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Developmental coordination disorder traits persistently affect physical activity and sedentary behavior in adults

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Developmental Coordination Disorder (DCD) is a prevalent condition that persistently affects motor skills performance from childhood through adulthood. Because the term DCD requires a formal clinical diagnosis, the terms at risk for DCD (r-DCD) and probable DCD (pDCD) were used in this study to acknowledge that participants may present characteristics consistent with the disorder. However, few studies have examined DCD traits in two developmental periods (childhood and adulthood) as a primary predictor of physical activity and sedentary behaviour in adulthood, while accounting for sociodemographic and health-related factors. To this end, we investigated whether longitudinal DCD traits are associated with physical activity and sedentary behaviour in university students, controlling for sociodemographic and health-related variables. Additionally, we tested the severity of DCD in the relationship with physical activity and sedentary behaviour in a sensitivity analysis considering pDCD over developmental periods. A total of 124 participants (mean age: 25.48 ± 7.20) completed the Adult DCD Checklist (ADC), the short-form of the International Physical Activity Questionnaire (IPAQ-short), and a structured questionnaire. Logistic regression analyses were conducted to examine associations between variables, adjusting for sex and age (Model 1), sociodemographic variables (Model 2), and health-related variables (Model 3). DCD traits significantly increased the odds of insufficient physical activity and elevated sedentary behaviour across all developmental periods, with some variations in Models 2 and 3 for physical activity. However, the association with sedentary behaviour persisted across developmental periods, and became stronger after a sensitivity analysis using pDCD, with odds ratios ranging from 3.99 to 11.99 in Model 1, and from 3.47 to 11.35 in Models 2 and 3. This study highlights the potential impact of DCD on reducing levels of physical activity and increasing sedentary behaviour in adults.

Keywords Motor skills disorders, Sedentary behaviour, Physical activity, Adulthood

Abbreviations

ADC	Adult DCD checklist
DCD	Developmental coordination disorder
DSM-5 TR	Diagnostic and statistical manual of mental disorders, fifth edition, text revision
IC	Interval confidence
IPAQ-short	International physical active questionnaire, short version
OR	Odds ratio
pDCD	Probable developmental coordination disorder

Developmental Coordination Disorder (DCD) is a specific condition classified as a neurodevelopmental disorder according to the fifth edition, text revision of the Diagnostic and Statistical Manual of Mental Disorders – DSM-5 TR[1]. The DSM-5 TR outlines four criteria for diagnosing DCD as follows: (A) motor coordination below what

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is expected for age and opportunities around; (B) compromised motor skills execution in daily, academic and leisure activities; (C) persistent lacking in motor skills since early childhood; (D) poor motor skills not attributed to physical, visual or intellectual disabilities, or caused by cerebral palsy or other specific medical condition[1]. DCD is a prevalent disorder, affecting approximately 6% of school-age children, and it impacts various domains, including physical, environmental, social and emotional development[2]. Despite its prevalence, DCD can often go unnoticed throughout childhood, adolescence, or even into adulthood[3], as it is considered a less obvious disorder when compared to the more noticeable neurodevelopmental disorders, such as Autism Spectrum Disorder (ASD)[4,5] or Attention Deficit Hyperactivity Disorder (ADHD)[6,7].

Neglecting motor difficulties during childhood may lead to negative consequences, as children with DCD tend to avoid sports or physical activities[8], due to the exposure of their motor coordination difficulties. This avoidance can lead to reduced levels of physical activity[9] and lower fitness[10] as well as increased sedentary behaviour[11,12], which may continue to impact into adulthood[13].

The persistence of DCD beyond childhood into adulthood ranges from 30% to 70%, with implications for various areas of life[14–16], particularly as individuals with DCD are challenged by their motor difficulties when faced with new tasks over time[16,17]. It is hypothesized that engaging in more complex physical activities remains an ongoing challenge for individuals with DCD. Moreover, as they grow older, individuals with DCD tend to become more aware of their motor difficulties[18], which may further contribute to increased sedentary behaviour over time. Previous studies also described the reduced physical activity hypothesis and the bad cycle of reduced physical activity in children[19] and adolescents with DCD[20].

However, the relationship between DCD, physical activity, and sedentary behaviour remains unclear, particularly when considering sociodemographic and health-related factors, as well as the scarcity of studies involving adults.

Understanding the role of sociodemographic and health-related factors in physical activity and sedentary behaviour is important due to the significant variation in health behaviours across age groups, sexes, or socioeconomic statuses[21–23]. Evidence shows that the amount of physical activity and time spent sitting can differ among individuals based on these factors[23]. Due to social inequities (e.g., limited access to goods and services based on race, sex or socioeconomic status), some population groups have more or fewer opportunities or motivations to be active[24]. A recent systematic review[25] summarized that the main barriers reported by university students to being physically active included insufficient time, low motivation, and a limited number of accessible facilities. These challenges should be considering when monitoring physical activity and sedentary behaviour, particularly in chronic and heterogeneous conditions such as DCD, as it can be an additional barrier to participate in physical activity programs. In this context, exploring the role of sociodemographic and health-related factors on physical activity and sedentary behaviour among adults of DCD can help clarify how public policies might support this population in improving participation and overall health outcomes. Although scarce, the literature on DCD in adults has provided valuable insights into how individuals cope with their motor coordination challenges when performing everyday tasks in adult life or engaging in physical activities These well-documented deficits in adults with DCD suggest that they face greater challenges and difficulties both in completing their university studies and in holding jobs that require high motor skills demands[26]. Therefore, since there is a relationship between psychological distress, which is common in adults with DCD, and psychosocial factors[27,28], a more nuanced understanding of how DCD traits across developmental periods can predict negatively or positively levels of physical activity and sedentary behaviour in adults, controlling by sociodemographic and health-related factors is warranted.

The rationale behind this proposed analysis is based on the fact that sex and age are both well-established determinants of physical activity and sedentary behaviour[29,30]. For example, males tend to report higher levels of physical activity than females, and activity patterns can vary significantly across age groups, even within young adults[31]. Furthermore, other sociodemographic factors have been investigated among university students as potential mediators of physical activity and sedentary behaviour[32–34] For instance, academic discipline may shape daily routines and opportunities for physical activity (e.g., students in health sciences may have greater health literacy or physical education components in their curriculum)[35]. Marital status may influence time allocation, lifestyle habits, and social support for physical activity[36]. Financial assistance and employment are related to socioeconomic status, which can affect access to resources (e.g., transportation, gym memberships, time availability, and health behaviours)[37,38] Students commuting from other cities may experience time constraints or environmental barriers to activity[39]. Academic workload or stress may vary across semesters, affecting lifestyle behaviours[40]. Differences in race/colour is important to account for potential sociocultural differences in physical activity patterns and access to health-promoting resources[37].

Additionally, alongside sociodemographic factors, those related to health conditions or health behaviours are also relevant, as physical activity is multifactorial and social inequities may determine how healthy, including how physically active, such population groups are, particularly in low-resources countries[41], where DCD is often underdiagnosed[42,43]. Regarding health-related factors, previous neurodevelopmental diagnosis may co-occur with or confound the expression of DCD traits[44,45] and affect physical activity behaviours independently. Medical condition could limit physical activity due to physical limitations, fatigue, or treatment effects[46]. Tobacco and alcohol use are health behaviours often cluster, and these behaviours may be correlated with lower activity levels or higher sedentary time[47].

Previous literature[48] has also shown that 68.6% of university students were not physically active, while the prevalence of tobacco smoking and alcohol consumption was approximately 16% and 84%, respectively. Some medications may have side effects (e.g., fatigue, motor impairments) that influence physical activity[49]. Although DCD does not primarily require the use of controlled medication, common co-occurring conditions such as ADHD or ASD may necessitate specific prescription medications. In addition, emotional comorbidities are frequently observed in adults with DCD[28], and pharmacological treatment for these symptoms may also mediate

the relationship between physical activity and sedentary behaviour in individuals with this condition. Further worsening this scenario, self-medication was highly prevalent among university students, with rates exceeding 70%[50].

Controlling for these sociodemographic and health-related factors allows the researchers to isolate the specific effect of DCD traits on physical activity and sedentary behaviour, minimizing the risk of confounding. Without controlling for them, observed associations could be due to these other variables rather than DCD traits per se. This approach improves the internal validity of the study and strengthens causal inference, especially important when examining longitudinal DCD traits into adulthood. Additionally, because DCD traits can be classified into different subgroups to potentially capture the severity of symptoms, an exploratory sensitivity analysis was also conducted. Similar analyses have been performed in previous studies[51–53] to better understand complex relationships among variables, particularly those related to human behaviours. As hypothesized, we believe that DCD traits significantly reduce physical activity levels and increase sedentary behaviour in university students, regardless of sociodemographic and health-related variables. Therefore, the aim of this study was to investigate whether longitudinal DCD traits are associated with physical activity and sedentary behaviour in a sample of Brazilian young adult university students, controlling for sociodemographic and health-related variables. Additionally, we tested the severity of DCD in the relationship with physical activity and sedentary behaviour in a sensitivity analysis considering pDCD across developmental periods.

Methods

Study design and sample

This cross-sectional study design was conducted with a convenient sample of 124 university students from a multi-campus State University, in Bahia, Brazil. All methods were performed in accordance with the Declaration of Helsinki, the project was approved by the State University of Bahia Human Research Ethics Committee (n. 6.814.433, CAEE n. 78718024.5.0000.0057) and all the volunteers signed the informed consent form. Participants were recruited by advertisement through social media (Instagram, WhatsApp and Facebook) and email, containing a link and a QR-code to Google forms, where the participants accessed the electronic consent form and questionnaires. After consenting to participate, participants completed three questionnaires used in this study.

The university where this research was conducted is a multicampus public institution that covers approximately the entire state of Bahia. Bahia, located in the Northeast of Brazil, is a very large state, and the university's logistics are highly multicultural and diverse. Reaching all students in person would have been extremely difficult; for this reason, the questionnaires were administered as an online survey. We made every effort to recruit the maximum number of participants, with the support of coordinators and directors. Recruitment was carried out through social media, emails, and WhatsApp messages using a link or QR code. Flyers containing research information and the QR code were also distributed at the facilities of Campus I, Campus IV, Campus X, and Campus XII of UNEB. These campuses were selected based on the research team's availability within the data collection schedule. In addition, a snowball sampling strategy was employed to increase participation, whereby students were encouraged to disseminate information about the research through their own social media, WhatsApp, or email contacts. A post hoc power analysis was conducted to evaluate whether the final sample size was adequate for the outcomes investigated. The study included 129 participants, of which five were excluded due to incomplete or duplicate information, resulting in a final sample of 124 individuals. Considering the observed prevalence of each outcome and using a 95% confidence level ($\alpha = 0.05$), the post hoc power estimates indicated a statistical power of 80% for DCD traits and 99.8% for sedentary behavior. These values demonstrate that the achieved sample size was sufficient to detect meaningful differences for the larger effects. Specifically, for DCD traits, the sample had a good chance ($\approx 80\%$) of detecting large effects ($\sim \geq 24\%$ points); for sedentary behavior, with the observed large difference ($\sim 45\%$ points) and the given group sizes, the study had very high power to detect this difference, practically certain detection, assuming the validity of the estimates. Although the sample size was sufficient to detect significant differences, considering the total number of students enrolled in the university's various courses, we expected to achieve a larger sample size. For this reason, the limited sample should be acknowledged as a limitation of the study.

Measures

The levels of physical activity and sedentary behaviour were collected through the short-form International Physical Activity Questionnaire (IPAQ-short)[54], the DCD traits were assessed through the Adult Developmental Coordination Disorder Checklist (ADC)[55], while the sociodemographic and health-related factors through a sociodemographic questionnaire developed by the research team.

The IPAQ-short form was used to evaluate the levels of physical activity and sedentary behaviour among participants[56]. It is considered a valid and cost-effective method to estimate the levels of physical activities in adults[57]. Levels of physical activity are in accordance of activities performed over the last seven days and classified in vigorous-intensity, moderate-intensity and walking[54]. The last part of the IPAQ-short assessed the sitting time during week and weekend days. The online version of the questionnaire was attested as reliable (rho > 0.30) to estimate physical activity in university students in Brazil[58].

Levels of physical activity were categorized into sufficiently active (> 1.368 MET-minutes/week) and insufficiently active (≤ 1.368 MET-minutes/week), based on the median value of the metabolic equivalents (METs), corresponding to 1.368 MET-minutes/week. This value is in accordance to the international guidelines for levels of physical activity for adults[59] Sedentary behaviour was calculated through the following formula: [(sitting time in a week day x 5 + sitting time in a weekend day x 2)/7][60] and considered elevated from the 75th percentile[60], corresponding to 2.2857 median value.

The ADC is a widely used instrument to identify DCD traits in adults[2]. It has demonstrated strong internal reliability, with alpha coefficients ranging from 0.87 to 0.95, and moderate, significant concurrent validity, with correlations ranging from 0.68 to 0.75 with the Handwriting Proficiency Screening Questionnaire (HPSQ)[55]. The checklist is composed of 40 items, divided into two sections. The first section comprises 10 questions about the difficulties during childhood, while the second section comprises 30 questions about the current difficulties in adult life. Each question is scored into a four-point Likert scale, considering the frequency of symptoms as follows: (0) Never; (1) Sometimes; (2) Frequently; and (3) Always[3]. In this study, the scores were summarized for each section as well as for the total score and participants were classified as "Probable DCD", "at risk for DCD", or "typically developing"[61]. During childhood (Sect. 1) scores ≥ 10 indicated "At risk for DCD" and scores ≥ 17 "Probable DCD". Current adult life (Sect. 2) scores ≥ 39 indicated "At risk for DCD" and scores ≥ 48 "Probable DCD". Total (Sect. 1 + Sect. 2) scores ≥ 56 indicated "At risk for DCD" and scores ≥ 65 "Probable DCD". Scores under the thresholds classified typically developing participants[61].

The sociodemographic questionnaire was a 14-item standard instrument developed by the researchers within the laboratory coordinated by the first author. The sociodemographic factors considered the personal, occupational, and demographic information, as follows: Sex (Male/Female); Age (years); Field of the course (Heath, Human or Exact Sciences); Marital Status (Married/Not married); If they received any financial assistance from the University (Yes/No); If they had any type of employment status (Yes/No); If they lived in the same city of the campus (Yes/No); Ongoing semester (Corresponding semester period in numbers); Self-reported race/colour (White/Black/Brown/Indigenous/Yellow/Not reported). The health-related factors considered health behaviours and clinical information, as follows: If they had previous neurodevelopmental disorders diagnosis (Yes/No); If they had previous medical condition diagnosis (Yes/No); If they consumed tobacco (Yes/No); If they consumed alcohol (Yes/No); and Controlled Medication use (Yes/No).

Statistical analyses

The participants' characteristics and prevalence of those "At risk for DCD" and "Probable DCD" were reported using descriptive statistics by absolute and relative frequencies. Cases were merged by "At risk for DCD" and "Probable DCD" as "DCD traits" for analysis. The levels of physical activity and sedentary behaviour were the outcomes, DCD traits by each period of time were independent variables, while the sociodemographic and health-related factors were assumed as co-variables. Bivariate analyses tested the associations a priori using the chi-square test. Logistic regression analysis was used to assess levels of physical activity and sedentary behaviour in adults with DCD traits over time (childhood, adult life and total score). The analysis was adjusted for those sociodemographic and health-related factors with $p \leq 0.20$ in the bivariate analyses. Each outcome was tested in a separate analysis, using three models. Considering the known role of sex and age in physical activity and sedentary behaviour[30,62], these two variables were included in all models. In Model 1 the relationship between each outcome and DCD traits over time was controlled by sex and age, only. In Model 2 the relationship between each outcome and DCD traits over time was controlled by sex ang age, including a range of other sociodemographic variables. Finally, in the Model 3 the relationship between each outcome and DCD traits over time was controlled by sex and age, including a range of health-related variables.

An additional sensitivity analysis using these three models was performed, considering only the cutoff for probable DCD, which allowed tested the importance of the categorization made for DCD traits in this study. Odds-ratio (OR) with 95% of confidence interval tested the associations and the level of significance was set at $p < 0.05$. The null hypothesis, that DCD traits do not explain levels of physical activity and sedentary behavior, was rejected when the significance levels was below 0.05. All analyses were performed using the Statistical Package for Social Sciences (SPSS Inc. version 28).

Results

The age of the participants ranged from 17 to 55 years (25.48 ± 7.20) and the majority were female (65.5%). Insufficient levels of physical activity and elevated sedentary behaviour were observed in 50% and 27.4% of the sample, respectively. The occurrence of DCD Traits (ADC Total scores) ranged from 10.5% to 12.9%, respectively for those screened at risk for DCD and probable DCD. The main characteristics of the participants are described in the Table 1.

Insufficient levels of physical activity were significantly more frequent in individuals with DCD traits, considering childhood (63.0%), adult life (68.4%), and total score (67.6%). Also, in those from exact sciences courses (71.4%), and those who used medication (75.0%) (Table 2).

Elevated sedentary behaviour was significantly more frequent in individuals with DCD traits, considering childhood (50.0%), adult life (55.3%), and total score (52.9%). Also, in those from Social and Human sciences courses (71.4%), previously diagnosed with neurodevelopmental disorders (70.0%), and those who used medication (60.0%) (Table 3).

Participants who reported DCD traits had significantly increased odds for both outcomes across all time periods. Although controlling for health-related variables (Model 3) eliminated the significant association between DCD traits during childhood and insufficient levels of physical activity, and between DCD traits total score and insufficient levels of physical activity, the association remained significant across all time periods for adult life, and after controlling for sociodemographic variables for childhood and total score. On the other hand, despite a slight reduction in the odds ratios, significant associations between DCD traits and elevated sedentary behaviour persisted across all time periods, even after adjustments in Models 2 and 3 (Table 4).

Considering only probable DCD (pDCD), the significant association observed in childhood and adult life with insufficient levels of physical activity (Model 1) remained significant after adjustments in Model 2 but was no longer significant after adjustments in Model 3. The presence of probable DCD remained significantly

Variables	*n*	%
Levels of Physical Activity		
Sufficiently active	62	50.0
Insufficiently active	62	50.0
Sedentary Behaviour		
Elevated	34	27.4
Non-elevated	90	72.6
DCD traits		
Childhood		
At risk for DCD	31	25.0
Probable DCD	15	12.1
Typically developing	78	62.9
Adult Life		
At risk for DCD	19	15.3
Probable DCD	19	15.3
Typically developing	86	69.4
Total		
At risk for DCD	13	10.5
Probable DCD	16	12.9
Typically developing	95	76.6
Sociodemographic variables		
Sex		
Female	85	68.5
Male	39	31.5
Age		
≤ 23 years	65	52.4
> 23 years	59	47.6
Race/colour		
White	32	25.8
Black	41	33.1
Brown	48	38.7
Indigenous	02	1.6
Not declared	01	0.8
Marital Status		
Married	17	13.7
Not married	107	86.3
Employment relationship		
Yes	20	16.1
No	103	83.1
Field of the course		
Health Sciences	78	62.9
Social and Human Sciences	39	31.5
Exact Sciences	07	5.6
Financial University assistance		
Yes	46	37.1
No	78	62.9
Living at the same city of campus		
Yes	90	72.6
No	34	27.4
Ongoing semester		
≤ 5th semester	63	50.8
> 5th semester	61	49.2
Health-related variables		
Previously diagnosed Neurodevelopmental Disorders		
ADHD	05	4.0
ASD	02	1.6
Continued		

Variables	*n*	%
Previously diagnosed medical condition		
Anxiety Disorder	11	8.8
Depression	07	5.6
HIV	01	0.8
PTSD	01	0.8
Use of controlled medication		
Yes	20	16.1
No	104	83.9
Alcohol consumption		
Yes	51	41.1
No	73	58.9
Tobacco consumption		
Yes	12	9.7
No	112	90.3

Table 1. Characteristics of the participants. DCD: Developmental Coordination Disorder; ADHD: Attention Deficit Hyperactivity Disorder; ASD: Autism Spectrum Disorder; HIV/AIDS: Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome; PTSD: Post-traumatic Stress Disorder.

associated with elevated sedentary behaviour across all Models in adult life. However, in childhood and total scores, this association was observed only after controlling for sociodemographic variables (Model 2) (Table 5).

Discussion

This study showed that DCD traits during childhood, adult life and combining both periods (total score) increased the risk of insufficient levels of physical activity by 2.19, 2.88 and 2.59 times, respectively. After adjustments by sociodemographic factors, the relationship with physical activity persisted for childhood, adult life, and total scores. However, after adjustments by health-related factors, the relationship with physical activity persisted only for adult life. It may highlight that the burden of such sociodemographic and health-related factors on physical activity appears to differ across developmental periods. This suggests that during childhood, these factors play a less prominent role in shaping physical activity behaviours compared to adulthood, even in the presence of DCD traits. In other words, these determinants seem to gain greater importance later in life, potentially acting as more significant barriers to physical activity as individuals age. This hypothesis aligns with the synthesis by Telama[63], which pointed out that the stability of regular physical activity varies across age groups, being notably less stable during the transition from adolescence to adulthood.

The odds were greater for sedentary behaviour, increasing the risk for elevated sedentary behaviour by 5.81, 6.72, and 4.95 times, respectively for childhood, adult life and total score. The relationship with sedentary behaviour persisted significantly for all time periods, with odds ratios increasing in Model 2 for childhood, and slightly decreasing for adult life and total score. This aligns with findings that a physical activity deficit may begin in early childhood[64], but its persistence can vary depending on sociodemographic or health-related factors.

Although physical activity has recently gained greater public health attention in Brazil[65], there is still a significant gap in opportunities to be physically active across the country. For instance, a pooled analysis from 2013 to 2019[66] revealed substantial inequalities in leisure-time physical activity, particularly among individuals with lower levels of education, women and non-white populations. This context may explain our findings, especially considering that the university where the study was conducted is known for its inclusion and equity policies. Many students come from low-resource backgrounds and are often the first in their families to access higher education. A large proportion are from rural areas, spend long hours sitting during classes and commuting by bus, and often need to work to support themselves financially. These circumstances place our sample at a significant disadvantage when it comes to engaging in physical activity, and make them more likely to lead sedentary lifestyles. Given this background, it becomes clear that reducing sedentary behaviour requires considerable resilience, something that may be particularly challenging for individuals with DCD traits, who often have reduced physical literacy[11].

However, for fair comparisons, methodological differences between the studies should be considered. Although both this and the previous study[66] used a similar weekly minutes-based reference to assess physical activity levels, our study included only university students, while the other study[66] recruited adults from the general population. Additionally, our participants completed the questionnaire online via Google Forms, whereas participants in the other study[66] were interviewed by telephone.

The role of DCD traits on physical activity and sedentary behaviour is consistent with previous literature, indicating that deficits in motor skills may limit individuals' participation in physical activities, contributing to increased sedentary behaviours[67] Although, we found significant associations between both outcomes and DCD traits, the variations in DCD traits across developmental periods and in odds ratios across the three models suggest that DCD traits present a greater burden on sedentary behaviour than on physical activity, especially when considering sociodemographic and health-related factors.

Independent variables	Levels of Physical Activity		
Sociodemographic variables	Sufficiently active *n* (%)	Insufficiently active *n* (%)	*p*-value
ADC - Childhood			
DCD traits	17 (37.0)	29 (63.0)	0.04
Typically developing	45 (57.7)	33 (42.3)	
ADC - Adult Life			
DCD traits	12 (31.6)	26 (68.4)	0.01
Typically developing	50 (58.1)	36 (41.9)	
ADC - Total			
DCD Traits	11 (32.4)	23 (67.6)	0.02
Typically developing	51 (56.7)	39 (43.3)	
Age			
≤ 23 years	37 (56.9)	28 (43.1)	0.15
> 23 years	25 (42.4)	34 (57.6)	
Sex			
Female	42 (49.4)	43 (50.6)	1.00
Male	20 (51.3)	19 (48.7)	
Race/colour			
White	19 (59.4)	13 (40.6)	0.30
Not white	43 (46.7)	49 (53.3)	
Marital Status			
Married	06 (35.3)	11 (64.7)	0.19
Not married	56 (52.3)	51 (47.7)	
Employment relationship			
Yes	09 (42.9)	12 (57.1)	0.47
No	53 (51.5)	50 (48.5)	
Field of the course			
Health Sciences	47 (60.3)	31 (39.7)	0.01
Social and Human Sciences	13 (33.3)	26 (66.7)	
Exact Sciences	02 (28.6)	05 (71.4)	
Financial University assistance			
Yes	23 (50.0)	23 (50.0)	1.00
No	39 (50.0)	39 (50.0)	
Living at the same city of campus			
Yes	48 (53.3)	42 (46.7)	0.22
No	14 (41.2)	20 (58.8)	
Ongoing semester			
≤ 5th semester	29 (46.0)	34 (54.0)	0.37
> 5th semester	33 (54.1)	28 (45.9)	
Health-related variables			
Previously diagnosed Neurodevelopmental Disorders			
Yes	06 (30.0)	14 (70.0)	0.08
No	56 (53.8)	48 (46.2)	
Previously diagnosed medical condition			
Yes	08 (44.4)	10 (55.6)	0.61
No	54 (50.9)	52 (49.1)	
Use of controlled medication			
Yes	05 (25.0)	15 (75.0)	0.02
No	57 (54.8)	47 (45.2)	
Continued			

Independent variables	Levels of Physical Activity		
Sociodemographic variables	Sufficiently active *n* (%)	Insufficiently active *n* (%)	*p*-value
Alcohol consumption			
Yes	28 (54.9)	23 (45.1)	0.46
No	34 (46.6)	39 (53.4)	
Tobacco consumption			
Yes No	05 (41.7) 57 (50.9)	07 (58.3) 55 (49.1)	0.54

Table 2. Distribution DCD traits, sociodemographic and health characteristics according to the levels of physical activity in university students.

This was not replicated in a study conducted with Korean adults found significantly lower levels of physical activity in adults with DCD compared to typically developing adults, but no significant differences in sedentary behaviour[68]. In contrast, a study conducted with Finnish adults[69] found significantly higher levels of sedentary behaviour in individuals with DCD, as measured by accelerometry compared to their peers without DCD.

The stronger association of DCD traits with sedentary behaviour was further supported by the sensitivity analysis using pDCD. The pDCD during childhood and adult life increasing the risk of insufficient physical activity by 3.96 and 3.14 times respectively in Model 1, remained significant after adjustments by sociodemographic factors (Model 2). On the other hand, pDCD markedly increased the risk of sedentary behaviour, ranging from 3.99 to 11.99 times when controlled for sex and age (Model 1), and from 3.47 to 11.35 times after adjustment for sociodemographic (Model 2) and health-related (Model 3) factors. These findings are in line with previous literature[27,70], which suggests that motor difficulties in adults with DCD can explain avoidance behaviours[70], including disengagement from physical activities.

It is important to note that sedentary behaviour and physical activity are distinct, though related. Each outcome can manifest differently, especially in emerging adulthood. For example, Aira et al.[71] through a cohort study, found that adolescents who were already physically inactive were more likely to increase sedentary behaviour over time. Similarly, Smith et al.[72] found that adolescents with low gross motor coordination at age 16 reported more screen time and sedentary behaviour into adulthood, a pattern that persisted at age 42. However, the relationship between motor coordination and physical activity was not significant at age 16 but became significant by age 42, suggesting a non-persistent effect of motor difficulties on physical activity over time or a delayed effect.

However, the literature presents mixed evidence regarding differences in physical activity and sedentary behaviour during childhood between individuals with and without DCD. A systematic review[9] showed lower levels of physical activity in children with DCD, but study heterogeneity limited the strength of this evidence. Another study[73] found that children with higher motor proficiency were 2.46 times more likely to meet the 60-minute daily physical activity recommendation. Yu et al.[67] did not find significant differences in physical activity or sedentary behaviour between children with and without DCD, but did observe sex-based differences, with girls being less active and more sedentary[67].

Our study suggests that DCD traits may explain insufficient levels of physical activity and sedentary behaviour in adults when childhood is considered alone, and only when controlling for sex and age. As this association became non-significant in Model 3, the findings suggest that there are other health-related factors may mediate physical activity in childhood more than DCD traits.

The persistent associations observed for adulthood, but not childhood, support the hypothesis that DCD traits may have been concealed or unrecognized during developmental stages, where movement challenges remained within their capacities. During adulthood, however, new challenges come up, individuals with DCD may fully manifest traits that were not apparent in childhood but become evident in adulthood as these individuals likely face demands beyond their capacities[2]. A series of case studies[43] has suggested that the limited motor capacities associated with DCD are often overshadowed by non-motor issues in adulthood, highlighting the presence of emotional comorbidities, such as anxiety and depression. While these findings are novel, more research is needed to clarify the mediating role of persistent DCD traits on physical activity and sedentary behaviour deficits in adults, as evidence remains limited.

Strengths and limitations

Exploring DCD traits and pDCD to understand the risks for insufficient levels of physical activity and elevated sedentary behaviour in adults is a significant strength of this study, given that the literature on DCD in adults is still limited. Dividing the DCD traits into three periods was crucial for identifying its role on physical activity and sedentary behaviour persistently. However, the lack of objective measures for physical activity and sedentary behaviour represents a limitation of this study. Future research should consider employing of self-reported and objectively measured assessments of physical activity and sedentary behaviours. Further research is also necessary to determine whether sedentary behaviour continues to pose a greater burden than physical inactivity in this population. Additionally, the absence of reliability and validity studies of the ADC checklist for the Brazilian population should indeed be acknowledged as a limitation of this study. However, the ADC checklist is the most widely used instrument to screen for DCD traits in adults and is, to date, essentially the only option available in the literature for assessing DCD in this age range. The original English questions were translated

Independent variables	Sedentary Behaviour		
Sociodemographic variables	Not Elevated	Elevated	*p*-value
ADC - Childhood			
DCD traits	23 (50.0)	23 (50.0)	< 0.001
Typically developing	67 (85.9)	11 (14.1)	
ADC - Adult Life			
DCD traits	17 (44.7)	21 (55.3)	< 0.001
Typically developing	73 (84.9)	13 (15.1)	
ADC - Total			
DCD Traits	16 (47.1)	18 (52.9)	< 0.01
Typically developing	74 (82.2)	16 (17.8)	
Age			
≤ 23 years	51 (78.5)	14 (21.5)	0.15
> 23 years	39 (66.1)	20 (33.9)	
Sex			
Female	62 (72.9)	23 (27.1)	1.00
Male	28 (71.8)	11 (28.2)	
Race/colour			
White	23 (71.9)	09 (28.1)	1.00
Not white	67 (72.8)	25 (27.2)	
Marital Status			
Married	11 (64.7)	06 (35.3)	0.55
Not married	79 (73.8)	28 (26.2)	
Employment relationship			
Yes	13 (61.9)	08 (38.1)	0.23
No	77 (74.8)	26 (25.2)	
Field of the course			
Health Sciences	63 (80.8)	15 (19.2)	0.02
Social and Human Sciences	22 (56.4)	17 (43.6)	
Exact Sciences	05 (71.4)	02 (28.6)	
Financial University assistance			
Yes	34 (73.9)	12 (26.1)	0.83
No	56 (71.8)	22 (28.2)	
Living at the same city of campus			
Yes	66 (73.3)	24 (26.7)	0.76
No	24 (70.6)	10 (29.4)	
Ongoing semester			
≤ 5th semester	42 (66.7)	21 (33.3)	0.16
> 5th semester	48 (78.7)	13 (21.3)	
Health-related variables			
Previously diagnosed Neurodevelopmental Disorders			
Yes	06 (30.0)	14 (70.0)	< 0.001
No	20 (19.2)	84 (80.8)	
Previously diagnosed medical condition			
Yes	11 (61.1)	07 (38.9)	0.26
No	79 (74.5)	27 (25.5)	
Use of controlled medication			
Yes	08 (40.0)	12 (60.0)	< 0.001
No	82 (78.8)	22 (21.2)	
Alcohol consumption			
Yes	39 (76.5)	12 (23.5)	0.41
No	51 (69.9)	22 (30.1)	
Tobacco consumption			
Yes	08 (66.7)	04 (33.3)	0.73
No	82 (73.2)	30 (26.8)	

Table 3. Distribution DCD traits, sociodemographic and health characteristics according to sedentary behaviour in university students.

		Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Insufficient levels of physical activity	DCD traits – Childhood	2.19 (1.02–4.68)*	2.22 (1.03–4.74)*	1.77 (0.79–3.98)#
	DCD traits – Adult life	2.88 (1.28–6.52)**	2.86 (1.26–6.47)**	2.43 (1.03–5.71)*
	DCD traits – Total score	2.59 (1.11–6.01)*	2.55 (1.09–5.94)*	2.14 (0.87–5.26)#
Elevated sedentary behaviour	DCD traits – Childhood	5.81 (2.44–13.83)***	6.11 (2.51–14.88)***	4.01 (1.54–10.43)**
	DCD traits – Adult life	6.72 (2.80-16.14)***	6.30 (2.59–15.29)***	4.50 (1.73–11.69)**
	DCD traits – Total score	4.95 (2.07–11.83)***	4.48 (1.83–10.96)***	2.80 (1.04–7.54)*

Table 4. Association between DCD traits over time periods and levels of physical activity and sedentary behaviour in university students. ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; $p > 0.05$#. Model 1: Adjusted for sex and age Model 2: Adjusted for variables in Model 1 and sociodemographic factors Model 3: Adjusted for variables in Model 1 and health-related factors

		Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Insufficient levels of physical activity	pDCD – Childhood	3.96 (1.03–15.18)*	3.92 (1.02–15.05)*	2.75 (0.67–11.33)#
	pDCD – Adult life	3.14 (1.03–9.63)*	3.21 (1.05–9.84)*	2.53 (0.75–8.51)#
	pDCD – Total score	3.34 (0.99–11.22)#	3.34 (0.99–11.21)#	2.41 (0.65–8.93)#
Elevated sedentary behaviour	pDCD – Childhood	3.99 (1.25–12.72)*	3.47 (1.06–11.33)*	1.59 (0.41–6.16)#
	pDCD – Adult life	11.99 (3.70-38.77)***	11.35 (3.48-37.00)***	6.79 (1.88–24.50)**
	pDCD – Total score	7.90 (2.44–25.51)***	7.56 (2.29–24.88)***	3.73 (1.00-13.96)#

Table 5. Association between pDCD over time periods and levels of physical activity and sedentary behaviour in university students. ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; $p > 0.05$#. Model 1: Adjusted for sex and age Model 2: Adjusted for variables in Model 1 and sociodemographic factors Model 3: Adjusted for variables in Model 1 and health-related factors

into Brazilian Portuguese, and a panel of the research team was convened to at least ensure the instrument was understandable for Brazilian participants. We anticipate that a proper cultural adaptation of the instrument will be conducted soon to minimize potential bias in future studies. Finally, self-report measurements cand introduce bias in this study and affect the validity of the reported associations. Objective measurements should be included in future studies.

Conclusions

DCD traits were associated with reduced levels of physical activity and increased sedentary behaviour in adults. After adjustments for sociodemographic and health-related factors, the persistent effect of DCD traits remained significant only for sedentary behaviour, and was even stronger for pDCD. While the impact of DCD on insufficient physical activity was overshadowed by its impact in increasing sedentary behaviour, further studies are needed to clarify the relationships observed in this study. This study also highlights its unique contribution to the literature, as to the best of our knowledge, it is the first investigation of DCD traits among adults in Brazil. From a practical perspective, information about potential DCD traits should be included in the health history of adults when participating in physical activity programs. As a recommendation, interventions should prioritize reducing sedentary behaviour among adults with DCD traits, incorporating psychosocial and behavioural strategies, preferably managed by the University.

Data availability

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

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Author contributions

JLCN conceptualized the paper, performed the analysis of data, wrote the first draft of the manuscript. JMCS performed the collection of data, supported the analysis of data, conceived and managed the original data collection. GT contributed to the data analysis and methodology. SMS contributed to the data collection and supported the management of the original data collection. IPS contributed to the data collection and supported the management of the original data collection. JC contributed to the conceptualization of the paper, supported the analysis of data. All authors reviewed and edited the manuscript and have read and agreed to the final version of the manuscript.

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Declarations

Competing interests

The authors declare no competing interests.

Ethics approval and consent to participate

Ethical approval to conduct this study was obtained from the State University of Bahia Human Research Ethics Committee (approval no. 6.814.433, CAEE n. 78718024.5.0000.0057). All the participants electronically consented their participation through the Informed Consent Form.

Additional information

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