



Health-related quality of life in developmental coordination disorder and typical developing children

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ARTICLE INFO

Number of reviews completed is 2

Keywords:

Health-related quality of life

Motor skills

Motor skills disorders

Self-report

Proxy-report

Preschool

ABSTRACT

Purpose: To analyse: 1) the differences in health-related quality of life (HRQoL) between typically developing (TD) children and children with developmental coordination disorder (DCD) according to parents' and children's perception, and 2) the differences and level of agreement between parents and children's perceptions in HRQoL in both children's samples.

Methods: Cross-sectional analysis in 115 Spanish schoolchildren 4-to-7 years. Motor competence and HRQoL were assessed using the MACB-2 and the KINDL-R questionnaire, respectively.

Results: ANCOVA model showed that children with DCD children obtained lower scores in physical well-being, friends, school and total HRQoL dimensions than TD peers after controlling for covariates ($p < 0.05$). Moreover, parents' perception scores in HRQoL were lower in children with DCD than in TD peers (79.7 vs 84.8; $p = 0.022$). Student T-tests for repeated-measures showed non-significant differences between children and parents' perceptions in mean HRQoL scores, by motor competence categories. The intraclass correlations coefficients between parents and children's perception of HRQoL was moderate in DCD category (0.62; $p = 0.024$) and small in TD category (0.29; $p = 0.049$).

Conclusions: Children under 6 years old with DCD have lower HRQoL scores than their TD peers. No differences were found between children's and parents' perceptions in total HRQoL, although the perceptions of children and parents in DCD category showed a significantly higher level of agreement than TD children. Interventions aimed at promoting motor skills in school settings during the preschool age seem necessary to improve children's quality of life.

Abbreviations: MC, motor competence; DCD, developmental coordination disorder; TD, typically developing; HRQoL, health-related quality of life; SES, socioeconomic status.

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<https://doi.org/10.1016/j.ridd.2021.104087>

Received 2 October 2019; Received in revised form 27 August 2021; Accepted 16 September 2021

Available online 28 September 2021

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What this paper adds?

Several studies have evidenced that children with developmental coordination disorder (DCD) have lower scores on multiples domains of quality of life. Nevertheless, only two studies have examined differences in health-related quality of life (HRQoL) between children with DCD and previous published normative values in children with TD, but none of them included potential confounders (Caçola & Killian, 2018; Karras, Morin, Gill, Izadi-Najafabadi, & Zwicker, 2019). This paper adds to the literature that children under 6 years of age with DCD have significantly lower scores after controlling for age, sex, body mass index, socioeconomic status and physical fitness than typically developing (TD) peers on physical well-being, friends, school, and total score HRQoL dimensions. On the other hand, parents' perception about quality of life of their children is known to be higher than the children themselves, but in children with health conditions the parent tend to underestimate child HRQoL (Upton, Lawford, & Eiser, 2008), but only one study examined the differences in HRQoL between self-report and parents' proxy-report in children with DCD and TD peers (Karras et al., 2019). This study showed a moderate level of agreement between parents and children in DCD category and small in TD category. The results establish the fact that children with DCD scores lower than TD and initiatives and programs for children into the school context focused on motor competence during the preschool age could improve their future HRQoL.

1. Background

Children with DCD, which is one of the most common health problems among children worldwide (Missiuna, Moll, King, Stewart, & Macdonald, 2008), are characterized by a delay in the development of motor skills, particularly the coordination of movements, which significantly impairs the child's actions and daily tasks (American Psychiatric Association, 2013). According to the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5), the prevalence of DCD in children is 5–6 % (American Psychiatric Association, 2013), although in Spanish children aged 4-to-7 years a prevalence of DCD of 9.9 % has been reported (Amador-Ruiz et al., 2018).

Several studies have shown that children with DCD have low scores on multiple domains of quality of life (Poulsen, Ziviani, Johnson, & Cuskelly, 2008; Raz-Silbiger et al., 2015; Wuang, Wang, & Huang, 2012; Zwicker, Harris, & Klassen, 2013). However, as far as we know, only two studies have examined the differences in the HRQoL between children with DCD and TD children (Caçola & Killian, 2018; Karras et al., 2019). Although neither of them compares with collected data rather than with previously published normative values, nor did any of them include potential confounders in their analysis. Since previous literature indicates that age, sex, body composition, fitness or socio-economic status (SES) are factors that affect HRQoL, thus, these factors should therefore be taken into account in studies examining HRQoL in children (Gallahue, Ozmund, & Goodway, 2019; Redondo-Tébar et al., 2019; von Rueden, Gosch, Rajmil, Bisegger, & Ravens-Sieberger, 2006). In addition, none of these studies has been performed in preschool age, which is a critical period (Britto et al., 2017) since developmental delays usually occur at the early childhood and often persist to adolescence and adulthood (Black et al., 2017).

Parents' perception about quality of life of their children is known to be higher than the children themselves, but in children with health disorders the parents tend to underestimate child HRQoL (Upton et al., 2008). In very young children, a HRQoL parent-proxy report is needed as they have difficulties expressing their feelings, understanding items on HRQoL instruments and reporting their own perceived HRQoL, which makes results unreliable (Bullinger, Brütt, Erhart, & Ravens-Sieberger, 2008; Eiser & Morse, 2001a; Upton et al., 2008). However, it has not yet been established at what age or under what conditions children's reporting is valid or invalid, or when to use self, parent or both forms to report (Wallander & Koot, 2016). Both parent and child perspectives should be utilized wherever possible (Eiser & Morse, 2001a, 2001b) especially when comparing healthy and non-healthy populations (Jozefiak, Larsson, Wichstrom, Wallander, & Mattejat, 2010). These differences between parents and children's perceptions in HRQoL could be important not only for research, but also for evaluation targeted programs for children with delay in the development of motor skills. However, only one study examined the differences in HRQoL between self-report and parents' proxy-report in children with DCD and TD peers (Karras et al., 2019).

Therefore, the aims of this study were: (1) to analyse the differences in HRQoL (parents' proxy-report and children's self-report) between children with DCD and TD children controlling for potential confounders; and (2) to examine the differences and level of agreement between self-report and parents' proxy-report perceptions in HRQoL by motor competence (MC) categories.

2. Methods

2.1. Design and participants

The present study is a cross-sectional analysis in which 161 schoolchildren were randomly selected of the baseline data from a cluster-randomized controlled trial (Sánchez-López et al., 2015) to assess the impact of a physical activity intervention program on obesity indicators, physical fitness, blood pressure, MC and cognition in children (MOVI-KIDS study). In MOVI-KIDS study a total of 1604 schoolchildren aged 4–7 years from 21 schools situated in the Spanish provinces of Cuenca and Ciudad Real, were invited and agreed to participate. After approval from School Councils, the schools were randomly assigned to either the intervention group ($n = 11$) or the control group ($n = 10$), by using the statistical package StatsDirect. The main characteristics of selected schools were as follows: 19 of them were public and 2 privates, 17 were in rural areas ($<10,000$ inhabitants) and 4 in urban areas. All schools have similar physical activity and treatment of pupils with special educational needs education policies. Due to lack of time and resources,

only 3 schools (belonging to 2 schools in the intervention group and 1 in the control group, located in urban areas and where 2 were private schools and 1 public school) were randomly selected to assess the complete MC. Finally, of the 161 schoolchildren belonging to these 3 schools, only 115 children (47 % girls) were included in the present study who had complete MC, HRQoL and potential confounders. These did not differ significantly in sociodemographic characteristics (age, sex, socioeconomic, anthropometric, and physical fitness) from the 161 in the selected subsample.

The study protocol was approved by The Clinical Research Ethics Committee of the 'Virgen de la Luz' Hospital, and all parent or legal guardians signed the informed consent forms to participate in the study. Also, children were asked for their participation before each variable measurement.

2.2. Instruments and procedures

Trained investigators measured all variables to minimize inter-observer variability. The measurement procedures are extensively described elsewhere (Sánchez-López et al., 2015), which, in brief, were as follows:

Motor competence (MC) was assessed using the Spanish validated-version of the Movement Assessment Battery for Children-Second Edition (MABC-2) (Henderson, Sudgen, & Barnett, 2007). The total score from the MABC-2 eight motor tasks was used in this study. All raw scores' tests were converted into scaled scores according to the age and normative reference values, where higher scores indicating better MC and were used to classify significant movement difficulties in three categories categorized into two (DCD and risk of DCD score below 69 and TD score above 69).

Health-related quality of life (HRQoL) was assessed using the Spanish language-versions of the KINDL-R self-report and parent's proxy-report questionnaires (Ravens-Sieberer & Bullinger, 1998), referring to the previous week. KINDL-R children self-report contains 12 items which score was transformed into a scale from 0 to 100 obtaining only a total score HRQoL (Ravens-Sieberer & Bullinger, 2000). KIND-R parent's proxy-report is distributed in six dimensions (physical well-being, emotional well-being, self-esteem, family, friends, and school) and a total score HRQoL. Each dimension scores were transformed into a scale from 0 to 100 points, making possible to obtain also a total score HRQoL (Ravens-Sieberer & Bullinger, 2000). Higher scores indicate better HRQoL (Ravens-Sieberer & Bullinger, 2000).

Physical fitness was assessed using three tests included in the Alpha-Fitness test Battery (Ruiz et al., 2011). Cardiorespiratory fitness measured using the 20-m shuttle run test, muscle strength evaluated by the standing long jump test, and speed-agility obtained through the test of maximum speed/agility 4×10 m. A physical fitness index was calculated by summing the standardized Z-scores of the three tests.

Socioeconomic status (SES) was assessed using self-reported occupation and education questions completed by either father or mother. An index of SES was calculated based parent' education and occupation levels according to the Spanish Society of Epidemiology scale procedures, which categorized family SES in five categories; these five levels were collapsed for our analyses into lower-upper lower, lower-middle and upper middle-upper (Chilet-Rosell, Álvarez-Dardet, & Domingo-Salvany, 2012).

Weight and height were measured twice following standardized procedures. **Body mass index (BMI)** was calculated by dividing the means of weight (Kg) by height (m^2). **Body fat mass percentage** was estimated using the BC-418 bioimpedance analysis system (Tanita Corp., Tokyo, Japan).

2.3. Statistical analyses

The normal distribution of all variables was evaluated by graphical procedures and the Kolmogorov-Smirnov test. Cronbach's alfa was calculated for the KINDL-R and the MABC-2 variables showed moderate-to-high (parents' version 24-items, 0.87; children version 12-items, 0.65) and moderate (scaled scores of the eight motor task, 0.52) internal consistency, respectively (Hinton, McMurray, & Brownlow, 2014). Differences in age, body composition and physical fitness variables between children with DCD and TD children were tested using *t*-test. Qualitative variables associations were tested with chi square test.

Analysis of variance (ANOVA) model was used to assess differences in HRQoL dimensions by MC categories. Taking into account previous literature on the influence that factors such as sociodemographic, anthropometric and physical fitness variables (Gallahue et al., 2019; Redondo-Tébar et al., 2019; von Rueden et al., 2006) may have on children's HRQoL, it was also conducted an analysis of covariance (ANCOVA) to test whether differences in mean scores on the HRQoL between children with and without DCD are maintained even when controlling for confounding variables such as age, sex, BMI, SES, and fitness index.

Moreover, Cohen's *d* effect size $\left[\frac{(M_2 - M_1)}{\sqrt{((SD_1^2 + SD_2^2)/2)}} \right]$ for *t*-test and partial eta squared (η_p^2) for ANCOVA test were calculated. Cohen's *d* indicates small effects (0.2–0.5), intermediate effects (0.5–0.8) and strong effects (>0.8) (Cohen, 1988) and partial eta squared (η_p^2) 0.01, 0.06, and 0.14 to indicate small, intermediate, or strong effect size respectively (Cohen, 1988).

Student *t*-Test for repeated-measures and intraclass correlations coefficients (ICC) were used to examine the differences and level of agreement between self-report and parents' proxy-report total score of HRQoL. The values of the ICC were interpreted as follows: small (0–0.4), moderate (0.4–0.75) and large (>0.75) (Fleiss, 1986).

Statistical analyses were conducted using IBM SPSS Statistics v25 Statistical, significance level was set at $p < 0.05$.

3. Results

Table 1 describes mean differences in anthropometry, body composition, and fitness characteristics by MC categories. Children with DCD obtained lower scores in height and poorer levels of muscular and motor fitness than TD peers ($p < 0.05$).

Table 2 shows differences in HRQoL between children with DCD and TD children. Children with DCD obtained lower scores of physical well-being, friends, school and total HRQoL dimensions than TD peers according to parents' perception ($p < 0.05$). Both parents' and children's HRQoL perceptions in children with DCD were lower than peers without DCD, although only parents' perception was statistically significant (78.9 vs. 84.7; $p = 0.005$). After adjusting for major confounding variables, the differences remain.

Fig. 1 shows the differences between parents' proxy-report and children's self-report total score HRQoL by MC categories. There were no differences between parents' proxy-report and children's self-report perceptions of HRQoL in both children with DCD and TD children ($p > 0.05$). The ICC was moderate in DCD category (0.62; $p = 0.024$) and small in TD category (0.29; $p = 0.049$).

4. Discussion

To our knowledge, this is the first study on analysing the differences in HRQoL between children with DCD and TD children under 6 years using collected data and controlling for potential confounders. The results of this study revealed that, after controlling for potential confounders, children with DCD obtained lower scores on physical well-being, friends, school and total score HRQoL dimensions than their TD peers, according to parents' perception. Moreover, no differences between children and parents' perceptions in total HRQoL were found regardless the category of MC. Finally, the level of agreement in the response of parents and children on the HRQoL was higher in children with DCD than in TD children.

Our results are in line with previous studies which have shown that children with DCD have poorer well-being, friends, school and total HRQoL than TD ones (Caçola & Killian, 2018; Karras et al., 2019). However, we did not find differences in emotional well-being, self-esteem and family dimensions as reported in previous studies (Caçola & Killian, 2018; Karras et al., 2019). A possible explanation for these differences could be due to the HRQoL questionnaires used, the lack of control for confounders in those previous studies, as well as the small sample size or the age of the children in our study, since they are younger than children in other studies, and therefore may not have the cognitive development to be able to accurately report emotional well-being or self-esteem compared to the children of the previous studies.

The literature suggests that parents' perception about quality of life, as compared with children's self-report, is overestimated in healthy children; on the contrary, in children with health disorders the parents tend to underestimate it (Upton et al., 2008). Karras et al. described that the parents' perception was lower than their children with DCD in half of the HRQoL dimensions (Karras et al., 2019). Our study did not show differences between parents and children's perception in any of the groups neither DCD nor TD. However, the results of this study suggest a higher level of agreement in the response of parents and children belonging to the DCD group than the TD one. Given that there is evidence that HRQoL scores differ between parents' reports and children's self-reports and

Table 1
Characteristics of the sample.

	DCD (n = 19)	TD (n = 96)	p	ES
Age (years)	5.4 (0.6)	5.4 (0.5)	0.69	
Sex (n; %)				
Male	12; 63.2	49; 51.0	0.33	
Female	7; 36.8	47; 49.0	0.33	
Socioeconomic status (n, %)				
Lower – Upper lower	2; 10.5	8; 8.3	0.76	
Lower middle	9; 47.5	44; 45.8	0.90	
Upper middle – Upper	8; 42.1	44; 45.8	0.77	
Anthropometry and body composition				
Weight (Kg)	20.4 (5.1)	21.9 (4.8)	0.23	
Height (cm)	112.0 (5.7)	117.0 (5.9)	0.001	0.86
Body mass index (Kg/m ²)	16.2 (3.3)	15.8 (2.3)	0.62	
Body fat (%)	20.4 (6.8)	19.8 (5.4)	0.69	
Fitness characteristics				
Cardiorespiratory fitness (20-m shuttle run, stage)	1.8 (1.4)	2.3 (1.3)	0.09	
Muscular strength (standing broad jump, cm)	86.9 (17.8)	98.3 (15.9)	0.006	0.67
Speed-agility (4 × 10 m, s) ^a	18.2 (2.3)	17.0 (1.5)	0.005	0.61
Fitness index (z-score)	−0.4 (1.3)	0.1 (1.2)	0.10	

The data are presented as means and standard deviations for anthropometry, body composition and fitness characteristics except for sex and socioeconomic status whose are presented as percentage.

DCD, developmental coordination disorder; TD, typical developing; ES, effect size [indicates small (0.2 to 0.5), intermediate (0.5 to 0.8) and strong effects (>0.8) by Cohen].

The categories of motor competence correspond to: children with DCD and risk of DCD, as 'DCD'; and 'TD' children.

The values of the p in bold indicate significant differences between DCD and TD children by categories of motor competence ($p < 0.05$).

^a Lower score indicate higher levels of speed-agility.

Table 2

Mean differences between motor competence categories in health-related quality of life.

Health-related quality of life ^b	Model 1				Model 2			
	DCD (n = 19)	TD (n = 96)	<i>p</i>	η_p^2	DCD (n = 19)	TD (n = 96)	<i>p</i>	η_p^2
Physical well-being	81.3 (3.6)	88.2 (1.0)	0.015	0.051	80.5 (2.8)	88.6 (1.2)	0.009	0.064
Emotional well-being	82.6 (2.6)	86.3 (1.1)	0.18		83.3 (2.7)	86.3 (1.1)	0.32	
Self-esteem	73.0 (3.1)	76.0 (1.4)	0.40		75.2 (3.5)	76.0 (1.5)	0.85	
Family	78.6 (2.8)	82.0 (1.4)	0.31		80.2 (3.3)	82.3 (1.4)	0.56	
Friends	79.3 (2.6)	87.4 (1.2)	0.007	0.062	79.3 (3.0)	87.6 (1.3)	0.013	0.057
School	78.6 (2.6)	88.2 (1.1)	0.001	0.100	79.5 (2.7)	88.1 (1.1)	0.004	0.076
Total score by parent's proxy-report	78.9 (1.7)	84.7 (0.8)	0.005	0.067	79.7 (2.0)	84.8 (0.8)	0.022	0.049
Total score by children self-report	80.5 (3.5)	85.7 (1.0)	0.06		81.2 (2.7)	85.5 (1.1)	0.15	

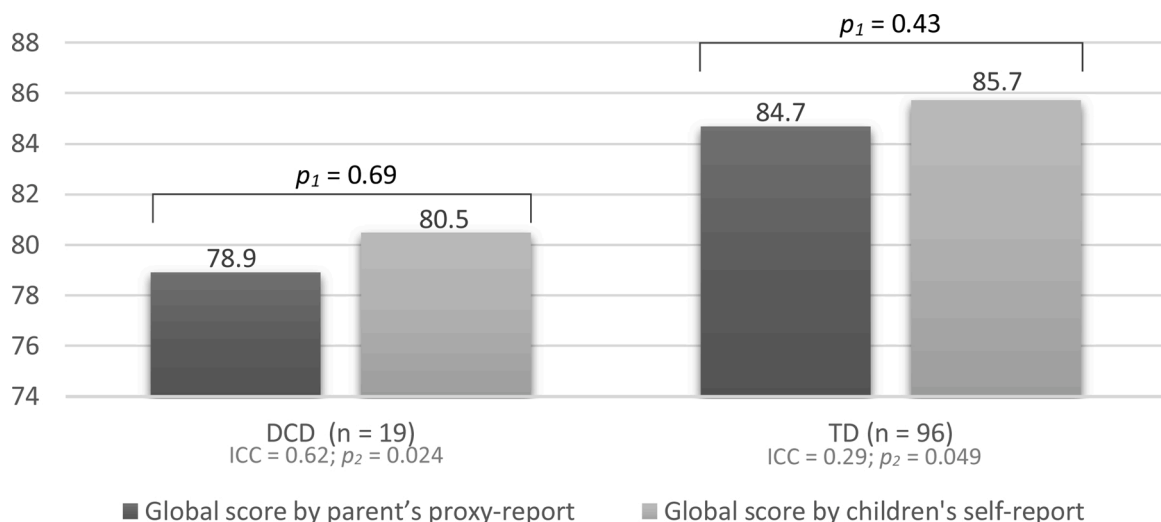
The data are presented as means (model 1 ANOVA; unadjusted) or marginals means (model 2 ANCOVA; adjusted by age, sex, body mass index, socioeconomic status, and fitness index) and standard error.

DCD, developmental coordination disorder; TD, typical developing; partial eta squared (η_p^2 ; which indicates small, intermediate, or strong effect size respectively 0.01, 0.06, and 0.14 by Cohen).

The categories of motor competence correspond to children with DCD and risk of DCD, as 'DCD'; and 'TD' children.

The values of the *p* in bold indicate significant differences between DCD and TD children by categories of motor competence (*p* < 0.05).

^b Higher scores indicate higher levels of health-related quality of life.

**Fig. 1.** Health-related quality of life total scores differences between parent's proxy-report and self-report by motor competence categories.

The data are presented as means and standard deviations.

DCD, developmental coordination disorder; TD, typical developing; ICC, intraclass correlation coefficient (indicates small, moderate, or large effect respectively 0–0.4, 0.4–0.75 and 0.76 by Fleiss).

The categories of motor competence correspond to children with DCD and risk of DCD, as 'DCD'; and 'TD' children.

Statistical significance *p* < 0.05. *p*₁ from Student t-Test for repeated-measures; *p*₂ from ICC analyses.

that the direction of the difference varies according to the type of child's health condition and also according to the HRQoL dimensions measured (Danckaerts et al., 2010; Hall et al., 2019; Jardine, Glinianaia, McConachie, Embleton, & Rankin, 2014; Upton et al., 2008), a possible explanation for the differences found between the results of our study and those of the Karras et al. study could be due to the characteristics of the sample, as the Karras study is a clinical sample in which 70 % of the participants had or were suspected of having ADHD. On the other hand, the results in Karras' study are shown by dimensions and in ours only for the total HRQoL score.

Among the limitations of this study should be acknowledged that this is a cross-sectional design, which prevents us from making causality inferences. In addition, given that the schoolchildren included in the study belonged to a random subsample with similar educational policies, sociodemographic characteristics where it is expected a similar prevalence of children with DCD, a cluster analysis was not performed because would add nothing in terms of representativeness and in order to avoid diminishing the statistical power of the analysis. On the other hand, the concordance between parent and child reports could not be estimates for each dimension of the HRQoL questionnaire, as the self-report version of the KINDL-R does not allow to obtain the HRQoL dimensions. Finally, the small sample did not allow for subgroup analyses in this study.

Overall, this study provides some evidence regarding differences in HRQoL between children under 6 years old with and without DCD. Thus, according to the results of this study, initiatives, and programs for children into the school context focused on MC during the preschool age could improve their future HRQoL.

CRedit authorship contribution statement

ART, MSL and VMV performed conceptualization, methodology and formal analysis. ART performed writing – original draft. ARH, VMV, NMME, BNP and MSL writing – review and editing. VMV and MSL obtained study funding acquisition.

Declaration of Competing Interest

The authors declare that there is no conflict of interest.

Andrés Redondo Tébar was the person who wrote the first draft of the manuscript. He had not received any honorarium, grant, or other form of payment to anyone to produce the manuscript.

All author listed on the manuscript has revised and approved the submission of this version of the manuscript and takes full responsibility for the manuscript.

Acknowledgements

This study was funded by the Ministry of Economy and Competitiveness Carlos III Health Institute and FEDER funds (FIS PI12/00761) and the Research Network on Preventative Activities and Health Promotion (RD12/0005/0009). ART is supported by a grant from the University of Castilla-La Mancha (2018-CPUCLM-7813).

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