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Prevalence of Developmental Coordination Disorder in Rio Maior and São João da Ribeira in children with 3 and 4 years old

[1] Cristiana Mercê cristianamerce@esdrm.ipsantarem.pt

[2] Marco Branco marcobranco@esdrm.ipsantarem.pt

[3] Orlando Fernandes orlandoj@uevora.pt

[1] David Catela catela@esdrm.ipsantarem.pt

[1]Escola Superior de Desporto de Rio Maior, Centro de Investigação em Qualidade de Vida – Comportamento Motor

[2]Escola Superior de Desporto de Rio Maior, Centro Interdisciplinar do Estudo da Performance Humana – Laboratório de Biomecânica e Morfologia Funcional

[3]Universidade de Évora, Departamento de Desporto e Educação Física

Resumo

A desordem coordenativa no desenvolvimento (DCD) é uma desordem motora sem comprometimento neural a qual afeta 5-6% das crianças em idade escolar (Zwicker, Missiuna, Harris, & Boyd, 2012).
Este estudo pretende identificar e descrever a prevalência de provável DCD em ****** e ****** em crianças com 3 e 4 anos de idade. Foi aplicada a bateria MABC-2 (Henderson & Sugden, 2007) em 46 crianças (3.9±0.26 anos de idade, 25 raparigas 21 rapazes) de 3 pré-escolas.
2 crianças foram identificadas como provável DCD (4.4%), 7 como em risco (15.2%), e 37 crianças com um desenvolvimento motor típico (80.4%). Foi verificada uma prevalência de sinistrómanos nas crianças com provável DCD (Cairney et al., 2008; Flouris, Faught, Hay, & Cairney, 2005). Os grupos revelaram diferença significativas em todas as categorias: destreza manual (DM) $H(2)$=16.267, $p<0.001$, atirar e agarrar (AG) $H(2)$=10.833, $p<0.01$, equilíbrio (Eq) $H(2)$=14.179, $p\leq0.001$. As categorias menos pontuadas foram o AG para as crianças típicas e com provável DCD, e Eq para as crianças em risco; provavelmente pela menor envolvência em atividades que requeiram AG e Eq, contrastando com a maior incidência em atividades de DM, no sentido de preparar as crianças para a escola primária.
Este estudo ajuda a clarificar a importância da aplicação do MABC-2 a fim de identificar provável DCD, assim como as crianças em risco as quais revelaram uma incidência 3.4 vezes superior.

Palavras-chave:

DCD, crianças, MABC-2, lateralidade

Abstract

The developmental coordination disorder (DCD) is a motor disorder without neural compromising that affects 5-6% of children in school-age (Zwicker, Missiuna, Harris, & Boyd, 2012).
The study aims to identify and describe the prevalence of probable DCD in ****** and ****** in children with 3 and 4 years old. It was applied MABC-2 (Henderson & Sugden, 2007) in 46 children (3.9±0.26 years old, 25 and 21 boys) of three preschools.
2 children were identified has having probable DCD (4.4%), 7 children as being in the risk zone (15.2%), and 37 children as having a typical motor development (80.4%). It was verified a prevalence of left-handedness in probable DCD children (Cairney et al., 2008; Flouris, Faught, Hay, & Cairney, 2005).Groups revealed significant differences in all categories: manual dexterity (MD) $H(2)$=16.267, $p<0.001$, aiming-catching (AC) $H(2)$=10.833, $p<0.01$, and balance (B) $H(2)$=14.179, $p\leq0.001$. The least scored categories were AC for typical and probable DCD children, and B for at risk children; probably due to the involvement in less activities requiring AC and B tasks, contrasting to a biggest incidence in MD activities, in order to prepare children for primary school.
This study clarifies the importance of MABC-2 application in order to identify probable DCD, as well as at risk children which had an incidence superior in 3.4 times.

Key concepts:

DCD, children, MABC-2, laterality

Introduction

The developmental coordination disorder (DCD) is a motor disorder without neural compromising identified and recognized by the Diagnostic and Statistical Manual of Mental Disorders (DSM) (American Psychiatric Association, 2013), which affects 5-6% of children in school-age (Zwicker et al., 2012). This disorder normally affects more boys than girls, with proportions from 2:1 to 5:1 (CanChild, 2016); however it's possible to find studies where this relation isn´t found (Cairney et al., 2008).

Generally called as "clumsy", the children with DCD experience motor coordination difficulties that affects significantly their daily live, and can also affect their academic achievements (CanChild, 2016). These children usually reveal a delay in attaining motor milestones, like crawling or walking problems in their fine and/or gross motor skills, e.g., tasks as drawing or jump with both feet can be extremely difficult; have a motor performance slower and less accurate (Zwicker et al., 2012); have poor balance control (Geuze, 2005); reveal difficulty in the acquisition of new motor skills, like tie shoes or ride a bike (Vaivre-Douret, 2014); and difficulties in space and temporal organization (Wilson & McKenzie, 1998). DCD children are an heterogeneous group, as they can reveal just some part of the symptoms and not all simultaneously, e.g., the child can reveal balance problems but no spatial difficulties, or vice versa (Vaivre-Douret et al., 2011).

DCD is a chronic disorder that remains through life; however it's possible to minimize it impact with an early intervention (Camden, Wilson, Kirby, Sugden, & Missiuna, 2015). For that it's crucial to recognize and to diagnose DCD early in life.

Although the increased interest of the scientific community in this theme, DCD continues to be frequently undiagnosed. A possible reason to that is the lack of knowledge by health professionals, teachers and family. A recent survey revealed that less that an half of paediatricians knew DCD (41%), and even less knew the secondary consequences of it; the percentages are even lower in teachers and parents, with 23% and 6%, respectively (Wilson, Neil, Kamps, & Babcock, 2013).

The MABC-2 battery test is one of the most employed to aid in the DCD diagnosis, allowing to identify and describe the motor impairment in children (Henderson & Sugden, 2007). The battery is composed by tests in three categories: manual dexterity (3 tests), aiming

and catching (2 test), and static and dynamic balance (3 tests). Scoring the tests, the battery allows to determine if the children has probable DCD (total test score ≤56, percentile range ≤5); if is at risk in motor development (total test score between 57 and 67 inclusive, percentile range between 5 and 16 inclusive), which is a transition zone where the child doesn't have the disorder but has motor impairments; or if is in a typical motor development zone (total test score above 67, percentile range above 16). It's important to note that DCD should be diagnosed by a multidisciplinary team of professionals qualified to examine the specific criteria for the disorder (Blank, Smits-Engelsman, Polatajko, & Wilson, 2012); if it doesn't occur we can just talk about a probable DCD.

Along with the total score, the battery also classifies the child's motor performance by category, so we can find children with probable DCD but with a risk classification in one or more categories. Taking into account that DCD children are a heterogeneous group (Laurence Vaivre-Douret et al., 2011), the possibility to discriminate the categories where the children have motor impairments is a strong point of MABC-2 (Henderson SE & Sugden DA, 2007).

The goal of the present study consists in identify and characterize the prevalence of probable DCD in three preschool of Rio Maior and São João da Ribeira, by using MABC-2 battery test.

1. Methods

1.1. Sample

The study took place in three preschools, two in the city of Rio Maior and one in the village of São João da Ribeira (belonging to Portugal). It was conducted the informed consent of the parents and the assent of the participants.

Only children with 3 and 4 years old were included, taking into account that the earlier the diagnosis and intervention the better the results (Smits-Engelsman et al., 2013). The children that violated the Diagnostic and Statistical Manual of Mental Disorders (DSM) criteria for DCD like with intellectual disability, visual impairment and neurological condition that affects movement were excluded (American Psychiatric Association, 2013).

From the 64 children, only 52 parents gave the informed consent, which represent an acceptance percentage of 81.25%. During the tests two children didn´t appeared, and four were excluded: one due to visual impairment, two didn´t gave assent, and one due to signals of fa-

tigue and demotivation during the tests. So, the final sample was composed by 46 children.

1.2. Procedures

Before the application of MABC-2 it was necessary to get the authorization from the school and parents. The researcher establish contact with the school centres by face meeting to explain the purposes of the study to the directors, and later by formal e-mail requesting authorisation. After the acceptance from school it was conducted the informed consent to the parents.

The present study was accomplished in the following year of a funded project (ALENT-07-0262-FEDER-001883) which also addressed the issue of DCD, namely with the application of MABC-2 followed by intervention, which facilitated the acceptance by directors and parents.

After the MABC-2 battery application and classification, it was elaborated a document by child with the individual scores and delivered to their parents in a sealed envelope. In the cases of the children that revealed one or more category's classification of risk or probable DCD, it was also added a document with suggestions of motor activities possible to apply at home. These procedures were performed to enable parents to know their child' classification and his/her impairments, so parents can be more awake and conscientious of that matter. And also, to eliminate a weak point of the previous project the lack of a final information to parents or educators. Various educators refer to us that parents would like to know their child' results.

1.3. Protocols

As mentioned before the identification of children with probable DCD and at risk was conducted according to the protocol of MABC-2; it was used the band 1 for the age group of 3 to 6 years old (Henderson et al., 2007).

The first contact between researcher and the children was mediated by the respective educator that presented the researcher as new teacher that will play with them. All test application was conducted in a game mode, to promote the children acceptance and minimize their possible timidity. In all cases the researcher tried to play with the child to create a connection and empathy before applying the tests.

In cases where the child continued embarrassed the researcher invited an auxiliary or the educator to assist the games/tests, so that the children could feel more comfortable. If the invitation of the auxiliary or educator didn't work, the researcher invited a parent to participate.

The first situation occurred 4 times and the last 1 time, for which was needed to program a specific day and hour to the mother of the child could assist to the games. If at any moment the child asked for a classmate, the researcher allowed him/her to pick a friend to assist the games, explaining to the classmate that he/she could not interfere or talk doing the games.

1.4. Statistical Analysis

For statistical analysis it was been used the software Statistical Package for the Social Sciences (SPSS) version 23.

It was performed descriptive statistics, mean and standard derivation, to characterize the sample, relative to age, MABC-2 scores by children groups, and MABC-2 scores by category. It was also performed frequency tables with prevalence of children's group, manual preference, and distribution of children classification by category.

In order to identify if the categories' results were significantly different between groups it was used Kruskal-Wallis test. To compare the categories' results group by group it was used the U-Mann Whitney test, with Bonferroni correction and effect size calculation. To determine within each group if the categories' results were different it was used the Friedman test. It was adopted a level of significance of p=0.05, two-tailed.

2. Results

The chronological age normally consists in an independently variable, however for the present study our purpose doesn't reside in chronological age but in motor age. So, we don´t consider it as an independently variable. This decision can be justified by the own battery tests, if MABC-2 consider age bands, and if band 1 is for 3 to 6 years old, we suppose that this means that inside this band the differences by age aren´t be significant. To prove that the chronological age isn´t the variable responsible for MABC-2 results we present bellow, in figure 1, a graphic of MABC-2´s percentile total score by chronological age. As we can notice, there is no clear tendency for data, like a regression line.

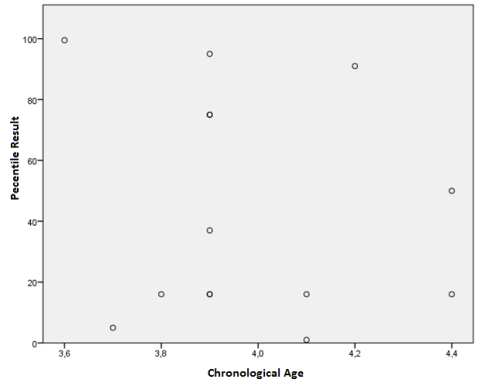

Figure 1 – MABC-2 results (percentile total score) by chronological age (in decimal age).

After the tests application it was founded that 37 children had typical motor development (80.4%), 7 were classified as at risk of developing DCD (15.2%), and 2 as with probable DCD (4.4%) (see table 1). In the risk group, 4 children were girls and 3 were boys; in the DCD group 1 child was a girl and the other was a boy.

Table 1 – Sample characterization (number of cases and percentage) according MABC-2 classification (typical, risk, probable DCD), and by gender.

	Male (n=21)	**Female** (n=25)	**Total** (n=46)
Typical	17 (81%)	20 (80%)	37 (80.4%)
Risk	3 (14.3%)	4 (16%)	7 (15.2%)
DCD	1 (4.8%)	1 (4%)	2 (4.4%)

Considering all the sample, the proportion found between dexterous and left-handed is close to 90% and 10%, respectively, as found in literature (Fonseca, 2011; Perelle & Ehrman, 2005), with effective values of 89.1% and 10.9%, respectively (see details in table 2). In the risk group all children were dexterous, and in the DCD group all children were left-handed.

Table 2 – Sample characterization according to preferred hand, by group (Typical, At risk, DCD) and gender.

	Gender	Dexterous	Left-handed
Typical	**Male** (n=17)	15 (88.2%)	2 (11.8)
	Female (n=20)	19 (95%)	1 (5%)
At Risk	**Male** (n=3)	3 (100%)	0
	Female (n=4)	4 (100%)	0
DCD	**Male** (n=1)	0	1 (100%)
	Female (n=1)	0	1(100%)
Total	**Male** (n=21)	18 (85.7%)	3 (14.3%)
	Female (n=25)	23 (92%)	2 (8%)
	All (n=46)	41 (89.1%)	5 (10.9%)

As showed in table 3, it's possible to a child to have a total classification as having a typical development, but being at risk zone or in probable DCD zone in some of the MABC-2 tests categories. In the present study it was found one child considered globally typical, but with at risk classification in manual dexterity, five children considered globally typical but with at risk classification in aiming and catching, one child considered globally typical but with probable DCD in aiming and catching, and four children considered globally typical but with at risk classification in balance.

Inside the risk group it was also found children with typical classification in some categories: two children with typical classification in aiming-catching and balance categories, two children with typical classification in manual dexterity and balance categories, one child with typical classification in balance category, one child with typical classification in manual dexterity category, and one child with typical classification in aiming-catching category. Inside the probable DCD group, it was found one child with at risk classification in manual dexterity and balance categories.

Table 3 - Distribution (frequency and percentage) of children´s total and partial classifications at the MABC-2 test, by group and gender.

MABC-2 test classification				Gender		Total
Total	**Manual dexterity**	**Aiming-catching**	**Balance**	**Boy**	**Girl**	
Typical	Typical	Typical	Typical	14 (30.4%)	12 (26.1%)	26 (56.5%)
Typical	Risk	Typical	Typical	1 (2.2%)	0	1 (2.2%)
Typical	Typical	Risk	Typical	2 (4.3%)	3 (6.5%)	5 (10.9%)
Typical	Typical	Typical	Risk	0	4 (11.1%)	4 (11.1%)
Typical	Typical	DCD	Typical	0	1 (2.2%)	1 (2.2%)
Risk	Risk	Typical	Typical	2 (4.3%)	0	2 (4.3%)
Risk	Typical	Risk	Typical	0	2 (4.3%)	2 (4.3%)
Risk	Risk	Risk	Typical	0	1 (2.2%)	1 (2.2%)
Risk	Typical	Risk	Risk	0	1 (2.2%)	1 (2.2%)
Risk	Risk	Typical	Risk	1 (2.2%)	0	1 (2.2%)
DCD	Risk	DCD	Risk	0	1 (2.2%)	1 (2.2%)
DCD	DCD	DCD	DCD	1 (2.2%)	0	1 (2.2%)
Percentages of the total sample						

For the present study, children with typical development revealed a mean percentile score of 69(±24), which value is well above percentile 16, that separates typical motor development from at risk. The group at risk presented a mean value near to the limit of a typical motor development (see table 4), as also found in a previous study (Arrais, 2014) with a larger sample from the same geographic area.

Table 4 - Distribution of MABC-2 total, standard and percentile scores (mean and standard deviation) by children's groups (Typical, At Risk, DCD).

	Typical (n=37)	**At Risk** (n=7)	**DCD** (n=2)
Total score	87.5 ± 10.5	64.9 ± 2.3	45.5 ± 9.2
Standard score	12.2 ± 2.8	6.9 ± 0.4	4 ± 1.1
Percentile score	69 ± 24	15 ± 2.6	3 ± 2.9

Table 5 also shows percentile scores by category for each children group. In typical and probable DCD groups the category with the lowest score was aiming and catching (AC), and in at risk group was balance.

Table 5 – MABC-2 percentile scores (mean and standard deviation) by category (MD, AC, B) and children's groups (Typical, At Risk, DCD).

	MD	**AC**	**B**
Typical (n=37)	68.2 ± 22.3	58.8 ± 30.7	65.6 ± 30.2
At Risk (n=7)	24.7 ± 19	27 ± 20.3	23.9 ± 11.5
DCD (n=2)	10.5 ± 7.8	5 ± 0	5 ± 5.7
H*(2), *p	16.267, <0.001	10.833, <0.01	14.179, ≤0.001

MD – manual dexterity; AC – aiming and catching; B – balance; *H*- Kruskal-Wallis test

By category, groups were significantly different in all categories: manual dexterity, aiming and catching and balance.

Between DCD and typical groups, we found the following results: manual dexterity - Z=-2.316, p=0.021, r=0.37; aiming and catching - Z=-2.24, p=0.025, r=0.359; and, balance Z=-2.277, p=0.023, r=0.365. Between at risk and typical groups: manual dexterity with Z=-3.478, p=0.001, r=0.524; aiming and catching with Z=-2.5, p=0.012, r=0.377; and balance with Z=-3,136, p=0.002, r=0.473. Between DCD and at risk groups: manual dexterity with Z=-1.283, p=0.2, r=0.428; aiming and catching with Z=-2.103, p=0.035, r=0.701; and balance with Z=-1.826, p=0.068, r=0.609. We didn't find significant differences between DCD and typical groups, just a tendency; but we found significant differences between at risk and typical groups in all categories; probably, due to the size of the samples; this argument is supported by effect size values that are bigger in the comparisons between risk-typical than between DCD-typical groups.

There were no significant differences between categories.

3. Discussion

In the present study it was found a percentage of 4.4% for probable DCD, slightly lower than 5-6% referred in some previous studies (Vaivre-Douret, 2014; Vaivre-Douret et al., 2011), probably due to the sample size. Similarly to Cairney et al. (2008) study, it wasn't found a higher prevalence of probable DCD in boys.

According to literature, it was found a prevalence of left-handedness in probable DCD children (Cairney et al., 2008; Flouris et al., 2005), which didn´t occur in typical or at risk groups. In literature we can find various possible explanations for the predominance of left-hand-

edness, , like learned behaviour, neurochemical variations during prenatal stage or genetic factors (Flouris et al., 2005). However, is consensual that left-handiness has a link with various neurologic and behavioural problems (Cairney et al., 2008). In children, it exists a reported association between left-handedness and developmental disorders, including language, sensory and motor impairments and also socioemotional and psychiatric problems (Coren & Bishop, 1993). The present study is one more to identify this left-handiness prevalence in DCD, however the reason of that is still not clear, more investigation in this field is needed.

The prevalence of children at risk of developing DCD was of 15.2%, about the triple of the DCD prevalence. So, it's crucial to detect not only the DCD children but also the ones that, despite not suffering of the disorder, have motor impairments. An early identification makes possible an early intervention and, consequently, better results (Smits-Engelsman et al., 2013). The possibility to identify children at risk of developing the disorder is a strong point of MABC-2 and should be considered in the future in studies with children with 3 years old.

Beyond the final classification of typical, at risk and probable DCD, the MABC-2 battery test allows us to discriminate in which categories the child has an impairment (Henderson & Sugden, 2007). In the present study, we found children classified as typical with classifications of at risk and probable DCD, but only in part of the categories: one child in manual dexterity risk, five in aiming and catching risk, one in aiming and catching probable DCD, and four in balance risk. Also, looking to categories' percentiles scores we verify that the least scored were aiming and catching for typical motor development and probable DCD groups, and balance for at risk group. Inside typical group, these percentiles scores and the highest prevalence of non-typical classification in aiming-catching and balance categories, can probably result from less motor practice in activities involving these tasks. Contrasting with a higher incidence in tasks like drawing letters, lines and numbers, that are stimulated to promote a better entrance in cognitive learning in the elementary school, and that further afford the manual dexterity, compared to other studied categories.

The possibility to identify in which categories children have impairments, is another strong point for MABC-2 that can also be applicable and very relevant for the intervention. If we cannot just only divide children by the total score but analyse more deeply and see in which areas they have a real impairment, we will be able to mould and adjust

our intervention for better results and greater success. It's important to note that DCD children are a very heterogeneous group (Vaivre-Douret et al., 2011); so, this can be a tool, not only to evaluated and support DCD diagnosis, but also as an instrument to support intervention.

The limitations of the present study reside mainly in the sample, is small and we used a kindergartens' convenience sample; so, it doesn´t include children that are not at kindergartens. The researcher that applied MABC-2 battery test wasn't blind relative to the study purpose, which is a threat to the internal validity to the study. In future studies, the ideal conditions would be to use a random, bigger and more representative sample, with researchers that apply the battery blinded relative to study purpose; so we can take conclusions for all the sample's universe and eliminate internal threats.

4. Conclusions

The at risk children revealed an incidence 3.4 times bigger than DCD children, and this fact should aware us to the importance of identifying not only DCD children but also at risk children.

According to literature it was verify a prevalence of left-handedness in probable DCD children (Cairney et al., 2008; Flouris et al., 2005), but still, our experimental design doesn't allow us to discuss why.

The least scored categories were aiming and catching for typical and probable DCD children, and balance for at risk children. These results and a highest prevalence of non-typical classifications, inside typical group, in the same categories, can probably result from a lesser involvement in aiming-catching and balance activities, contrasting to a greater incidence in manual dexterity activities, in order to prepare children for elementary school.

The possibility of identify children at risk, and also identify in which categories children have impairments, are strong points of MABC-2 battery test, that can be useful to support a more adjusted intervention.

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Curricular notes

Cristiana Mercê, é Doutoranda em Motricidade Humana especialidade Comportamento Motor pela Universidade de Lisboa. É Docente Convidada na Escola Superior de Desporto de Rio Maior, do Instituto Politécnico de Santarém. Publicou 7 artigos em revistas especializadas e 16 trabalhos em actas de eventos, possui 12 capítulos de livros e 1 livro publicados. Possui 17 itens de produção técnica. Participou em 1 evento no estrangeiro e 12 em Portugal. Recebeu 5 prémios e/ou homenagens. Nas suas atividades profissionais interagiu com 46 colaboradores em coautorias de trabalhos científicos. No seu curriculum DeGóis os termos mais frequentes na contextualização da produção científica são: Crianças, Desenvolvimento Motor, Controlo Motor, Aprendizagem Motora, Análise da Recorrência, DCD e Variabilidade da Frequência Cardíaca.

Marco Branco, Concluiu o Doutoramento em Motricidade Humana, especialidade Biomecânica em 2016 pela Universidade de Lisboa. É Professor Adjunto no Instituto Politécnico de Santarém. Publicou 28 artigos em revistas especializadas. Possui 15 capítulos de livros e 3 livros. Participou em 28 eventos. Orientou 3 dissertações de mestrado. Recebeu 1 prémio e/ou homenagem. Participa como investigador em vários projetos. Atua nas áreas de Ciências Sociais com ênfase em Outras Ciências

Sociais. Nas suas atividades profissionais interagiu com 117 colaboradores em co-autorias de trabalhos científicos. No seu curriculum DeGóis os termos mais frequentes na contextualização da produção científica, tecnológica e artístico-cultural são: Biomecânica, Crianças, Gravidez, Biomecânica, Cinemática, Comportamento Motor, Marcha e Modelação.

Orlando Fernandes, Concluiu o Doutoramento em Ciências do Desporto em 2011 pela Universidade de Trás-os-Montes e Alto Douro. É Professor Auxiliar na Universidade de Évora. Publicou 35 artigos em revistas especializadas, possui 2 capítulos de livros publicados. Possui 1 item de produção técnica. Nas suas atividades profissionais interagiu com 126 colaboradores em coautorias de trabalhos científicos. No seu curriculum DeGóis os termos mais frequentes na contextualização da produção científica, tecnológica e artístico-cultural são: Biomecânica; Estabilidade Articular, Controlo Postural, Risco de Lesão, Soccer, Tato e Tornozelo.

David Catela, Concluiu o Doutoramento em Motricidade Humana em 2007 pela Universidade Técnica de Lisboa. É Professor Coordenador no Instituto Politécnico de Santarém. Publicou 15 artigos em revistas especializadas e 34 trabalhos em atas de eventos, possui 50 capítulos de livros e 5 livros publicados. Participou em 1 evento no estrangeiro e 32 em Portugal. Orientou 2 teses de doutoramento e orientou 16 dissertações de mestrado nas áreas de Ciências da Motricidade, Psicologia Ecológica e Problemas Motores. Recebeu 1 prémio e/ou homenagem. Entre 2010 e 2014 coordenou 1 projeto de investigação. Atua na área de Ciências Sociais e Ciências da Educação. Nas suas atividades profissionais interagiu com 61 colaboradores em co-autorias de trabalhos científicos. No seu curriculum DeGóis os termos mais frequentes na contextualização da produção científica são: Crianças, Idosos, Desenvolvimento Motor, Análise da Recorrência, Controlo Motor, Aprendizagem Motora, Psicologia Ecológica, Dificuldades Motoras, Lateralidade e Variabilidade da Frequência Cardíaca.