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Translation and Adaptation of the Adult Developmental Coordination Disorders/Dyspraxia Checklist (ADC) into European Portuguese Language

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Abstract

This paper reports the psychometric characteristics of the Portuguese version of the Adult Developmental Coordination Disorders/Dyspraxia Checklist (ADC). An independent translation of the questionnaire from the original version into European Portuguese was conducted. The sample consisted of 346 Portuguese adults, aged 18 to 65 years. Analyses were performed using R software (version 4.1.0). Exploratory factor analysis was performed to analyze the factor structure of the ADC scale, and a shorter 32-item version was found, with three new factors related to adaptation and daily life activities, gross motor coordination regarding ludic and physical activities that involve major muscular groups, and fine motor coordination activities. The Portuguese version demonstrated adequate reliability, as measured by internal consistency, item-total correlations, and

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test-retest reliability. All three factors and total scores were positively correlated with age. Gender differences were only found for the ludic and physical activities factor, with women presenting a higher score (more difficulties). This is a smaller-scale version that has good psychometric properties, making it a suitable alternative to the original scale when applied to Portuguese adults.

Keywords: Developmental Coordination Disorder; Portuguese adults; assessment tool; reliability; validity.

Tradução e Adaptação da Adult Developmental Coordination Disorders/Dyspraxia Checklist (ADC) para a Língua Portuguesa Europeia

Resumo

Este artigo relata as características psicométricas da versão em português europeu da *Adult Developmental Coordination Disorders/Dyspraxia Checklist* (ADC). Uma tradução independente do questionário da versão original para o português europeu foi realizada. A amostra incluiu 346 adultos portugueses, com idades entre 18 e 65 anos. As análises foram realizadas utilizando o *software* R (versão 4.1.0). A análise fatorial exploratória foi realizada para analisar a estrutura fatorial da escala ADC e uma versão mais curta, com 32 itens, foi encontrada, com três novos fatores relacionados com adaptação e atividades da vida diária, coordenação motora grossa relacionada com atividades lúdicas e físicas que envolvem grandes grupos musculares e atividades de coordenação motora fina. A versão em português apresenta adequada fiabilidade medida em termos de consistência interna, correlações item-total e fiabilidade teste-reteste. Todos os três fatores e o *score* total correlacionaram-se positivamente com a idade. Diferenças de género apenas foram encontradas no fator das atividades lúdicas e físicas, com as mulheres a apresentarem um *score* superior (mais dificuldades). Esta é uma escala mais reduzida que apresenta boas propriedades psicométricas, o que a torna uma boa alternativa à escala original, quando aplicada a adultos portugueses.

Palavras-chave: Perturbação do Desenvolvimento da Coordenação; adultos portugueses; ferramenta de avaliação; confiabilidade; validade.

INTRODUCTION

Discussions of Developmental Coordination Disorder (DCD) typically focus on its onset in childhood, often overlooking the potential for persistent symptoms into adulthood. This is supported by the fact that some literature reports a decrease or change in manifestations as age advances (Kirby & Sugden, 2010). About 70% of children with DCD continue to struggle with motor skills as they get older (Losse et al., 1991).

The ability of adults to develop coping mechanisms to deal with the limitations associated with the disorder is also relevant to this finding. Nevertheless, functional deficits with motor difficulties and neuropsychological development, namely brain maturation during early adulthood, especially of the prefrontal cortex (which is responsible for executive functions) remain affected (Kirby & Sugden, 2010; Tal-Saban et al., 2014). Some of the consequences of this condition are reflected in longer reaction times and more inhibition of behavioral responses. However, a recent study found no impairments in stop actions, suggesting that inhibitory motor control, an executive function required for goal-directed motor performance, is preserved in adults with DCD (Mayes et al., 2021). From a neurocognitive point of view, adults with DCD have a distinctive executive functioning profile, inclu-ding attention deficits, slowness, clumsiness, and lack of activity organization, that impacts academic achievement, activities of daily living, and their quality of life (Tal-Saban et al., 2014). They may also demonstrate associated emotional, social, and affective difficulties, especially during the pandemic (Engel-Yeger & Engel, 2023). Hence, DCD in adulthood should be screened and treated. Therefore, psychologists and clinical researchers must continue to adopt interdisciplinary approaches to the research and treatment of DCD (Meachon et al., 2022a). The question, then, arises about how to assess this disorder in adulthood, using specific instruments, such as those used with children and adolescents. The Adult Developmental Coordination Disorders/Dyspraxia Checklist (ADC) was the first instrument used to screen adults with possible DCD (Kirby et al., 2010). The ADC construct was based on Criterion B of the DSM-IV diagnostic criteria and presents good psychometric properties, including content validity. Kirby et al. (2010) found significant correlations between its 40 items and the total questionnaire score (r= .44 – .79, p < .001), good internal consistency (α > .85), and discriminant validity. The ADC includes three subscales: the first relates to difficulties that the individual experienced as a child (subscale A); the second focuses on the influence of DCD on the individual's perception of their performance (subscale B); and the third addresses current feelings about its performance, as reflected upon by others (subscale C). The authors suggested conducting studies in different countries to establish future comparisons, as the

ADC has proven to be an applicable instrument in adult populations with cultural differences. This challenge resulted in further studies. Meachon et al. (2022b) presented a translation and preliminary validation of the German ADC, which showed strong reliability, internal consistency, and construct validity. The study identified three new subscales related to motor skills and cognitive control: fine motor coordination (α = .88), gross motor coordination (α = .89), and executive functions (α = .84). Zappullo et al. (2023) provided an Italian version of the ADC with good reliability and concurrent validity. The subscales showed good internal consistency: subscale A (α = .78), subscale B (α = .79), and subscale C (α = .79). A confirmatory factor analysis indicated a good fit for the 40-item three-factor model, validating the separation of the A, B, and C subscales. The Italian version helps evaluate challenges in adult motor coordination. Furthermore, Saidmamatov et al. (2023) investigated the factor structure of the ADC scale in an Uzbek population through an exploratory factor analysis. A single-factor structure emerged, with satisfactory psychometric properties and a strong internal consistency reliability (α = .89). This version, with 29 items, reduces the respondents' fatigue since it is smaller than the original one. Governmental legal dispositions and cultural factors may influence the interpretation of the new unifactorial structure.

To also respond to Kirby's challenge, this research aimed to translate the ADC scale into Portuguese and examine its psychometric properties to determine its suitability for assessing motor coordination in Portuguese-speaking individuals.

METHOD

Participants

The sample was defined by convenience, according to accessibility, and comprised 346 Portuguese adults (55.8% males) between 18 and 65 years old (26.32 ± 12.39). After one week, the questionnaire was applied again in a subsample of 77 individuals (83.1% males) between 18 and 37 years old (20.55 ± 3.34).

Instrument

The ADC is a self-report questionnaire that is practical, simple to complete, and brief (15 to 20 minutes to complete) (Kirby et al., 2010). It provides information on adults' ability to act in home, academic, and social environments. It consists of 40 items that relate to space and time organization while performing daily life activities and self-care skills, everyday academic and vocational activities, hobbies, and social participation capacity. The questionnaire's structure includes three subscales:

subscale A (10 items) relates to difficulties experienced during childhood; subscale B (10 items) focuses on the influence of DCD on the individuals' perception of their performance as adults; subscale C (20 items) relates to the current feelings that individuals have about their performance but as reflected upon by others. A 4-point Likert scale (1 "never" to 4 "always") is used for the item's evaluation. Subscale scores and total scores are obtained by adding the corresponding items. Lower scores correspond to better performance. Kirby et al. (2010) analyzed the instrument's validity, including content validity. The results showed that ADC (and each subscale) could distinguish the DCD group from the control group.

Procedures

In this present study, several steps were followed to adapt the ADC scale to the Portuguese context. Before its administration to a sample of Portuguese adults, its items were translated into Portuguese. Five English specialists (one Portuguese teacher and two from the sport sciences area) independently translated the questionnaire into European Portuguese. Experts trained in psychology, sport sciences, and physiotherapy verified the lexical and grammatical equivalence and content validity. Doubts resulting from this process were discussed in three working sessions to reach a consensus solution. Subsequently, the assessment of the initial translation was based on a retroversion that an English teacher with skills in the field of translation carried out. This retroversion was compared with the original English instrument. As no significant discrepancies were detected, a preliminary version of the translated instrument was found (Table 1). This version was administered to 63 students (57.1% male) from the 12th grade of two Secondary Schools, using cognitive debriefing to ensure understanding of the different items, and no modifications were necessary afterwards.

Table 1

ADC items with corresponding Portuguese translation and original subscales.

Item
Subscale A (as a child):
1. Have difficulties with self-care tasks, such as tying shoelaces, fastening buttons and zips? (Teve dificuldade em realizar tarefas de autocuidado, como apertar os atacadores, os botões ou abrir e fechar fechos?)
2. Have difficulty eating without getting dirty? (Teve dificuldade em comer sem se sujar?)
3. Have difficulty learning to ride a bike compared to your peers? (Teve dificuldade em aprender a andar de bicicleta, comparado com as outras crianças da sua idade?)
4. Have difficulties with playing team games, such as football, volleyball, catching or throwing balls accurately? (Teve dificuldade em praticar desportos coletivos, como futebol, voleibol, em apanhar ou lançar a bola com precisão?)

Table 1 (Continuation)

ADC items with corresponding Portuguese translation and original subscales.

Item
Subscale A (as a child):
5. Have difficulty writing neatly (so others could read it)? (Teve dificuldade em escrever de forma legível (de modo a que os outros conseguissem ler)?)
6. Have difficulty writing as fast as your peers? (Teve dificuldade em escrever tão rapidamente quanto as outras crianças da sua idade?)
7. Bump into objects or people, trip over things more than others? (Chocava contra objetos ou pessoas, tropeçava em coisas, mais do que as outras crianças?)
8. Have difficulty playing a musical instrument (e.g. violin, recorder)? (Teve dificuldade em tocar instrumentos musicais (como violino, flauta)?)
9. Have difficulties with organizing/finding your things in your room? (Teve dificuldade em organizar/encontrar coisas no seu quarto?)
10. Have others comment about your lack of coordination or call yourself clumsy? (Os outros faziam comentários sobre a sua falta de coordenação ou chamavam-lhe de desajeitado/a?)
Subscale B (current symptoms):
11. Self-care tasks, such as shaving or make-up? (Tarefas de autocuidado como barbear ou maquilhar?)
12. Eating with a knife and fork/spoon? (Comer com faca e garfo/colher?)
13. Hobbies that require good coordination? (Passatempos que exigem boa coordenação?)
14. Writing neatly when having to write fast? (Escrever de forma legível, quando tem de escrever rápido?)
15. Writing as fast as your peers? (Escrever tão rápido como as outras pessoas?)
16. Reading your own writing? (Ler a sua própria escrita?)
17. Copying things down without mistakes? (Copiar textos sem cometer erros?)
18. Organizing/finding your things in your room? (Organizar/encontrar coisas no seu quarto?)
19. Finding your way around new buildings or places? (Orientar-se em locais ou edifícios que são novos para si?)
20. Have others called you disorganized? (Ter outras pessoas a apelidá-lo/a de desorganizado/a?)
Subscale C (current symptoms manifested by others):
21. Do you have difficulties with sitting still or appearing fidgety? (Tem dificuldade em manter-se sentado/a ou em estar tranquilo/a?)
22. Do you lose or leave behind possessions? (Costuma perder ou esquecer-se de objetos pessoais?)
23. Would you say that you bump into things, spill or break things? (Diria que costuma chocar com coisas, entornar ou deixar cair coisas?)
24. Are you slower than others getting up in the morning and getting to work or college? (Costuma ser mais lento/a do que os outros a levantar-se de manhã e a ir para o trabalho ou para a escola?)
25. Did it take you longer than others to learn to drive? (Demorou mais tempo do que os outros para aprender a conduzir?)
26. Do others find it difficult to read your writing? (Os outros consideram difícil ler a sua escrita?)
27. Do you avoid hobbies that require good coordination? (Evita passatempos que exigem boa coordenação?)
28. Do you choose to spend leisure time more on your own than with others? (Prefere passar o seu tempo de lazer mais sozinho/a do que com os outros?)

Table 1 (Continuation)

ADC items with corresponding Portuguese translation and original subscales.

Item
Subscale C (current symptoms manifested by others):
29. Do you avoid team games/sports? (Evita jogos/desportos de equipa?)
30. If you do a sport, is it more likely to be on your own, e.g. going to a gym, than with others? (Se pratica um desporto, é mais provável estar sozinho/a (ex: ir ao ginásio) do que com outros?)
31. Did you tend in your teens/twenties or currently to avoid going to clubs/dancing? (Durante a sua adolescência evita/evitou frequentar clubes de dança/discotecas?)
32. If you are a driver, do you have difficulty parking a car? (Se conduz, sente dificuldade em estacionar um carro?)
33. Do you have difficulty preparing a meal from scratch? (Tem dificuldade em preparar/cozinhar uma refeição desde o início?)
34. Do you have difficulty packing a suitcase to go away? (Tem dificuldade em fazer uma mala de viagem para viajar?)
35. Do you have difficulty folding clothes to put them away neatly? (Tem dificuldade em dobrar roupas para as guardar organizadamente?)
36. Do you have difficulty managing money? (Tem dificuldade em gerir o seu dinheiro?)
37. Do you have difficulties with performing two things at the same time (e.g. driving and listening)? (Tem dificuldade em realizar duas tarefas ao mesmo tempo (ex: conduzir e ouvir ou guardar uma mensagem de telemóvel)?)
38. Do you have difficulties with distance estimation (e.g. with regard to parking, passing through objects)? (Tem dificuldade em calcular distâncias? (ex: no que diz respeito a estacionar, passar entre objetos))
39. Do you have difficulty planning ahead? (Tem dificuldade em fazer planos com antecedência?)
40. Do you feel you are losing attention in certain situations? (Tem falta de concentração em determinadas situações?)

Data analysis

Analyses were conducted using R software (version 4.1.0). The *psych* package (version 2.1.6) for descriptive analysis, exploratory factor analysis, and evidence of reliability in terms of internal consistency; the *irr* package (version 0.84.1) for intraclass correlation coefficients; and the vcd package (version 1.4-10) for weighted Kappa.

Items 25 and 32, related to driving, had several answers missing because the individuals who needed a driving license were not included. Since the questionnaire was also applicable to individuals who did not drive, the missing answers to these items were coded with 0, which was identified as a missing value. Pairwise deletion procedures were applied to consider the responses that these individuals gave to the other items.

To analyze the latent factor structure of the ADC scale, when applied to a Portuguese sample, exploratory factor analysis (EFA) was performed. A significant Bartlett's sphericity test and KMO ≥ .70 were used as guidelines for data adequacy (Watkins, 2018). EFA was performed using principal axis factoring (PA), as PA is a least-squares estimation method that makes no assumptions about the data

distribution. According to Briggs and MacCallum (2003), least-squares estimation methods increase the likelihood of recovering all major common factors. Based on Meachon et al. (2022b), it was assumed that factors would be correlated, and oblimin rotation was considered. To decide the number of factors to retain, the visual inspection of the Scree Plot and Horn's method of parallel analysis was applied. According to Howard (2015), the .40-.30-.20 rule for factor loading cut-off was considered: satisfactory variables should load onto their primary factor above .40 and alternative factors below .30; the difference between their primary and alternative factor loadings should be .20.

Following the guideline of Pestana and Gageiro (2020) for EFA with ordinal items, Spearman correlations were considered since the ordinal items had only four response categories and were not symmetrical.

Known-groups validity was also assessed by applying t-tests and multivariate analyses of variance (MANOVAs) to identify statistically significant differences between genders, after validating all the assumptions of these procedures. The effect sizes, Cohen's d and partial eta squared, respectively, were considered.

Reliability was assessed by the internal consistency of the factors, as measured by Cronbach's alpha. Values of .70 or higher were considered adequate (Marôco, 2014). The test-retest reliability of each item, subscales, and total score was also assessed. Test-retest reliability of the subscales and the total score was evaluated by intraclass correlation coefficients (ICC) using single-measurement, absolute-agreement, and 2-way mixed effects models (Koo & Li, 2016). Due to the ordinal nature of the items, the test-retest reliability of each item was evaluated using the Kappa coefficient with quadratic weights, as its interpretation is similar to that of the ICC (Miot, 2016). The strength of the agreement was considered following the guidelines of Landis and Koch (1977) (for kappa cut-offs) and Koo and Li (2016) (for ICC cut-offs). Correlations between the ADC factors and item-total correlations were calculated, as in Kirby et al. (2010). However, the present study used Spearman correlations when considering the ordinal items.

Correlations between both total scores were calculated to compare the adapted scale with the original one. Spearman correlations (due to the asymmetric nature of the variable age) between age and the total/factor scores of both scales were also presented. The allocation of each individual in one of the groups related to DCD ("without DCD", "at risk of DCD", and "with probable DCD") when using the total score of both scales was compared.

RESULTS

Table 2 presents descriptive statistics of all 40 items of the original ADC scale applied to the Portuguese sample. All four response categories of each item were used (*Min* = 1, *Max* = 4 for all items).

Table 2

Descriptive statistics of the 40 items of the ADC

Subscale	Item	*n*	*Min*	*Max*	*Me*	*M*	*SD*
A		346	10	38	23.00	23.08	4.91
	1	346	1	4	2.00	2.13	0.64
	2	346	1	4	2.00	2.38	0.71
	3	346	1	4	2.00	2.23	0.78
	4	346	1	4	2.00	2.26	0.75
	5	346	1	4	2.00	2.31	0.78
	6	346	1	4	2.00	2.29	0.75
	7	346	1	4	2.00	2.16	0.64
	8	346	1	4	2.00	2.58	0.87
	9	346	1	4	2.00	2.56	0.80
	10	346	1	4	2.00	2.16	0.67
B		346	10	36	24.00	23.15	4.79
	11	346	1	4	2.00	2.05	0.55
	12	346	1	4	2.00	1.90	0.48
	13	346	1	4	2.00	2.27	0.73
	14	346	1	4	2.00	2.48	0.77
	15	346	1	4	2.00	2.35	0.81
	16	346	1	4	2.00	2.18	0.72
	17	346	1	4	2.00	2.34	0.73
	18	346	1	4	2.00	2.53	0.77
	19	346	1	4	3.00	2.63	0.81
	20	346	1	4	2.00	2.42	0.78
C		346	21	68	48.31	47.53	9.57
	21	346	1	4	2.00	2.48	0.79
	22	346	1	4	3.00	2.65	0.74
	23	346	1	4	2.00	2.36	0.69
	24	346	1	4	2.00	2.51	0.82
	25	283	1	4	2.00	2.15	0.57

Note: *Me* = median.

Table 2 (Continuation)

Descriptive statistics of the 40 items of the ADC

Subscale	Item	*n*	*Min*	*Max*	*Me*	*M*	*SD*
C	26	346	1	4	2.00	2.39	0.77
	27	346	1	4	2.00	2.21	0.71
	28	346	1	4	3.00	2.57	0.75
	29	346	1	4	2.00	2.23	0.76
	30	346	1	4	3.00	2.58	0.81
	31	346	1	4	2.00	2.51	0.84
	32	281	1	4	2.00	2.42	0.66
	33	346	1	4	2.00	2.41	0.78
	34	346	1	4	2.00	2.25	0.71
	35	346	1	4	2.00	2.36	0.80
	36	346	1	4	2.00	2.38	0.79
	37	346	1	4	2.00	2.47	0.76
	38	346	1	4	2.00	2.39	0.77
	39	346	1	4	2.00	2.40	0.73
	40	346	1	4	3.00	2.66	0.68
Total score		346	43	133	96.00	93.75	18.05

Note: *Me* = median.

Construct and known-groups validity

The results of the Bartlett's sphericity test ($\chi 2$ (780) = 6865.967; p <.001) and KMO = .94 suggested that these data were adequate for performing exploratory factor analysis. Both the visual inspection of the Scree Plot and Horn's parallel analysis method suggested the extraction of three factors. After applying the .40-.30-.20 rule for factor loading cut-off, eight items were eliminated (items 1, 8, 11, 12, 25, 28, 31 and 33).

Table 3 shows which items load into each of the three new factors. As can be seen, all the remaining 32 items had adequate factor loadings (of .40 or higher) and, following rotation, factor 1 accounted for 20% of the total variance. In contrast, factors 2 and 3 accounted for 12% of the total variance.

Table 3

Factor loadings and communalities of the 40 items of ADC after EFA with a Portuguese sample

Item	*n*	Pattern loadings		
		Factor 1	Factor 2	Factor 3
1	346	.31	.33	.15
2	346	.54	.01	.08
3	346	.04	.58	.18
4	346	.02	.75	.03
5	346	.03	.01	.75
6	346	.03	.17	.51
7	346	.53	.16	.03
8	346	.03	.22	.32
9	346	.58	.18	.20
10	346	.49	.23	.07
11	346	.01	.42	.32
12	346	.04	.43	.45
13	346	.22	.58	.07
14	346	.00	.06	.69
15	346	.06	.25	.57
16	346	.18	.08	.52
17	346	.17	.09	.46
18	346	.61	.10	.13
19	346	.46	.25	.09
20	346	.58	.02	.10
21	346	.51	.08	.22
22	346	.70	.08	.02
23	346	.59	.11	.02
24	346	.51	.01	.09
25	283	.24	.34	.11
26	346	.06	.03	.68
27	346	.23	.62	.04
28	346	.25	.35	.00
29	346	.05	.82	.07
30	346	.05	.41	.10
31	346	.04	.31	.15
32	281	.46	.23	.13
33	346	.13	.16	.22
34	346	.40	.15	.23
35	346	.40	.00	.25
36	346	.46	.08	.10
37	346	.40	.15	.04
38	346	.56	.34	.12
39	346	.63	.09	.03
40	346	.54	.12	.13

Note: *h*2 = commonalities; the bold loadings indicate the 32 items that were retained after EFA and the factors to which they were allocated.

Considering the items that were allocated to each of the new factors, it was determined that factor 1 (items 2, 7, 9, 10, 18, 19, 20, 21, 22, 23, 24, 32, 34, 35, 36, 37, 38, 39, 40) was related to adaptation and **daily life activities** (short name: daily life activities), factor 2 (items 3, 4, 13, 27, 29, 30) was related to gross motor coordination regarding ludic and physical activities that involve major muscular groups (short name: **ludic and physical activities**), and factor 3 (items 5, 6, 14, 15, 16, 17, 26) was related to **fine motor coordination activities**.

The descriptive statistics of the new version's total score and factors are shown in Table 4.

Table 4

Descriptive statistics of the adapted version of the ADC scale

Factor	*n*	*Min*	*Max*	*Me*	*M*	*SD*
Daily life activities	346	19	68	46.70	45.72	9.29
Ludic and physical activities	346	6	23	14.00	13.78	3.47
Fine motor coordination activities	346	7	28	16.00	16.35	3.94
Total score	346	33	111	78.00	75.85	14.93

Note: *Me* = median

Concerning known-groups validity, comparing both total scores (the total score of the original version of the ADC and the total score of the short version) between genders, no differences were found (original scale: $t(344) = -1.37$, $p = .170$, $d = 0.149$; adapted scale: $t(344) = -1.59$, $p = .114$, $d = 0.172$). The same occurred when comparing the original version's three subscales ($\lambda = .99$, $F(3,342) = 1.37$, $p = .252$, $\eta^2_P = .012$). Gender differences were found when considering the factors of the adapted version ($\lambda = .95$, $F(3,342) = 5.98$, $p < .001$, $\eta^2_P = .050$). However, only the factor ludic and physical activities was significantly different between genders ($t(344) = -3.31$, $p = .001$, $d = 358$), with women presenting a higher score, i.e., more coordination difficulties (14.47 ± 3.58) than men (13.24 ± 3.29).

Internal consistency, item-total correlation, and test-retest reliability

According to Table 5 and Table 6, all item-total correlations ranged between .41 and .67. Cronbach's alphas indicated strong internal consistency of both scales. Based on the ICC results, the test-retest reliability of the original/revised scale was good to excellent for all subscales/factors and total score. According to the Kappa values, the strength of agreement was considered substantial or practically perfect for almost all items. The only exception was item 28 ("Do you choose to spend your leisure time more on your own than with others?").

Table 5

Reliability analysis of the original (40 items) version of the ADC scale when applied to a Portuguese sample.

Item	*n*	Item-total correlations	α	*Test-retest*	
				n	Kappa coefficient with quadratic weights (95% CI)
1	346	.59***		77	.82*** (.73 - .91)
2	346	.57***		77	.81*** (.73 - .89)
3	346	.58***		77	.90*** (.81 - .98)
4	346	.54***		77	.77*** (.67 - .88)
5	346	.58***		77	.79*** (.69 - .89)
6	346	.54***		77	.84*** (.76 - .92)
7	346	.57***		77	.86*** (.75 - .98)
8	346	.48***		77	.77*** (.65 - .90)
9	346	.53***		77	.77*** (.67 - .86)
10	346	.61***		77	.90*** (.82 - .98)
11	346	.49***		77	.85*** (.70 - .99)
12	346	.60***		77	.98*** (.93 – .99)
13	346	.65***		77	.81*** (.71 - .92)
14	346	.58***		77	.83*** (.75 - .91)
15	346	.57***		77	.83*** (.75 - .91)
16	346	.62***		77	.79*** (.68 - .89)
17	346	.56***		77	.83*** (.75 - .91)
18	346	.57***		77	.77*** (.65 - .89)
19	346	.53***		77	.85*** (.79 - .92)
20	346	.58***		77	.74*** (.62 - .86)
21	346	.58***		77	.80*** (.72 - .89)
22	346	.53***		77	.69*** (.58 - .81)
23	346	.57***		77	.67*** (.56 - .79)
24	346	.54***		77	.82*** (.70 - .94)
25	283	.55***		77	.89*** (.81 - .97)
26	346	.57***		77	.91*** (.86 - .97)
27	346	.65***		77	.91*** (.84 - .97)
28	346	.50***		77	.52*** (.33 - .72)
29	346	.58***		77	.80*** (.66 - .93)
30	346	.48***		77	.67*** (.52 - .82)
31	346	.41***		77	.74*** (.60 - .88)
32	281	.54***		77	.76*** (.63 - .88)
33	346	.42***		77	.87*** (.79 - .94)
34	346	.64***		77	.82*** (.70 - .93)
35	346	.55***		77	.84*** (.73 - .95)
36	346	.53***		77	.75*** (.61 - .88)
37	346	.51***		77	.66*** (.51 - .80)
38	346	.67***		77	.81*** (.72 - .91)
39	346	.64***		77	.76*** (.62 - .89)

Note: ***$p < .001$

Table 5 (Continuation)

Reliability analysis of the original (40 items) version of the ADC scale when applied to a Portuguese sample.

Item	*n*	*Item-total correlations*	*α*	*Test-retest*	
				n	*Kappa coefficient with quadratic weights (95% CI)*
40	346	.51***		77	.76*** (.66 - .86)
Subscale A	346		.86	77	
Subscale B	346		.86	77	
Subscale C	346		.90	77	
Total score	346		.95	77	

Note: ***$p < .001$

Table 6

Reliability analysis of the short (32 items) version of the ADC scale when applied to a Portuguese sample.

Item	*n*	Item-total correlations	*α*	*Test-retest reliability*	
				n	ICC (95% CI)
2	346	.56***			
3	346	.57***			
4	346	.53***			
5	346	.58***			
6	346	.53***			
7	346	.59***			
9	346	.54***			
10	346	.63***			
13	346	.66***			
14	346	.60***			
15	346	.57***			
16	346	.63***			
17	346	.58***			
18	346	.59***			
19	346	.54***			
20	346	.61***			
21	346	.59***			
22	346	.56***			
23	346	.60***			
24	346	.56***			
26	346	.57***			
27	346	.65***			
29	346	.57***			
30	346	.46***			

Note: ****$p < .001$; Kappa coefficients were omitted since they are the same as in Table 5.

Table 6 (Continuation)

Reliability analysis of the short (32 items) version of the ADC scale when applied to a Portuguese sample.

Item	*n*	Item-total correlations	α	*Test-retest reliability*	
				n	ICC (95% CI)
32	283	.52***			
34	346	.64***			
35	346	.55***			
36	346	.54***			
37	346	.51***			
38	346	.67***			
39	346	.65***			
40	346	.52***			
Daily life activities	346		.92	77	.93*** (.87 - .96)
Ludic and physical activities	346		.86	77	.92*** (.88 - .95)
Fine motor coordination activities	346		.86	77	.94*** (.90 - .96)
Total score	346		.94	77	.95*** (.92 - .97)

Note: ***$p < .001$; Kappa coefficients were omitted since they are the same as in Table 5.

Long and short ADC versions comparison

In the original 40-item scale, all subscales were highly correlated ($r = .80$ between subscales A and B; $r = .79$ between subscales A and C; $r = .82$ between subscales B and C). In the adapted scale, the correlations were as follows: between daily life activities and ludic and physical activities, $r = .66$; between daily life activities and fine motor coordination activities, $r = .70$; and between ludic and physical activities and fine motor coordination activities, $r = .55$.

The total score of both scales was almost perfectly correlated ($r = .99$, $p < .001$), and correlations between age and the total score of both scales were very similar, statistically significant, and positive (original scale: $r = .28$, $p < .001$; adapted scale: $r = .27$, $p < .001$). Additionally, the correlations between age and all three subscales/factors were also statistically significant and positive (subscale A: $r = .25$, $p < .001$; subscale B: $r = .30$, $p < .001$; subscale C: $r = .29$, $p < .001$; daily life activities: $r = .22$, $p < .001$; ludic and physical activities: $r = .37$, $p < .001$; fine motor coordination activities: $r = .28$, $p < .001$) and, as already seen, only ludic and physical activities was significantly different between genders, with women presenting a higher score than men. Both scales presented strong internal consistency reliability. In terms of test-retest reliability, only item 28 (which was not included in the short version) did not present a substantial or almost perfect agreement.

Following the recommendation of Geuze et al. (2001), cut-off scores for "at risk of DCD" (5th percentile (*M* – 1.65 *SD*) or above) and "with probable DCD" (15th percentile (*M* - 1.00 *SD*) or above) were calculated, for both scales. The cut-off scores obtained for the original scale were 63 and 75, respectively. For the adapted version, the cut-off scores were 51 and 60, respectively. When comparing the allocation of each individual to one of the groups related to DCD ("without DCD", "at risk of DCD", and "with probable DCD") after using both total scores, it was verified that 343 of the 346 individuals (99.1%) were equally allocated. The new scale identified the remaining three as "with probable DCD" while the original scale identified them as "at risk of DCD".

DISCUSSION

This paper reports the psychometric characteristics of the Portuguese version of the ADC scale. An independent translation of the questionnaire from the original version into European Portuguese was conducted. Concerning the original version of the ADC scale, Cronbach's alphas indicated strong internal consistency reliability of the overall scale and its subscales, similar to Kirby et al. (2010) and Meachon et al. (2022b), and the three original subscales were very highly correlated, similarly to what happened in Meachon et al. (2022b).

When performing EFA in a Portuguese sample, the original structure of the 40-item ADC scale did not hold. Instead, eight items had to be removed, namely, items 8 (playing a musical instrument), 28 (preferring to spend leisure time alone), and 31 (avoiding going to clubs/dancing), as in Meachon et al. (2022b). In addition, we also removed items 1 (self-care tasks, as a child), 11 (self-care tasks, currently), 12 (eating with knife and fork/spoon), 25 (taking longer to learn to drive), and 33 (preparing a meal from scratch), while they only removed another item – item 21 (sitting still or appearing fidgety). From the eight items that were eliminated, six did not load on any factor and only items 11 and 12 had cross loadings. As noted by Meachon et al. (2022b), items 28 and 31 are related to social interactions, and the responses to these items could be more related to the respondents' social preferences independent of DCD. Item 8 addresses playing a musical instrument, and other cultural factors, beyond DCD, could influence the opportunity to learn to play it. In the present study, item 1 also did not load on any factor, possibly because children may experience these kinds of difficulties simply due to their age and not because of DCD. Concerning items 25 and 33, other reasons unrelated to DCD could also explain the more extended period necessary to learn to drive or the difficulties in preparing a meal from scratch. For instance, individuals could engage in other activities while learning to drive (e.g., work or attend school).

When comparing the total score and all three factors of the adapted ADC version with age, statistically significant positive correlations were obtained. Cleaton et al. (2021), using the ADC, found that emerging adults with DCD are more challenged compared to older adults, which warrants a closer examination of this transitional phase of the life cycle (Arnett, 2000). Those challenges impact education, work, and social fields and include difficulties with writing and driving. These functions are controlled by the frontal-parietal brain network, which is still undergoing development during emerging adulthood. Nevertheless, the positive correlation found in the present study points to the fact that older adults with DCD also deserve additional attention since DCD has long-term health problems that are not confined to motor and coordination difficulties (Cleaton et al., 2021). Regarding gender, no differences in the adapted version total score were found, which aligns with previous studies (Tal-Saban et al., 2014; Zappullo et al., 2023). Furthermore, ludic and physical activities differed between genders, with women experiencing more coordination difficulties, which aligns with the findings of Cleaton et al. (2021). However, there has been a lack of consensus in the literature regarding gender differences, and further studies are needed to deepen knowledge about the relationship between gender and this disorder, both in children and adults.

Although the original scale and the one adapted to the Portuguese context did not coincide, there were some similarities. The total scores were almost perfectly correlated; both total scores and all subscales/factors were significantly and positively correlated with age, and no gender differences were found when considering both total scores. In general, both scales demonstrated adequate reliability, as measured by internal consistency, item-total correlations, and test-retest reliability. Both overall scales had Cronbach's alphas and item-total correlations similar to the ones obtained by Kirby et al. (2010). Additionally, when comparing the allocation of each individual in one of the DCD groups, "without DCD", "at risk of DCD", and "with probable DCD", only three of the 346 analyzed cases differed when using both scales. However, in the original scale, one of the items had a low Kappa (item 28), and in the new 3-factor structure, all items presented Kappa values that suggested substantial or almost perfect strength of agreement. Also, of the three cases that both scales allocated differently in the DCD groups, there was never a situation where the new scale would identify as not having DCD someone that the original version would identify as "at risk of DCD" or "with probable DCD", which seems to indicate that the sensitivity of the adapted scale is providing accurate identification of those who have DCD when applied to Portuguese adults. In the adapted scale, correlations between factors were moderate, suggesting that these factors measured different constructs, which did not occur in the original version. The new factors of the adapted Portuguese version were easily identified as being related to adapta-

tion and daily life activities, gross motor coordination regarding ludic and physical activities that involve large muscular groups, and fine motor coordination. These last two factors are in line with the symptom-based rather than time-based, unlike the original ADC. Additionally, they are widely recognized as core symptoms of DCD (Blank et al., 2019). This can also be applied to daily life activities, as they are included in Criterion B of the DSM-5-TR (American Psychiatric Association, 2022). Furthermore, the new proposed scale is smaller than the original one, reducing respondent fatigue, and it has good psychometric properties, making it an excellent alternative to the original scale when applied to Portuguese adults. Its temporally based structure enables clinicians to address DSM Criteria A for symptoms in childhood and criterion B regarding current symptoms that interfere with daily life. Future research should consider the possibility to integrate the data-driven ADC structure with an option to address diagnostic criteria accordingly.

The analysis of the factorial structure of the ADC scale, through EFA, when applied to a Portuguese sample, was a novelty of the present study. Indeed, there is not, to our knowledge, any other study of this scale with Portuguese individuals, and although the factorial structure of the ADC scale was analyzed through EFA in Saidmamatov et al. (2023), the sample was from Asian Uzbekistan. The factorial structure was not analyzed by the author of the original scale (Kirby et al., 2010) and, although it was analyzed in Meachon et al. (2022b), that structure was analyzed in a German sample, with one additional item compared to the original version, and the authors used PCA and not standard factor analysis. Since the present study aimed to identify the latent factor structure, common factor analysis was employed (Watkins, 2018). In sum, the psychometric properties of the Portuguese version of ADC appear promising. Further psychometric evaluations are required to conduct work on new samples.

LIMITATIONS AND FUTURE STUDIES

The absence of a variable in our questionnaire that would allow the identification of individuals with or without diagnosed DCD is a limitation of our study. This absence prevented us from assessing the scale's ability to differentiate between the DCD and non-DCD groups, as Kirby et al. (2010) did. Furthermore, construct and known-groups validity were assessed; however, it was not possible to assess other types of validity, namely concurrent validity, as the protocol did not include variables such as handwriting measures that could be considered for this analysis. Before suggesting its use with Portuguese adults, more studies with larger Portuguese samples are recommended to see if it correctly discriminates between those with and those without DCD. We note that the calculation of the cut-off scores was

only performed to compare the allocation of each individual to one of the groups related to DCD ("without DCD", "at risk of DCD", and "with probable DCD") using the total score of the original scale and the total score of the Portuguese version. Therefore, studies to confirm and discuss the cut-off scores of this new scale are also suggested. It would also be valuable to confirm the new structure by performing a confirmatory factor analysis with another Portuguese sample and assessing other types of validity, such as concurrent and predictive validity.

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REFERENCES

American Psychiatric Association. (2022). *Diagnostic and statistical manual of mental disorders* (5th ed., text rev.; DSM-5-TR). https://doi.org/10.1176/appi.books.9780890425787

Arnett, J. J. (2000). Emerging adulthood: A theory of development from the late teens through the twenties. *American Psychologist, 55*(5), 469–480. https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=0194af743cf01b2d97f59148eb599e5282086d80

Blank, R., Barnett, A. L., Cairney, J., Green, D., Kirby, A., Polatajko, H., Rosenblum, S., Smits-Engelsman, B., Sugden, D., & Vinçon, S. (2019). International clinical practice recommendations on the definition, diagnosis, assessment, intervention, and psychosocial aspects of developmental coordination disorder. *Developmental Medicine and Child Neurology, 61*(3), 242–285. https://doi.org/10.1111/dmcn.14132

Briggs, N. E., & MacCallum, R. C. (2003). Recovery of weak common factors by maximum likelihood and ordinary least squares estimation. *Multivariate Behavioral Research, 38*(1), 25–56. https://doi.org/10.1207/S15327906MBR3801_2

Cleaton, M. A. M., Tal-Saban, M., Hill, E. L., & Kirby, A. (2021). Gender and age differences in the presentation of at-risk or probable developmental coordination disorder in adults. *Research in Developmental Disabilities, 115*, 104010. https://doi.org/10.1016/j.ridd.2021.104010

Engel-Yeger, B., & Engel, A. (2023). Emotional distress and quality of life among adults with developmental coordination disorder during COVID-19. *The British Journal of Occupational Therapy, 86*(2), 130–138. https://doi.org/10.1177/03080226221126892

Geuze, R. H., Jongmans, M., Schoemaker, M., & Smits-Engelsman, B. (2001). Developmental coordination disorder. *Human Movement Science, 20*(1–2), 1–5. https://doi.org/10.1016/S0167-9457(01)00026-4

Howard, M. (2015). A review of exploratory factor analysis (EFA) decisions and overview of current practices: What we are doing and how can we improve? *International Journal of Human--Computer Interaction, 32*(1), 51–62. https://doi.org/10.1080/10447318.2015.1087664

Kirby, A., & Sugden, D. A. (2010). Developmental coordination disorder. *British Journal of Hospital Medicine, 71*(10), 571–575. https://doi.org/10.12968/hmed.2010.71.10.78947

Kirby, A., Edwards, L., Sugden, D., & Rosenblum, S. (2010). The development and standardization of the adult developmental coordination disorders/dyspraxia checklist (ADC). *Research in Developmental Disabilities, 31*(1), 131–139. https://doi.org/10.1016/j.ridd.2009.08.010

Koo, T. K., & Li, M. Y. (2016). A guideline of selecting and reporting intraclass correlation coefficients for reliability research. *Journal of Chiropractic Medicine, 15*(2), 155–163. https://doi.org/10.1016/j.jcm.2016.02.012

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics, 33*(1), 159–174.

Losse, A., Henderson, S. E., Elliman, D., Hall, D., Knight, E., & Jongmans, M. (1991). Clumsiness in children—Do they grow out of it? A 10-year follow-up study. *Developmental Medicine and Child Neurology, 33*(1), 55–68. https://doi.org/10.1111/j.1469-8749.1991.tb14785.x

Marôco, J. (2014). *Análise de equações estruturais: Fundamentos teóricos, software & aplicações*. ReportNumber.

Mayes, W., Gentle, J., Parisi, I., Dixon, L., Velzen, J., & Violante, I. (2021). Top-down inhibitory motor control is preserved in adults with developmental coordination disorder. *Developmental Neuropsychology, 46*(6), 409–424. https://doi.org/10.1080/87565641.2021.1966431

Meachon, E., Zemp, M., & Alpers, G. (2022a). Developmental coordination disorder (DCD): Relevance for clinical psychologists in Europe. *Clinical Psychology in Europe, 4*(2), Article e4165. https://doi.org/10.32872/cpe.4165

Meachon, E. J., Beitz, C., Zemp, M., Wilmut, K., & Alpers, G. W. (2022b). The adult developmental coordination disorders/dyspraxia checklist—German: Adapted factor structure for the differentiation of DCD and ADHD. *Research in Developmental Disabilities, 126*, 104254. https://doi.org/10.1016/j.ridd.2022.104254

Miot, H. A. (2016). Análise de concordância em estudos clínicos e experimentais. *Jornal Vascular Brasileiro, 15*(2), 89–92. https://doi.org/10.1590/1677-5449.004216

Pestana, M. H., & Gageiro, J. M. (2020). *Análise de dados para ciências sociais: A complementaridade do SPSS* (6ª ed.). Edições Sílabo.

Saidmamatov, O., Jammatov, J., Sousa, C., Barros, R., Vasconcelos, O., & Rodrigues, P. (2023). Translation and adaptation of the adult developmental coordination disorder/dyspraxia checklist (ADC) into Asian Uzbekistan. *Sports, 11*(135). https://doi.org/10.3390/sports11070135

Tal-Saban, M., Ornoy, A., & Parush, S. (2014). Executive function and attention in young adults with and without developmental coordination disorder—A comparative study. *Research in Developmental Disabilities, 35*(11), 2644–2650. https://doi.org/10.1016/j.ridd.2014.07.002

Zappullo, I., Conson, M., Baiano, C., Cecere, R., Raimo, G., & Kirby, A. (2023). The relationships between self-reported motor functioning and autistic traits: The Italian version of the adult developmental coordination disorders/dyspraxia checklist (ADC). *International Journal of Environmental Research and Public Health, 20*(2), 1101. https://doi.org/10.3390/ijerph20021101

Watkins, M. W. (2018). Exploratory factor analysis: A guide to best practice. *Journal of Black Psychology, 44*(3), 219–246. https://doi.org/10.1177/0095798418771807