Executive functions and functioning in women with fibromyalgia

Funções executivas e funcionalidade em mulheres com fibromialgia

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Abstract

Background Fibromyalgia (FM) is a chronic condition characterized by widespread pain that is associated with sleep, emotional, and cognitive disturbances, including in executive functions (EFs).

Objective To investigate the relationship between EFs and functionality in women with FM.

Methods The study included 17 women with FM, aged between 30 and 59 years, with no history of neurological disease. The EFs were assessed using the Digit Span Subtest (DS), Five Digit Test, Trail Making Test (TMT), Corsi Block-Tapping Task, Hayling Test (HT), and Verbal Fluency Task. Functionality was evaluated through the Fibromyalgia Impact Questionnaire. The Beck Depression Inventory, Hamilton Anxiety Rating Scale, and Brief Pain Inventory were used to measure depression, anxiety, and pain, which were controlled in the statistical analyses.

Results The FM patients showed longer response latency on the HT and TMT. They made fewer errors on part B of the HT, and they performed worse on the DS backward and on the Corsi Block-Tapping Task forward and backward. There were moderate correlations in the expected direction between performance on the Corsi Block-Tapping Task backward and interference at work, as well as between the time to complete part B of the Trail Making Test – B (TMT-B) and fatigue. An unexpected relationship was found between errors on part B of the HT and interference at work.

Conclusion The results suggest lower efficiency in processes such as inhibitory control and cognitive flexibility, difficulties in working memory and non-executive processes such as processing speed. Even with pain, anxiety, and depression controlled, some relationships between EFs and functionality were observed, indicating that these symptoms do not fully explain this relationship. We suggest that cognition, particularly EFs, and broader measures of functionality be considered in the evaluation of FM.

Keywords
- Fibromyalgia
- Neuropsychology
- Cognition
- Pain
- Psychological Tests

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Resumo

Antecedentes A fibromialgia (FM) é uma condição crônica caracterizada por dor generalizada, associada a distúrbios do sono, emocionais e cognitivos, entre os quais os das funções executivas (FEs).

Objetivo Investigar a relação entre FEs e funcionalidade em mulheres com FM.

Métodos O estudo incluiu 17 mulheres com FM, com idades entre 30 e 59 anos, sem histórico de doença neurológica. Para a avaliação das FEs, utilizou-se Subteste de *Span* de Dígitos (SD), o Teste dos Cinco dígitos, o Teste de Trilhas (TT), Tarefa dos Cubos de Corsi, O Teste de Hayling (TH), e a Tarefa de Fluência Verbal. A funcionalidade foi avaliada pelo Questionário de Impacto da Fibromialgia. O Inventário de Depressão de Beck, a Escala de Ansiedade Hamilton e o Inventário Breve de Dor foram usados para mensurar depressão, ansiedade e dor, que foram controladas nas análises estatísticas.

Resultados Pacientes com FM apresentaram maior latência de resposta na TH e no TT. Elas cometeram menos erros na parte B da TH, e tiveram pior desempenho no SD em ordem inversa e na Tarefa dos Cubos de Corsi nas ordens direta e inversa. Houve relações moderadas, na direção esperada, entre a Tarefa dos Cubos de Corsi na ordem inversa e interferência no trabalho, assim como entre tempo até completar a parte B do Teste de Trilhas (TT) e fadiga. Encontrou-se uma relação inesperada entre erros na parte B da TH e interferência no trabalho.

Conclusão Os resultados sugerem menor eficiência em processos como controle inibitório e flexibilidade cognitiva, dificuldades na memória de trabalho e em processos não executivos, como velocidade de processamento. Mesmo com controle da dor, da ansiedade e da depressão, houve algumas relações entre FEs e funcionalidade, o que indica que esses sintomas não explicam completamente essa relação. Sugere-se considerar a cognição, particularmente as FEs, e medidas mais abrangentes de funcionalidade na avaliação da FM.

Palavras-chave

- Fibromialgia
- Neuropsicologia
- Cognição
- Dor
- Testes Psicológicos

INTRODUCTION

Fibromyalgia (FM) is a chronic disease primarily characterized by generalized pain, diffuse hyperalgesia, as well as sleep disturbances, emotional symptoms, and the "fibrofog", which refers to cognitive impairments.[1] It is the second most common disease treated by rheumatologists.[2] Studies conducted in the United States and Europe show that the prevalence of fibromyalgia (FM) is up to 5% in the general population and accounts for more than 10% of visits to rheumatology clinics. In Brazil, it is present in up to 2.5% of the general population, predominantly in women, especially those between the ages of 30 and 44 years.[3]

Widespread muscle pain is one of the most frequent symptoms of FM, and it affects the patients' quality of life. However, FM symptoms include a heterogeneous group of other conditions such as hyperalgesia and/or allodynia, physical and mental fatigue, interrupted or nonrestorative sleep, headaches, irritable bowel, psychiatric disorders, cognitive impairment, among others.[4] Recently, the presence of cognitive deficits was included as one of the diagnostic criteria by the American College of Rheumatology (ACR).[5] However, this symptom is seldom assessed in the clinical practice.

Impairment of cognitive functions in FM encompasses various domains, such as inhibitory control, attentional processes, cognitive flexibility, working memory, goal formulation, and planning.[6–8] Studies[6,9,10] have indicated that attentional aspects become compromised due to pain, which appears to be an obstacle to the efficiency of cognitive processes. In particular, there is evidence of difficulties in executive domains in FM,[11] including inhibitory control[12] and working memory,[13] in addition to processing speed.[14]

Executive functions (EFs) are a set of relatively independent processes that enable the regulation of behavior and self-management. There is consensus about some of their core components, which are considered foundational for more complex processes, such as inhibition, working memory (specifically updating in some studies), and flexibility (or shifting).[15] Besides cognition, another important aspect of quality of life in FM is functionality. The model of functioning and disability of the World Health Organization (WHO) adopts a biopsychosocial approach, reflecting the interaction involving various dimensions of health (biological, individual, and social dimensions). In this regard, an ability or disability in a domain represents an interaction between a health condition, be it a disease, trauma, or injury, and contextual, environmental and/or personal factors. Thus, functionality encompasses body functions, activities, and participation.[16]

Patients with FM present reduced functioning, higher perceived stress, and higher intensity of depressive symptoms compared to healthy individuals. The depressive

symptoms appear to be directly related to the impairment in quality of life, as they increase the sensation of pain and the perception of functional incapacity. Greater impairment in the performance of daily-life tasks has also been reported by Homann et al.[17] among FM patient who had a condition ranging from moderate difficulty in functioning to severe incapacity; furthermore, among the patients, the higher the reported pain intensity, the greater the difficulty in performing daily-life activities. The authors suggested that the relationship between stress, depression, and functionality seems to be part of a complex process that could influence the quality of life in FM.

Patients with FM present higher levels of pain, resulting in functional and physical limitations, reduced flexibility, muscle fatigue, and lower capacity to perform daily-life activities.[18] These aspects impact their functioning. Using the Fibromyalgia Impact Questionnaire (FIQ), a classic instrument to assess functioning in FM, there is evidence that FM patients experience a negative impact on quality of life, with a reduction in functional capacity, increased pain, and worsened overall health.[19] Functioning impairment in FM is also associated with deficits in EFs.[5,20] However, exploring this relationship is complex, as variables such as depression, anxiety, and pain, which are common among these patients,[11] can influence both functioning and EFs. To better understand the relationship between functioning and cognition, specifically in terms of EFs, adding the control of anxiety, depression, and pain, the aim of the present study is to clarify the correlation between EFs and functioning in a group of female FM patients.

METHODS

The Research Ethics Committee of Universidade Federal de Santa Catarina approved the current study (under CAAE: 21334518.8.0000.0121). The research was publicized, and we invited individuals from FM associations and clinics of two Brazilian states to participate. After the initial contact, evaluation sessions were scheduled.

We recruited 18 women diagnosed with FM, due to the higher prevalence of the condition among individuals of this gender.[3] This was a deliberate decision to control gender as a strange variable. The inclusion criteria were: female gender, age between 30 and 59 years, and diagnosis of FM established by a rheumatologist. The exclusion criterion was: injuries or degenerative diseases that could explain some degree of cognitive impairment.

In the first session, each participant received an Informed Consent Form. Data collection took place individually in two sessions. In the first session, we applied scales to measure functioning and symptoms of anxiety, depression, and pain, and, in the second session, we applied the EF assessment instruments. The sessions were scheduled via telephone and conducted at a university psychology service (in the state of Santa Catarina, Southern Brazil) and at a psychology clinic (in the state of Amazonas, Northern Brazil).

We used tests, scales, and questionnaires for the cognitive assessment, especially that of EFs, collecting personal and socioeconomic data, and evaluating symptoms of depression, anxiety, pain, and functioning impairments. To collect personal data from the participants, we used the Patient/Participant Identification Questionnaire. To collect socioeconomic data, we used the Questionnaire of the Brazilian Association of Research Companies (Associação Brasileira de Empresas de Pesquisa, ABEP, in Portuguese).[21]

For the cognitive assessment, we used the following instruments: the Wechsler Abbreviated Scale of Intelligence (WASI),[22] solely for sample characterization; the Digit Span Subtest from the Wechsler Adult Intelligence Scale (WAIS-III);[23] the Five Digit Test (FDT);[24] the Trail Making Test (TMT);[25] the Corsi Block-Tapping Task (CBTT);[26] the Hayling Test (HT);[27] and the Verbal Fluency Task.[28]

The level of pain of the patients was assessed through the Brief Pain Inventory (BPI), a multidimensional instrument with 9 items that assesses pain points. It uses a scale from 0 to 10 to identify the intensity of pain in the last 24 hours. To assess symptoms of depression and anxiety, we used The Beck Depression Inventory – second edition (BDI-II)[29] and the Hamilton Anxiety Rating Scale (HAM-A).[30] The FIQ,[31] a self-administered questionnaire, was used to assess functional capacity, professional situation, psychological disorders, and physical symptoms associated with fibromyalgia.

As a criterion to compare the performances of the patients on the EF measures, the normative data of the instruments, as presented in their manuals, were used when available. In the absence of normative data, reference values published in studies using the same tests/tasks were used. To do this, the mean performance of the healthy/control/normative group closest in age to the participants of the current study was selected. In no case were the norms or reference performances stratified by sex. For each EF measure, the sources used to access this reference performance were as follows:

- Digit Span Subtest and CBTT: De Mello, R. D. (2016). Avaliação das relações entre a memória de trabalho verbal e visuoespacial de adultos saudáveis. Dissertação de mestrado, Universidade Federal do Paraná, Brasil;[32]
- FDT: Sedó et al.;[24]
- Verbal Fluency Task and TMT: Zimmermann and Fonseca;[28] and
- HT: Miotto, E. C. (2018). Manual de avaliação neuropsicológica: a prática da testagem cognitiva. Memnon.[33]

Henceforth, this group will be referred to as the normative group (NG), and their mean performances are presented in ►**Table 1**.

We used a bootstrapping procedure (1,000 resamplings; with 95% BCa confidence interval) in all analyses to correct for deviations from normality and ensure continuity in the application of the parametric statistical analyses. To compare the performance on the EFs of the FM patients with the mean performance of the NG, we used a one-sample *t*-test. The relationship of anxiety, depression, and pain with EFs and functioning was assessed it using the Pearson correlation coefficient. To assess the relationship between FM and functioning, controlling for measures of anxiety, depression, and pain, we used partial correlation.

Table 1 Characterization of the study sample

	Mean	Standard deviation
Age (years)	43.59	8.78
Wechsler Abbreviated Scale of Intelligence	90.53	11.98
Time since diagnosis (years)	4.71	1.40
Level of schooling	N	%
Primary education	1	5.9
High school	1	5.9
Higher education	15	88.2

RESULTS

We recruited 18 women diagnosed with FM. However, 1 patient was excluded from the study due to reporting a stroke suffered ~ 2 years before. The final sample was composed of 17 women with FM (FM group), aged between 30 and 59 years, with no history of neurological disease. In total, 88.2% of the participants were classified as A or B2 regarding the socioeconomic status. The time since diagnosis varied between 3 and 7 years. ►**Table 1** shows the sociodemographic characteristics, and ►**Table 3** shows the degree of severity of anxiety and depression symptoms among the sample.

The performance of FM patients on EF measures were initially compared with the mean performance of the NG; these results are shown in ►**Table 3**.

We found significant differences in several measures. In the time measure in Part B of the HT, which assesses inhibitory control, the FM group exhibited greater latency. The same thing occurred in the time measure in Part B of the TMT and in the difference in the time taken to complete Parts A and B, which are indexes of cognitive flexibility, in which the participants were also slower compared with the NG performance. This result may suggest some difficulty in inhibition and flexibility in terms of efficiency (speed) of these processes. On the other hand, in terms of performance, the participants made fewer mistakes in Part B of the HT, which may be associated with the greater response latency that enabled better control of errors. The participants had poorer performance in the Digit Span subtest and the CBTT, thus suggesting difficulty in working memory, as well as in short-term memory. In summary, in indices with executive demands, we observed poorer performance of the FM group, and difficulties in processing speed (part A of the HT and TMT) and short-term memory also appear to be present.

We could also observe relationships involving EFs and anxiety, depression, and pain (►**Table 4**). Specifically, greater difficulty in inhibition (FDT) was associated with higher pain intensity. Additionally, there was a marginally significant association regarding poorer performance in flexibility (TMT-Part B) and more symptoms of anxiety and depression.

The FIQ indices showed few relationships with measures of anxiety and depression, and no index was associated with pain. We found a relationship between the frequency of feeling well and anxiety (r = -0.56; p = 0.02), and between fatigue and anxiety (r = -0.52; p = 0.03) and fatigue and depression (r = -0.51; p = 0.04). The relationships between EFs and functioning, according to the FIQ indices, with control for anxiety, depression, and pain, are shown in ►**Table 5**. Since these variables were controlled in the analysis, the corresponding FIQ indices of anxiety, depression, and pain were omitted in the correlations.

We identified a few relationships, but it is noteworthy that none of them involved the FIQ functioning index. In general, individuals with lower performance in visuospatial working memory (backward CBTT) reported greater interference of FM at work, and those who took more time in the flexibility task (the time measure in Part B of the TMT) also

Table 2 Anxiety and depression symptoms among the study sample

Symptoms		N	%
Anxiety	Severe	7	41.2
	Mild	4	23.5
	Moderate	6	35.3
Depression	Severe	4	23.5
	Mild	6	35.3
	Minor	2	11.8
	Moderate	5	29.4

Table 3 Descriptive statistics on executive function tasks and comparison with NG performances

	FMG ($n = 17$)				NG
Variable	Mean	SD	*t*	*p*	Mean
Hayling_time A	76.24	11.68	20.623	**0.001**	17.81
Hayling_error A	0.35	0.70	1.016	0.308	0.18
Hayling_time B	278.94	108.438	8.383	**0.001**	58.47
Hayling_error B	1.59	1.77	-7.575	**0.001**	4.84
Digit Span forward	7.29	1.80	-2.380	0.051	8.33
Digit Span backward	4.82	1.43	-3.202	**0.013**	5.93
FDT inhibition	18.06	7.965	0.134	0.888	17.8
FDT flexibility	32.82	14.930	0.863	0.393	29.7
TMT time A	50.41	11.06	5.810	**0.001**	34.83
TMT time B	107.06	15.82	4.409	**0.003**	90.14
TMT time B-A	56.71	15.82	2.235	**0.049**	48.13
Corsi forward	5.82	2.30	-4.372	**0.002**	8.26
Corsi backward	4.82	2.38	-5.144	**0.001**	7.79
Phonological VFT	25.12	5.52	1.805	0.086	22.7
Semantic VFT	23.24	6.35	-1.068	0.276	24.88

Abbreviations: Corsi backward, Corsi Block-Tapping Task, in reverse order; Corsi forward, Corsi Block-Tapping Task in direct order; Digit Span backward, Digit Span Subtest, in reverse order; Digit Span forward, Digit Span Subtest, in direct order; FDT flexibility, Five Digit Test, flexibility index; FDT inhibition, Five Digit Test, inhibition index; FMG, fibromyalgia group; Hayling error A, Hayling Test, part A, number of errors; Hayling_error B, part B, number of errors; Hayling_Time A, execution time in part A; Hayling time B, execution time in part B; NG, normative group; Phonological VFT, phonological verbal fluency task; SD, standard deviation; Semantic VFT, semantic verbal fluency task; TMT time A, Trail Making Test, response time in part A; TMT time B, response time under flexibility demand; TMT time B-A, difference between response times in parts A and B.

Table 4 Correlation of anxiety, depression, and pain with executive functions

	HAM-A	BDI-II	BPI-intensity	BPI-interference
Digit backward	0.12	-0.16	0.33	0.33
Corsi backward	-0.11	-0.41	-0.10	-0.08
FDT: inhibition index	0.17	0.12	**0.51***	0.18
FDT: flexibility index	0.11	-0.05	0.16	0.31
TMT: part B	***-0.46***$^{+}$	***-0.45***$^{+}$	-0.26	-0.17
TMT Time B	-0.17	0.20	0.24	-0.16
Hayling time B	0.15	-0.17	0.07	0.06
Hayling errors B	0.06	-0.17	0.17	0.08
Phonological VFT	0.03	0.00	-0.15	0.17
Semantic VFT	0.08	0.35	-0.22	0.23

Abbreviations: BDI-II, Beck Depression Inventory – II Edition; BPI, Brief Pain Inventory; Corsi backward, Corsi Block-Tapping Task, in reverse order; Digit backward, Digit Span Subtest, in reverse order; FDT, Five Digit Test; HAM-A, Hamilton Anxiety Rating Scale; Hayling errors B, number of errors in Part B of the Hayling Test; Hayling time B, execution time in Part B of the Hayling Test; TMT, Trail Making Test; TMT time B, Trail Making Test – response time under flexibility demand; VFT, Verbal Fluency Task.
Notes: $^{**} < 0.01$; $^{*} < 0.05$; $+ > 0.05 < 0.075$

reported greater fatigue. Contrary to expectations, difficulties in inhibition (errors in Part B of the HT) were associated with reports of less interference at work. However, this may be due to the time it took the patients to respond to this part of the task, which will be revisited later.

DISCUSSION

The present study aimed to identify the relationship between EFs and functioning in women with FM, considering measures of anxiety, depression, and pain. The results show a

Table 5 Relationship between executive functions and functioning, with control for anxiety, depression, and pain

	Fibromyalgia Impact Questionnaire[a]					
	Functioning	Feel good frequency	Work missed	Interference at work	Fatigue	Sit-to-stand
Digit backward	0.39	-0.27	-0.09	-0.18	-0.16	0.18
Corsi backward	-0.23	-0.28	0.16	**-0.55***	-0.46	0.12
FDT: inhibition index	0.48	0.01	0.00	0.21	0.28	0.00
FDT: flexibility index	0.06	0.04	0.05	0.29	0.46	-0.35
TMT part B	-0.25	-0.14	0.45	-0.22	0.19	-0.42
TMT time B	0.52	-0.13	0.07	0.28	**0.67****	-0.10
Hayling time B	0.13	0.07	0.15	0.24	0.35	0.10
Hayling errors B	-0.30	0.06	0.24	**-0.58***	-0.30	-0.33
Phonological VFT	-0.31	0.00	0.07	-0.09	-0.06	0.19
Semantic VFT	-0.42	0.25	-0.13	-0.35	0.09	-0.25

Abbreviations: Corsi backward, Corsi Block-Tapping Task, in reverse order; Digit backward, Digit Span Subtest, in reverse order; FDT, Five Digit Test; Hayling errors B, number of errors in Part B of the Hayling Test; Hayling time B, execution time in Part B of the Hayling Test; TMT, Trail Making Test; TMT time B, Trail Making Test – response time under flexibility demand; VFT, Verbal Fluency Task.
Notes: **< 0.01; *< 0.05; [a]the higher the score, the worse the indicator, that is, the greater the impact of FM on the patient's quality of life.

particular profile of deficits in EFs and in other non-executive skills. Additionally, some specific associations between EFs and functioning were evident, despite the control for symptoms of anxiety, depression, and pain.

In the performance of EF tasks, compared to the mean performance of the NG, the results of Part B of the HT, a measure that assesses planning and inhibition skills, showed that the FM group made fewer errors but took longer to complete the task. This result indicates that, despite achieving an appropriate performance in the task, it came at the cost of efficiency in its execution. This aligns with the findings of previous studies,[6–8] in which FM patients took more time to respond than the control group in the Stroop task, demonstrating a slowing of processing speed. We found a similar result on Part B of the TMT, in which the FM group was slower compared with the NG. However, despite these findings suggesting lower efficiency in executive processes, specifically in inhibition and flexibility, it is important to consider that even in part A of the HT and TMT, in which executive demands are reduced, the FM group presented longer execution times, suggesting lower processing speed.[14]

The FM group also presented lower performance compared with the NG in measures of working memory. Difficulties in working memory, both auditory and visuospatial, have been highlighted in the literature.[5,34,35] Some studies have indicated other executive deficits in patients with the same condition.[9,36,37] However, we did not observe difficulties in the FDT indices, which measure inhibition and flexibility, or in verbal fluency tasks. This result may indicate that not all skills are compromised due to the disease. The results may also be related to the specific demands of each task or the lack of greater control in terms of a more appropriate comparison group, for example, through pairing with the patient group. Finally, short-term memory, especially visuospatial, also appeared to be compromised in the FM group, which may be linked to the attentional demand of the task.[9,10] The results suggest a need for a more comprehensive assessment of cognition in FM patients.

Studies[17,38] have shown the presence of symptoms of anxiety and depression in patients with FM. Furthermore, there is evidence that pain could compromise performance in cognitive and functioning tasks.[39] In the current study, we found that patients with better performance in cognitive flexibility reported fewer symptoms of anxiety and depression. There was also an association between the inhibition index of the FDT and pain intensity, which means individuals with poorer inhibition tend to report higher pain intensity. Other studies[40] have suggested that more intense pain may be related to longer response times.

Functioning and other FIQ indices were not related to pain, which was unexpected in relation to the literature in this field.[18] We observed some relationships with anxiety and depression: individuals who were more anxious reported feeling well less frequently, and those with more symptoms of anxiety and depression reported more fatigue.[17] Regarding the associations between performance in executive measures and the functioning scale, with control for anxiety, depression, and pain, few relationships emerged. No relationship was identified between performance in EFs and the functioning scale of the FIQ. This result was unexpected given the evidence that impairment in functioning, specifically in FM, is associated with deficits in EFs.[5,20] Several hypotheses can be considered to understand this result. One of them concerns a limitation to the present study, the sample size, which did not provide sufficient statistical power for some relationships to reach statistical significance (we can see in the ►**Table 5**, for instance, that some exhibit moderate magnitude). Another aspect pertains to the FIQ instrument itself, which assesses functioning with a focus on the symptomatology of the clinical condition and, above all, on the performance of simple daily-life tasks.[31] Perhaps a more comprehensive instrument in the

domain of functioning would yield greater data variability and clarity in relationships with executive components.

Regarding the associations found, we observed that performance on visuospatial working memory was associated with work interference, and efficiency in cognitive flexibility was associated with fatigue, both occurring in the expected direction, that is, individuals with poorer working memory performance reported greater interference at work, and those who were slower to flexibly adapt a behavioral pattern reported greater fatigue. Considering fatigue and work interference as aspects of functioning in FM, these results are in line with previous findings that EFs play some role in the functioning of these patients.[5,12] Once again, the few significant relationships observed may be associated with the limited statistical power of the study (some relationships of moderate magnitude were not significant). Contrary to expectations, however, the relationship between performance on Part B of the HT Test and the work interference index showed that patients with higher error rates self-reported less interference. Our hypothesis is that this association may have been overestimated due to unusual performance in committing errors in this part of the HT. These participants tended to make fewer errors than the NG, yet at the cost of almost five times more time spent on the task.

The present study corroborates, and adds to previous research, evidence of impairments in working memory and, considering time measures, in cognitive flexibility and inhibition efficiency in women with FM. Furthermore, it suggests cognitive impairment that extends beyond the domain of EFs, with difficulties also in short-term memory and processing speed, which may, in fact, be an underlying difficulty contributing to the executive deficit we found. In addition to the executive deficit,[11] attentional and inhibitory control mechanisms, specifically, appear to be impaired in FM. This supports the hypothesis of hypervigilance to pain, impairing daily functioning in this population,[6,9,10,41,42] which also explains the results of the current investigation.

The results also suggest that, in the presence of more depressive and anxious symptoms, specific aspects of functioning are more affected. These could be aspects to be monitored, especially in women, given the evidence that they experience a greater impact of the disease in certain functioning domains. There was no relationship between functioning and pain, which strengthens our suggestion that other instruments, besides the FIQ, may contribute to the assessment of the functioning domain in FM.

Functioning in daily-life activities, as assessed through the FIQ, presented few associations with EFs. However, it is essential to highlight that this occurred even with the control for pain, anxiety, and depression, indicating that these factors do not fully explain the relationship between EFs *and* daily-life functioning. Executive functions are involved in a set of skills necessary for self-management of everyday situations, and their impairment in FM could be another factor impacting the already compromised functioning of these patients. Indeed, this has been suggested in previous research,[5,20] and the present study specifically corroborates this regarding fatigue and work interference. However, there were no relationships with the functioning index of the FIQ. The limitations to the current study may explain this finding. Another related factor concerns limitations to the FIQ itself.

Thus, regarding the limitations to the present study, the sample size was small, which may pose a risk of bias, as it might not adequately represent the population of interest. However, it is essential to highlight the challenge of conducting studies with certain clinical populations. A second limitation is the absence of a control group, which may have affected performance comparisons. However, it is important to note that the research assessments, which were conducted in person, had to be interrupted due to the coronavirus disease 2019 (COVID-19) pandemic, which was declared in Brazil in March 2020. We employed some controls and statistical procedures to ensure good interpretability of the data, aiming to minimize these limitations, which should be taken into account in future studies.

In conclusion, despite controlling for pain, anxiety, and depression – a noteworthy aspect of the current study in terms of methodological control –, we were able to find some relationships between EFs – especifically, visuospatial working memory and cognitive flexibility efficiency – and functioning. This suggests that these symptoms do not fully explain the relationships between these constructs in FM. In light of this, in addition to aspects of pain and functioning already considered in the monitoring of these patients, this finding reinforces the importance of including the assessment of anxiety and depression symptoms, along with the evaluation of EFs, in the evaluation of these patients. Another potential contribution of the findings is to broaden the perspective of the neuropsychological profile in FM beyond EFs, encompassing cognition more comprehensively. Finally, given the limited relationships found between EFs and functioning, we suggest that more comprehensive measures than the FIQ be included in the assessment of functioning in FM. This would enable a broader understanding of this domain and its relationship with other variables of interest in FM clinical practice.

Authors' Contributions

BTVM: study conception and design, data collection, methodology, data curation, project administration, and writing – original draft; VM: writing – original draft, statistical analysis, and writing – review and editing; GGS: data curation, statistical analysis, methodology, and writing – review and editing; NMD: study conception and design, data collection, methodology, data curation, project administration, writing – original draft, and writing – review and editing.

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Conflict of Interest
The authors have no conflict of interest to declare.

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