet Criteria A-C of the DSM-5 regarding DCD diagnosis (APA, 2013). Background questions regarding the presence of conditions including Visual Impairment and neurologicalconditions affecting movement such as Cerebral Palsy are also included, fulfilling Criterion D(APA, 2013).

Each answer is scored from zero to three, with three representing greatest levels of difficulties. A summary score is calculated for Section 1 (childhood symptoms), Section 2 (current symptoms) and for Sections 1 and 2 combined (overall symptoms). 'At risk of DCD' is indicated by a score of over 10 on Section 1, over 39 on Section 2 and over 56 on the two sections combined, 'probable DCD' is indicated by a score of over 16 on Section 1, over 48 on section 2 and over 65 on the two sections combined. The ADC has been shown to have high internal reliability for Sections 1 and 2 and for the whole test (Cronbach's alpha 0.914, 0.873 and 0.900, respectively). It has significant construct validity in comparison with both clinician diagnosis and significant concurrent validity with the Handwriting Proficiency Screening Questionnaire (Kirby et al., 2010).

ADC total scores were analysed for childhood symptoms (Section 1), current symptoms (Section 2) and overall symptoms. They were also grouped into sections based on the International Classification of Functioning, Disability and Health (ICF) framework (WHO, 2019) in order to compare gender-based and age-based patterns of functioning, activity and participation among individuals whose ADC score indicated they had at-risk or probable DCD. The ICF framework is designed to be a universal classification system of disabilityand health for use in health-related sectors (WHO, 2019); it is gaining traction as a way of holistically considering various health conditions, including NDDs such as DCD (for example:

Ferguson, Jelsma, Versfeld, & Smits-Engelsman, 2014; Watter et al., 2008).

The ADC questions were grouped into four categories following the ICF framework: gross motor difficulties (questions 3, 4, 7 and 23); fine motor difficulties (questions 1, 2, 5, 6, 8, 11, 12, 14-16, 26 and 35); non-motor difficulties (questions 9, 17-19, 21, 22, 32-34 and 36-40); and impact on participation and activities (questions 10, 13, 20, 24, 25 and 27-31). Mean scores were calculated for each section for each participant. In line with the original questions, mean scores ranged from zero to three, with higher scores representing greater difficulties.

The ADC was administered online via the XXX system, a person-centred, computer-based, and assessment system created ~~b~~y XXX company (REF-XXX1).

2.4 Statistical procedures

Data were analysed using R version 3.5.1 (R Core Team, 2013). Differences in the proportions of respondents with scores indicating 'probable DCD', 'at risk of DCD' and 'typically-developing' were analysed using the Chi-squared Test of Independence. This test was also used to assess whether there were gender differences in the likelihood of having a prior NDD diagnosis.

To analyse questions grouped following the ICF framework, mean scores were calculated for each section as described above. As Shapiro-Wilk tests indicated that the distributions of these scores were predominantly, significantly different from normal distribution, they were analysed using non-parametric Mann-Whitney tests. In all cases, a *P*-value of less than 0.05 was considered significant.

3 Results

3.1 Cohort description

The cohort consisted of 75.9% women and 24.1% men (Table 1). Just over half of the cohort were aged 31-60 years (Table 1). A small minority reported a prior diagnosis of

ADHD, ASD and/or speech/language impairments (SLI); approximately 10% reported a prior diagnosis of Dyslexia (Table 1). Only 0.3% of the cohort reported a prior diagnosis of DCD or Dyspraxia (Table 1). Of those who reported being previously diagnosed with any of the above conditions, 88.8% had one prior diagnosis, 10.4% had two diagnoses and, 0.8% had three diagnoses. None reported having more than three diagnoses. Men were more likely than women to report a diagnosis of ADHD (5.2% versus 3.3%); ASD (4.1% versus 3.1%); SLI (1.7% versus 1.1%); Dyslexia (15.2% versus 9.2%); and DCD (0.6% versus 0.2%). These gender differences were not significant, except in the case of Dyslexia (*p* =0.0017).

3.2 Effect of gender on motor and non-motor challenges and their impact

Amongst participants who suspected they had DCD, significantly greater percent of women reported higher levels of current challenges than men, although similar percent of levels of childhood challenges were reported (Table 2). However, when responses from those with at-risk or probable DCD were analysed on the basis of ICF groupings, a more complex pattern was observed (Table 3). Women with at-risk or probable DCD reported significantly greater challenges relating to gross motor skills, non-motor skills and impact on activities and participation. In contrast, men with at-risk or probable DCD reported significantly greater challenges relating to fine motor skills.

The gender differences included both childhood and current difficulties and, despite the small effect sizes at a section level, were sometimes quite marked at an individual question level. For example, among those with at-risk or probable DCD, 51.6% of women compared with 33.2% of men reported that 'always' 'as a child others called me called "clumsy" or commented on my lack of coordination' (question 10) and 46.5% of women compared with 20.4% of men reported that they 'always' 'currently have difficulties finding my way around new buildings or places' (question 19). In contrast, 68.1% of men, but only 36.2% of women, with at-risk or probable reported that they 'always' 'as a child had difficulty writing neatly so others could read it'.

3.3 Effect of age on motor and non-motor challenges and their impact

Amongst adults' participants (aged 26-60 years), who suspected they had DCD, the percent of challenges reported were significantly fewer in childhood, current and overall challenges than emerging adults (aged 16-25 years; Table 4). When responses from those with at-risk or probable DCD were categorized using the ICF framework, emerging adults and adults were found to report similar levels of difficulty relating to gross motor skills and impact on participation (Table 5). However, emerging adults reported significantly greater challenges with fine motor skills and non-motor skills (Table 5). In all cases the effect sizes were very small (range: 0.014-0.098).

Despite this, when assessed at an individual question level some fairly marked difference was observed. For example, among individuals with at-risk and probable DCD, 46.4% of emerging adults reported that 'always' 'others call me disorganised, e.g., forgetting to clean up after myself, forgetting to pay bills' (question 20), in contrast to 35.7% of adults.

3.4 Relationship between diagnosed DCD and ADC score

Specific consideration was paid to the four individuals (two women, two men) who reported a prior diagnosis of DCD or Dyspraxia. All four met the ADC cut-off for ‘probable DCD’ in childhood and overall. Three met the cut-off for ‘probable DCD’ currently; the remaining individual, a man, scored one point below the cut-off for current ‘probable DCD’ and thus was ‘at risk of DCD’.

Interestingly, the two women with a prior DCD diagnosis scored much higher on the ADC (overall scores of 108 and 99) than the two men with a prior diagnosis (overall scores of 86 and 71).

4 Discussion

This study is the first to assess age and gender differences in DCD presentation. There is growing evidence that females with ADHD and ASD (and NDDs in general) present differently compared to males with the same condition. This study demonstrated that amongst females who suspected they had DCD likewise present differently from males who suspected they had DCD. It also demonstrated that DCD in emerging adults presents highly percent of challenges compared to adults, highlighting the importance of considering this distinct phase of maturation.

4.1 DCD and gender

Within the cohort, women reported significantly greater challenges, currently. However, based on the ICF framework, women were significantly more likely to report gross motor and non-motor challenges and impact on activities and participation, whereas men were significantly more likely to report fine motor challenges. Whilst the overall effect sizes were small, this may be because the questions within the sections showed considerable heterogeneity in whether or not differences were present.

Several questions did show marked differences between men and women. For example, more women than men reported that they ‘always’ ‘currently bump and spill things’ (62.0% versus 32.3%; question 23), that they ‘always’ ‘currently have difficulties with finding my way around new buildings or places’ (46.5% versus 20.4%; question 19) and that they ‘always’ ‘avoid team games/sports’ (58.7% versus 46.0%; question 29). Conversely, more men than women reported that they ‘always’ ‘currently have difficulty writing neatly’ (80.0% versus 64.0%; question 14) and that they ‘always’ ‘as a child had difficulty writing neatly’ (68.1% versus 36.2%; question 5). These differences may have clinical significance. For example, women with at-risk or probable DCD may experience social censure due to physical clumsiness, with consequent effects on their self-esteem and mental health. They may also be more likely to avoid exercise, with consequent effects on physical health. In contrast, men with at-risk or probable DCD may be more likely to struggle with employment due to current handwriting difficulties and/or the effect childhood handwriting difficulties may have had on their educational achievement.

The differences observed may reflect gender norms seen more generally in the population (for example: Morley, Till, Ogilvie, & Turner, 2015). The differences may also be related to gender stereotypy in activities and play, which may be encouraged and/or directed from an early age by social pressures and expectations from adults and other children. For example, UK primary school-aged boys play significantly more ball games than girls (O'Connor, McCormack, Robinson, & O'Rourke, 2017; Pellegrini, Blatchford, Kato, & Baines, 2004). Thus, boys may have a greater opportunity to practice gross motor skills, whereas girls may have a greater opportunity to practice fine motor skills. Stereotype threat may also affect girls' abilities to learn gross motor skills such as ball skills, even if they do seek to practice them (Gentile, Boca, & Giammusso, 2018).

Alternatively (or additionally), the differences in motor and non-motor challenges reported by men and women may reflect the attitudes of others during their education. Prior research indicates that teachers may be more concerned about boys' gross motor and girls' fine motor performance (Rivard, Missiuna, Hanna, & Wishart, 2007). This may result in differential school support, resulting in gender-specific acquisition or improvement of skills.

A third explanation may be attributed to the significant difference in Dyslexia diagnoses between men and women in this cohort. Half of the 12 ADC questions in the ICF-grouped 'fine motor skills' section relate to writing (questions 5, 6, 14-16 and 26). Men may have reported greater difficulties than women in this section because of literacy, rather than fine motor, difficulties. However, this would not explain the observed gender differences in gross motor skills, non-motor skills or impact on activities and participation.

Very few participants had received a prior diagnosis of DCD or Dyspraxia. Anecdotally, we know that DCD/Dyspraxia diagnoses are often missed and/or misdiagnosed as Dyslexia or behavioural problems. However, that only four participants reported a DCD or Dyspraxia diagnosis is unexpected. We consider this is unlikely to be caused by the convenience sampling approach missing diagnosed individuals since we recruited specifically through several channels (notably the Dyspraxia Foundation's adult membership) that may be reasonably expected to include a greater proportion of diagnosed individuals than the general population of individuals with poor motor skills. The lack of diagnoses is particularly concerning with regard to the women, who not only reported significantly greater gross motor and non-motor challenges than men, but also significantly greater impact on their activities and participation. Furthermore, the ADC scores of the few individuals with a prior diagnosis of DCD suggests that females may require more severe symptoms than males in order to be diagnosed. As DCD is typically diagnosed in childhood, this may indicate a need for greater teacher awareness (Kirby, Davies, & Bryant, 2005; B. N. Wilson, Neil, Kamps, & Babcock, 2013). Alternatively, girls may be more able to mask their gross motor difficulties, because of gender stereotypes producing lower expectations for girls in sports (Slater & Tiggemann, 2010; Wetton, Radley, Jones, & Pearce, 2013). Likewise, gender stereotypes mean greater expectation for girls to write neatly (Burr, 2002); being less able to mask these fine motor difficulties might motivate girls to practice this skill more.

Individuals with DCD who remain undiagnosed are at risk of cumulative adversity. DCD is particularly associated with internalising problems, an interaction hypothesised to be mediated by environmental stressors (Cairney et al., 2013). In adolescents and emerging adults, motor competence is associated not only with self-perception of athletic competence, but also, with self-perception in non-motor domains and global self-esteem (Rose, Larkin, Parker, & Hands, 2015). Women with DCD may be particularly at risk, since for them motor competence is additionally associated with self-perception of physical appearance and is more strongly associated with self-perception of friendships than in males (Rose et al., 2015). Thus, women with DCD may be not only underdiagnosed, but also more likely to develop mental health problems.

4.2 DCD and age

Within the cohort, adults reported significantly fewer challenges in childhood, currently and overall, than emerging adults. Although levels of gross motor challenges and impact on activities and participation were similar between the two groups, emerging adults with at-risk and probable DCD reported significantly greater non-motor challenges than adults with at-risk and probable DCD. However, the overall effect sizes were very small.

Despite this, a few questions did appear to show differences between emerging adults and adults that may be clinically relevant. For example, more emerging adults than adults with at-risk and probable DCD reported that they ‘always’ ‘currently have difficulty writing neatly’ (47.5% versus 41.2%; question 14), that ‘always’ ‘others call me disorganised, e.g., forgetting to clean up after myself, forgetting to pay bills’ (46.4% versus 35.7%; question 20) and that they ‘always’ ‘had difficulties learning to drive’ (38.8% versus 19.8%; question 25). The differences in difficulty with writing and driving, in particular, may impact widely on individuals’ education, employment and social lives.

These differences may simply be due to differences in the length of time that participants were recalling childhood symptoms. It is reasonable to expect that some adults (aged 26–60 years) might not remember their childhood experiences completely, objectively and/or accurately, compared to emerging adults (aged 16-25 years).

Another possibility is that these differences, particularly in non-motor challenges, reflect differences in executive function (EF). EFs are higher-order cognitive processes that include response inhibition, sustained attention, working memory, planning, sense of time and emotional regulation. Executive functions, and the frontal-parietal brain network that manages them, continue to develop through adolescence and into emerging adulthood (Blakemore & Choudhury, 2006; Giedd, 2008; Lebel & Beaulieu, 2011). Young adults with DCD have significantly lower EF profiles compared to controls (Tal-Saban, Ornoy, & Parush, 2014a) and EFs are a major concern for young adults with DCD and their parents (Kirby et al., 2011). Thus, it is unsurprising that in this cohort emerging adults reported significantly more challenges with regard to non-motor EF traits such as ‘lose possessions’, ‘difficulty multi-tasking’, ‘difficulty planning ahead’ and ‘lose attention easily’. These would be impacted by the fact that emerging adults are continuing to develop these skills, whereas adults are reporting from an established and stable EF skill set. Emerging adults may have yet to develop all the strategies needed to compensate for ongoing motor difficulties.

An additional possibility is that some of these differences may be the result of different leisure and play experiences in childhood. For example, the increased use of digital devices in the past two decades may have resulted in fewer opportunities for emerging adults to practice their fine motor skills, e.g., through play with puzzles, Lego and craft activities.

The significant difference in fine motor challenges between emerging adults and adults is less easy to explain. It is possible that the level of challenge decreases with age because of more time to practice a given skill, such as writing or brushing teeth, although it is unclear why this would be the case for fine motor but not gross motor skills. Alternately, adults may have more opportunity to avoid tasks and activities that they struggle with, for example by using a computer rather than hand-writing texts. This is supported by the fact that adults were more likely than emerging adults to state that they avoid team games and/or sport. However, emerging adults were as likely as adults to state that they avoid hobbies needing coordination or requiring group participation; additionally, they were more likely than adults to avoid hobbies needing dexterity. In any case, it is clear that emerging adulthood represents a period where individuals with DCD continue to have many challenges.

4.3 Limitations

This study employed a convenience sampling method and focused on adults who either thought that they had motor and/or coordination difficulties or knew that other people thought so. Very few individuals had a diagnosis of DCD or Dyspraxia.

As is common for convenience samples (Porter & Whitcomb, 2005; Sax, Gilmartin, & Bryant, 2003), the cohort contained more women than men. Additionally, nearly half of the cohort were aged 16-30 years. However, these issues were mitigated by the comparatively large sample (*n* = 1,476).

Since NDDs have very high rates of co-occurrence (Cleaton & Kirby, 2018), it was decided not to exclude individuals reporting co-occurring NDD diagnoses, as this would make the sample unrepresentative of the general population. Approximately one-sixth of the cohort reported a diagnosis of at least one other NDD. However, it was beyond the scope of this study to screen for NDDs besides DCD, so it is unknown whether there were individuals with undiagnosed NDDs in the cohort. A very high proportion (83.2%) of individuals with NDD diagnoses other than DCD/Dyspraxia had at-risk or probable DCD according to their ADC scores. It is possible that some of their answers may relate to their diagnosed condition, rather than potential DCD. This issue needs further consideration.

Identification of DCD relied on the self-report ADC for rapid, affordable and consistent assessment. However, self-report of one’s own abilities may not always be accurate, particularly when reporting on one’s childhood several decades later. However, the ADC has demonstrated high levels of internal validity in both the whole scale and the subscales (childhood and current) and is able to distinguish individuals with DCD from controls in UK adults (Kirby et al., 2010).

A motor assessment was beyond the scope of this study and was not undertaken. Indeed, there are no standardised motor assessments for adults. There was, therefore, a potential for reported coordination challenges to be due to factors other than DCD, such as Cerebral Palsy. This was, however, mitigated by excluding all respondents who reported any confounding formal diagnoses, including Cerebral Palsy.

5 Conclusions

This study is the first to consider gender and age differences in self-reported prevalence and presentation of DCD in adults. It revealed a considerable number of women had levels of motor difficulties meeting the criteria for at-risk or probable DCD based on the ADC, but very few reported having received a prior diagnosis. This may be due to lack of awareness and gendered expectations of skills among teachers and caregivers. Females might also be better at masking their motor difficulties. This study did not consider the impact of non- identification for females and whether this was associated with greater levels of mental ill- health and/or lower self-esteem. However, previous work among adults with DCD has highlighted this association (Harrowell, Hollén, Lingam, & Emond, 2017; Hill & Brown, 2013; Kirby et al., 2013).

This study also highlighted some potential differences in levels of challenge and presentation between emerging adults and adults, which are not limited to the motor domain. Differences are particularly apparent with regard to EF skills. This is likely related to the well-described continuation into emerging adulthood of frontal-parietal brain network development and corresponding EF development.

Overall, it appears that there may be gender-based and age-based differences in motor skills and presentation of DCD. A clear need exists for future assessment tools to consider age- and gender-specific norms. Further work is needed to consider how and where motor skill deficits impact the day-to-day functioning of females with DCD; for example, whether they have a greater risk of road traffic accidents or falls. Teacher training is also needed to eliminate potential gender biases hampering identification of DCD in childhood, for example by training teachers to consider handwriting as a motor skill and poor writing ability as not ‘just’ a symptom of Dyslexia. This is particularly critical as provision for adult diagnosis of DCD is patchy (Dyspraxia Foundation, 2016) and DCD has long-term health consequences extending beyond motor and coordination difficulties.

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