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Prediction of Caregiver Psychological Distress in Amyotrophic Lateral Sclerosis: A Cross-Sectional Study

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Purpose/Objective: To propose a predictive model for caregivers' psychological distress (including anxiety, depression, and cognitive overload) based on different data gathered from amyotrophic lateral sclerosis (ALS) patients (cognitive level, psychological distress, type of ALS, and sex). ***Research Method/Design:*** A cross-sectional study with a sample of 51 ALS patients and their respective main carers. Various instruments were used such as the Beck Anxiety Inventory, ALS Depression Inventory-12, and the Edinburgh Cognitive and Behavioral ALS Screen, Zarit Burden Interview, Self-Rating Depression Scale, and Self-Rating Anxiety Scale for caregivers. ***Results:*** ALS type, sex, and cognition were predictive variables for caregiver distress, with the main explanatory variable being the distress of the patients themselves. Spinal ALS led to higher psychological distress in caregivers ($\beta = .38$), as did male patients with ALS and preserved cognition. ***Conclusions/Implications:*** The proposed confirmatory model demonstrates that patients' psychological distress is the best predictor of psychological distress in their caregivers.

Impact and Implications

There is a direct relationship between the symptomatology of amyotrophic lateral sclerosis (ALS) patients and the psychological distress of their caregivers. The type of ALS, gender, or cognitive function of ALS patients may determine the psychological distress of their caregivers. Patients' psychological distress is the best predictor of the same variable in their caregivers.

Keywords: amyotrophic lateral sclerosis, caregiver burden, psychological, stress

Amyotrophic lateral sclerosis (ALS) is irreversible, and it is the most common form of neurodegeneration affecting motor neurons, with consequent weakness, atrophy, and progressive paralysis of all muscles (Logroscino et al., 2008). Additionally, there is emotional distress characterized by high levels of anxiety and depression (Carvalho et al., 2016; Kurt et al., 2007).

Typically, it is accepted that the disease occurs between the ages of 58 and 63 years; however, a recent studio observed that 50% of the diagnosed people were over 70 years old. Therefore, late age onset of ALS seems to be more common than formerly assumed (Broussalis et al., 2018).

Among demographic factors, gender is an independent factor influencing the development of ALS, with men being 2–3 times more susceptible than women (Pape & Grose, 2020). Additionally, gender influences the pathophysiology of the disease (Chiò et al., 2020). Although the prevalence and incidence vary worldwide, a

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Jesús Privado served as lead for formal analysis and investigation and served in a supporting role for project administration and writing–review and editing. Elena Sanchis Sanchis served in a supporting role for investigation and writing–review and editing. David Sancho-Cantus served as lead for writing–original draft and writing–review and editing and contributed equally to formal analysis. Laura Cubero-Plazas served as lead for conceptualization and served in a supporting role for funding acquisition, project administration, supervision, and writing–review and editing. Esther Navarro-Illana served as lead for writing–review and editing. José Enrique de la Rubia Ortí served as lead for funding acquisition, contributed equally to supervision and writing–review and editing, and served in a supporting role for conceptualization, formal analysis, and project administration.

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global average incidence of 1.59 and a prevalence of 4.42 per 100,000 people are estimated (Xu et al., 2020). In Spain, the incidence of the disease is 1.4 per 100,000 people (Castro-Rodríguez et al., 2021). In addition, given the severity of the illness, patients are highly dependent on their carers, with whom they have a highly complex and poorly investigated relationship (Brunori et al., 2021; Cipolletta et al., 2018).

Emotional Distress Syndrome

The caregiver burden syndrome is characterized by the stress experienced by the carers due to the challenges and difficulties involved in caring for another dependent person, which will ultimately impact the well-being of the caregivers (Foley et al., 2016; Giannaki et al., 2021; Siciliano et al., 2017), in addition to having associated economic, social or personal repercussions (Tramonti et al., 2019). Due to the characteristics of ALS, both the quality of life and the mood of caregivers are significantly lower, as they have a significant involvement in the functional care of patients (Maksymowicz-Śliwińska et al., 2023). In fact, it is estimated that an average of 11 hr per day is invested in their care. Aspects such as apathy, executive dysfunction, or disinhibition in patients with ALS have been linked to psychological stress (Andrews et al., 2017; Costa et al., 2021). For example, coping style, age, sex, time dedicated to caregiving, patient's disability, and neurobehavioral alterations are factors that play a role in this association.

Various studies have shown that both the psychological distress and the excessive physical demand on caregivers of patients with ALS are associated with the characteristics of the disease, as well as with the characteristics of the caregivers themselves. For example, the way of coping (De Wit et al., 2018), age and sex (Pagnini et al., 2016), time dedicated to patient care, patient's disability, and neurobehavioral alterations are factors that play a role in this association (Pinho & Gonçalves, 2016). In this regard, one of the main consistently shown issues in the literature is the lack of training in emotional management, and this is precisely one of the main needs of caregivers (Galvin et al., 2016, 2018; Poppe et al., 2020). In fact, these individuals are defined as "hidden patients" (Pagnini et al., 2016).

Providing physical care, symptom management, and ensuring safety and well-being are just some of the responsibilities of caregivers for people with ALS (Tramonti et al., 2019). Previous studies suggest a direct relationship between the behavioral symptoms reported by patients and those experienced by their carers (Andrews et al., 2017; Bock et al., 2016). Additionally, caregivers often experience grief, anxiety, depression, fatigue, or sleep disturbances (Aoun et al., 2020). The caregiver's subjective perception of excessive caregiving physical demand can also influence the disease process (Burke et al., 2017; Thomas et al., 2018). Therefore, it is good practice for healthcare systems to incorporate the needs of both patients and caregivers into health protocols (Tobin et al., 2021).

Predictors of Psychological Distress in Caregivers of ALS Patients

In chronic diseases like diabetes (Gonzalez et al., 2008), depressive symptoms of caregivers have been linked to the patient's glycemic control, the duration of the illness, comorbidity, and the caregiver's quality of life. In cancer (Lee et al., 2016), the severity of the disease, the type of treatment, the patient's age, and the caregiver's quality of life all influence their emotional distress.

In chronic degenerative pathologies, the relationship between these aspects of the disease and the presence of psychological disturbances in caregivers is more evident. For Alzheimer's disease, for example, the patient's level of dependence, the duration of the illness, the presence of neuropsychiatric symptoms, and cognitive impairment are related to a higher occurrence of depressive symptoms in caregivers (Byeon, 2019). Similarly, in patients with Parkinson's disease, their degree of disability or the presence of psychological symptoms have been linked to the quality of life and emotional distress (anxiety, depression, and apathy) of their main carers (Mosley et al., 2017).

For ALS, and due to the severity and characteristics of the disease, the emotional demand on caregivers is higher than in other chronic-degenerative diseases (Tang et al., 2021). However, there is limited evidence available regarding the most predictive variables. Among these, it seems that the cognitive status of patients with this condition is related to the distress, quality of life, and psychological burden of their carers (Caga et al., 2016; Chio et al., 2005; Mioshi et al., 2014; Rabkin et al., 2000). Cognitive and behavioral changes have been described in over 50% of patients, and in 5%–15% of patients, these changes reach clinical relevance, leading to a diagnosis of frontotemporal dementia (Montuschi et al., 2015; Strong et al., 2017). These alterations have a direct impact on the carer's burden, especially due to decreased motivation, memory dysfunction, and difficulties in completing daily activities experienced by the patients (Andrews et al., 2017; Bock et al., 2016). Furthermore, concerning frontotemporal dementia, it is worth noting that emotional disturbances in these patients, such as anxiety and depression, are predictors of an increased burden on caregivers (Chio et al., 2005).

Another crucial factor in the distress of caregivers of ALS patients is the type of ALS. According to the diagnostic criteria, clinical presentations are subdivided into bulbar or spinal ALS. Bulbar ALS initially affects the muscles of the head and neck, causing early speech and swallowing problems. Spinal ALS primarily affects the limbs and motor function, with patients requiring additional assistance for mobility and personal care. As a result, caregivers of patients with bulbar ALS experience greater psychological distress compared to caregivers of patients with spinal ALS (Hagiwara et al., 2019; Kawasaki et al., 2019).

Regarding the influence of sex, most studies focus on the predictive value of the caregivers' own sex in this caregiving burden (Pinho & Gonçalves, 2016; Qutub et al., 2014; Tramonti et al., 2015). However, the patient's sex can affect not only the progression of the condition but also the way of coping with the disease, adherence to therapies, and communication between the patient and carer, especially in chronic diseases characterized by a heterogeneous and progressive spectrum of clinical characteristics (GBD 2016, 2018). In fact, sex has been identified as a variable that influences caregiver burden in ALS (Tülek et al., 2023), but there are hardly any studies that delve deeper into this relationship.

In conclusion, a better understanding of the influence of these factors, particularly their impact on caregiver burden, is required to develop interventions that support carers and that, in turn, have an effect on the patients' well-being. ALS is a disease with a high overload on the main carer. A better understanding of the factors that influence this excessive physical caregiving demand can help both caregivers and health care professionals in the provision of quality

care. This is why the aim of this study was to propose a predictive model of caregivers' psychological distress (anxiety, depression, and cognitive burden) based on the measurement of various factors in ALS patients (cognitive level, psychological distress, type of ALS, and sex).

Method

Design

A descriptive, quantitative, and cross-sectional study was conducted with a ClinicalTrial Identifier NCT04654689.

Participants

On one hand, the sample was composed of 51 patients diagnosed with ALS according to the El Escorial criteria (Brooks et al., 2000), with an average diagnosis time of 26.02 months (range = 2–146 months) and an average age of 56.67 years ($SD = 10.15$). About 62.7% were male, 15.7% with bulbar ALS and 84.3% with spinal ALS. Patients with tracheostomy, with invasive ventilation or noninvasive positive pressure ventilation, evidence of dementia, or dependence on alcohol or drugs were excluded. The sample size ($n = 51$) may seem limited, but this disease has a low worldwide incidence (1.75/100,000 inhabitants/year; Marin et al., 2017). Previous studies have obtained similar sample sizes: $n = 75$ (Kübler et al., 2005), $n = 37$ (Hammer et al., 2008), and $n = 85$ (Pain et al., 2021). The sample also included a higher number of men, which corresponds to a higher incidence in male (1.6/100,000) compared to female (1.2/100,000; Couratier et al., 2016). Clinically, there are two types of ALS: bulbar (two out of three diagnosed patients) or spinal (present in one third of the ALS population; Traxinger et al., 2013).

On the other hand, the study included the 51 main carers of the selected ALS patients. Inclusion criteria: caregivers had to be family members of the patient (including spouse, parent, child, son-in-law, daughter-in-law, siblings, etc.) and responsible for the main caregiving tasks. Individuals with severe mental illness and cognitive impairment who could not complete the questionnaire were excluded as potential participants in the study. The average age of the caregivers was 51.51 years ($SD = 10.75$); 31.4% were male.

Instruments

The questionnaires used for ALS patients were the following:

Beck Anxiety Inventory (BAI; Beck et al., 1988). The BAI is a 21-item self-report instrument designed to assess anxiety. Each item represents an anxiety symptom, and the individual rates the extent to which they have been affected by it during the past week, using a 4-point Likert scale ranging from 0 = *not at all* to 3 = *severely, could hardly stand it*. The scale measures both somatic and affective-cognitive anxiety. The Spanish version of the BAI, by Sanz and Navarro (2003), was used. Table 1 presents the internal consistency of all the applied instruments.

ALS Depression Inventory-12 (Hammer et al., 2008). It consists of 12 items designed to assess depression. It was specifically developed for ALS patients and addresses depressive symptoms, excluding the increasing physical impairments that are characteristic of ALS. The inventory describes depression as a one-dimensional construct ("mood, anhedonia, energy") and allows individuals to answer questions about depressive symptoms. The ALS Depression Inventory-12 considers the mood of the past 2 weeks and uses a four-level response format ("completely agree" to "completely disagree").

Edinburgh Cognitive and Behavioral ALS Screen (Spanish version; De Icaza Valenzuela et al., 2021; Hodgins et al., 2020). The Edinburgh Cognitive and Behavioral ALS Screen is a practical screening tool that includes a series of cognitive tests that have been shown to be sensitive to cognitive impairment in ALS. It consists of several subtests that assess language, verbal fluency, executive functions, memory, and visuospatial abilities. It has been designed for ALS patients and responses can be given orally or by combining writing and signaling. Caregivers or family members of the patients can also respond to it. It is suitable for patients with speech difficulties or lack of hand motor function. It takes approximately 15–20 min.

The questionnaires used for caregivers were as follows:

Zarit Burden Interview (Schreiner et al., 2006; Seng et al., 2010; Zarit et al., 1980). It is a 22-item self-administered questionnaire (Oh & Kim, 2018). It is used to assess the level of burden experienced by the caregiver. Each item is answered on a Likert scale from 0 = *no burden* to 4 = *high burden*. It consists of three factors: social restrictions, self-criticism, and anger and frustration.

Self-Rating Depression Scale. Developed by Zung (1965). This tool allows discriminating the presence of depressive signs, both positive and negative types. It consists of 20 Likert-type items with scores ranging from 1 = *never* to 4 = *always* (Rodríguez-de Avila et al., 2020).

Self-Rating Anxiety Scale. Also developed by Zung (1971), in order to detect anxiety symptoms. It consists of 15 Likert-type items ranging from 1 = *never* to 4 = *always*. It comprises two subscales: affective and physiological (Qu et al., 2020; Rodríguez-de Avila et al., 2020).

The questionnaires were administered by neuropsychologists specialized in neurodegenerative diseases and the use of such diagnostic tools. The data were collected at the same time (10 a.m.) on different days due to the total volume of patients

Procedure

ALS patient associations in Spain were contacted via email and phone to recruit participants. They were informed that participation in the study was voluntary and anonymous and that no financial compensation would be provided. ALS patients and their carers received information before participating in the study. The measurement instruments were completed by members of the research team. Carers were recruited through the selected patients themselves by being offered the possibility of participating in the study. The medication taken by each of the participating patients in the study was recorded, and no treatment for anxiety or depression was identified. Regarding the intake of medications related to the treatment of ALS, as an inclusion criterion, all participants had to be taking riluzole.

The project was approved by the Ethics Committee of Clinical Research at Hospital *La Fe* in Valencia, Spain (2021-001989-38), and conducted in accordance with the Declaration of Helsinki (World Medical Association, 2013).

Data Analysis

First, data distribution was calculated to check for normality, and internal consistency was assessed using the SPSS V 21 software. In addition, Pearson correlations between the different measures were calculated.

Table 1
Descriptives, Distribution, Internal Consistency, and Communality (h^2) for Each Measure

Group	Measure	*M*	*SD*	Asymmetry	Kurtosis	Cronbach's α	h^2 models a and d	h^2 models b, c, and e
ALS	Language	25.16	3.26	−1.32	1.69	.339	0.62	0.62
	Verbal fluency	14.59	7.59	−0.95	−0.50	.713	0.01	
	Executive functions	36.12	7.55	−0.83	0.58	.617	0.76	0.76
	Memory	16.67	4.08	−1.59	4.21	.574	0.18	0.17
	Visuospatial capability	11.55	1.14	−2.85	7.55	.323	0.18	0.18
	Depression	11.14	8.46	1.22	0.96	.911		0.44
	Somatic anxiety	21.43	7.71	1.10	0.63	.891		0.92
	Affective-cognitive anxiety	19.10	8.44	1.06	−0.05	.912		0.83
Caregivers	Affective anxiety	7.41	2.78	1.39	2.35	.866	0.66	0.66
	Physiological anxiety	16.63	5.40	1.47	2.32	.877	0.48	0.48
	Depression	40.06	9.41	0.05	−0.44	.854	0.52	0.50
	Social constraints	11.82	8.36	0.66	−0.35	.885	0.88	0.88
	Self-criticism	3.00	2.56	0.51	−0.75	.845	0.04	
	Anger-frustration	16.02	9.34	0.79	0.22	.877	0.81	0.81

Note. ALS = amyotrophic lateral sclerosis.

Secondly, confirmatory factor analyses were conducted using the AMOS V. 23 program (Arbuckle, 2006) to measure cognition and psychological distress of the patients, as well as the psychological distress of the caregivers, separately, to check if they theoretically grouped into a latent factor.

Two types of goodness-of-fit indices were used to evaluate the fit of the data to the tested models:

(a) Absolute, to assess how well the theoretical model aligns with the empirical data. These indices include the index χ^2/df (Bentler & Bonett, 1980), whose values below 3 indicate a good fit; the goodness-of-fit index (Jöreskog & Sörbom, 1993), with values >0.95 considered a good fit; the standardized root-mean-square residual (Hu & Bentler, 1999); and the root-mean-square error of approximation (Steiger, 1990), with values <0.08 indicating a good fit (Hair et al., 1999). Additionally, the presence of <5% of standardized residuals exceeding 2.58 in absolute value is considered a criterion for a good fit (Hair et al., 1999; Jöreskog & Sörbom, 1993). (b) Incremental, used to compare the obtained model with a null model. These indices include the normed fit index (Bentler & Bonett, 1980), the comparative fit index (Bentler, 1990), and the Tucker–Lewis index (Tucker & Lewis, 1973), which with values >0.95 indicates a good fit.

A recommendation of 10 participants per indicator is suggested for factor analyses (Byrne, 2001). However, others propose using only five participants per indicator when the distribution is normal (Hair et al., 1999). Our study met the latter criterion as there were 51 participants for three to seven indicators in the different tested models ($51/3 = 10.2$, $51/7 = 7.29$). Moreover, MacCallum et al. (1999) conducted numerous simulations, varying the communality, the ratio between indicators and extracted factors, and the sample size. They found that with $n = 60$ participants, there was an 87% convergence between empirical and population factors for ratios of $20/3 = 6.67$ (indicators/factors) and communality values between 0.20 and 0.40. In our case, the ratios for the tested models were between 10.2 and 7.29, and the extracted communalities were appropriate for models b, c, and e (see Table 1), with $n = 51$ participants. Therefore, these criteria were also fulfilled.

Third, a predictive model was tested using different data from patients with ALS (type of ALS, sex, cognition, and psychological distress) to predict the psychological distress experienced by the patients. The estimated factors from the confirmatory factor analyses for cognition and psychological distress in patients, as well as psychological distress in caregivers, were used to reduce the number of measurements in the model and meet the criterion of having at least 10 subjects per measurement. Specifically, five variables were employed for a sample size of $n = 51$, resulting in a ratio of $51/5 = 10.2$.

This study was not preregistered.

Results

Descriptive Analysis

Table 1 presents the descriptive statistics for the different data collected from patients with ALS and their caregivers. Skewness values not exceeding 2 and kurtosis not exceeding 7 in absolute value would indicate a normal distribution of the variable, which is a requirement for using the maximum likelihood procedure to estimate confirmatory factor and predictive models (Tucker & Lewis, 1973; West et al., 1995). The only measurement that does not meet these normal distribution criteria is the Visuospatial Ability, but it is not expected to significantly impact the results. Table 2 shows the Pearson correlations between the different measures collected in this study.

Confirmatory Factor Analysis

Three confirmatory factor analyses were conducted to extract three latent factors: cognition and psychological distress for patients with ALS, and psychological distress for caregivers. Figure 1 displays the various estimated models. For the cognitive measurements in patients, two models were estimated (a and b). Both models demonstrated multivariate normality, calculated using the Bolle–Stine bootstrap method (Bollen & Stine, 1993; $p = .314$), and were, therefore, estimated using maximum likelihood. Model a had the issue of almost all its goodness-of-fit indices being worse than expected (see Table 3), and it had a factor loading below the recommended minimum of 0.40 (Hair et al., 1999), specifically for Verbal Fluency. For these reasons, this model was discarded. On the other hand, Model b was found to have good goodness-of-fit indices, and all factor

Table 2
Pearson Correlations Between the Different Measurements

Group	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
ALS	1. Sex	—															
	2. ALS type	−.11	—														
	3. Language	−.04	−.16	—													
	4. Verbal fluency	−.35	.05	.00	—												
	5. Executive functions	−.14	−.03	.69	.07	—											
	6. Memory	−.07	−.13	.29	.46	.37	—										
	7. Visuospatial capability	−.09	−.17	.36	.04	.35	.21	—									
	8. Depression	.11	−.18	.00	−.23	−.12	.04	−.24	—								
	9. Somatic anxiety	.23	−.16	−.18	−.13	−.17	−.07	−.21	.64	—							
	10. Affective-cognitive anxiety	.30	−.16	−.17	−.26	−.17	−.19	−.29	.60	.87	—						
Caregivers	11. Affective anxiety	−.28	.07	.07	.10	.02	−.12	−.25	.23	.09	.17	—					
	12. Physiological anxiety	−.29	.08	.01	−.04	−.01	−.17	−.11	.24	.15	.17	.66	—				
	13. Depression	−.27	.20	.00	.14	−.01	.02	−.04	.16	.04	.11	.67	.78	—			
	14. Social constraints	−.12	.30	.08	.06	.08	−.08	−.29	.20	.19	.25	.66	.62	.63	—		
	15. Self-criticism	.08	.04	.10	−.06	.04	.06	−.20	.21	−.06	.08	.28	.20	.27	.18	—	
	16. Anger-frustration	−.26	.30	.13	−.03	.09	−.20	−.25	.27	.14	.19	.63	.71	.59	.85	.12	—

Note. Correlations $\geq |\pm .28|$ are statistically significant at 5%. ALS = amyotrophic lateral sclerosis.

loadings were above 0.40. Consequently, Model b was considered for estimating the cognitive factor in patients.

For the Psychological Distress of patients (Model c in Figure 1), multivariate normality was achieved as it presented a kurtosis of 4.23, less than 7 in absolute value. The Bolle–Stine bootstrap index could not be calculated. The model was estimated using maximum likelihood, resulting in factor loadings >0.40 for all three indicators and perfect goodness-of-fit indices (see Table 3).

In the case of Psychological Distress for caregivers (Models d and e in Figure 1), a kurtosis value of 6.96 was obtained, which is less than 7 in absolute value. Therefore, multivariate normality can be assumed, and the models can be estimated using maximum likelihood. Model d has good goodness-of-fit indicators (see Table 2), but it shows a factor loading of 0.19 for self-criticism, which is less than the recommended 0.40. As a result, Model e was chosen because it presents similar goodness of fit and does not have any factor loadings below 0.40.

Finally, in Table 1, the communalities (h^2) for the final models (b, d, and e) are within the recommended range (between 0.20 and 0.40) by MacCallum et al. (1999), except for two cognitive measures (Memory and Visuospatial Capacity). Therefore, the findings are quite stable despite having a small sample size ($n = 51$).

Predictive Model

Given the sample size for the predictive model, our team worked with the factors estimated in Confirmatory Factor Analyses, in addition to including the type of ALS and patients' sex as predictors. The model (see Figure 2) showed multivariate normality calculated using the Bolle–Stine bootstrap method (Bollen & Stine, 1993; $p = .522$), estimated using maximum likelihood. Table 3 displays the goodness-of-fit indices, indicating a very good fit to the model's data.

Spinal ALS leads to higher psychological distress in caregivers ($\beta = .38$). This variable was coded as 1 = *spinal ALS* and 0 = *bulbar ALS*, so a positive correlation indicates that spinal ALS leads to more distress in caregivers. Sex (coded as 1 = *female* and 0 = *male*) is negatively related to psychological distress ($\beta = -.33$), implying that male patients with ALS cause more distress to caregivers than female patients. The cognition of ALS patients, when more preserved, leads to higher distress in caregivers ($\beta = .20$). Finally, higher psychological distress in ALS patients results in greater distress in caregivers ($\beta = .46$ being the most significant predictor of the criterion. Together, the four predictors account for 31% ($R^2 = .31$) of the variance in caregivers' psychological distress.

Furthermore, when considering the relationships between the predictors, women with ALS experience higher psychological distress ($\beta = .24$), ALS patients with higher cognitive scores experience less psychological distress ($\beta = -.25$), and bulbar ALS patients have better cognition ($\beta = -.16$) but also higher psychological distress ($\beta = -.16$).

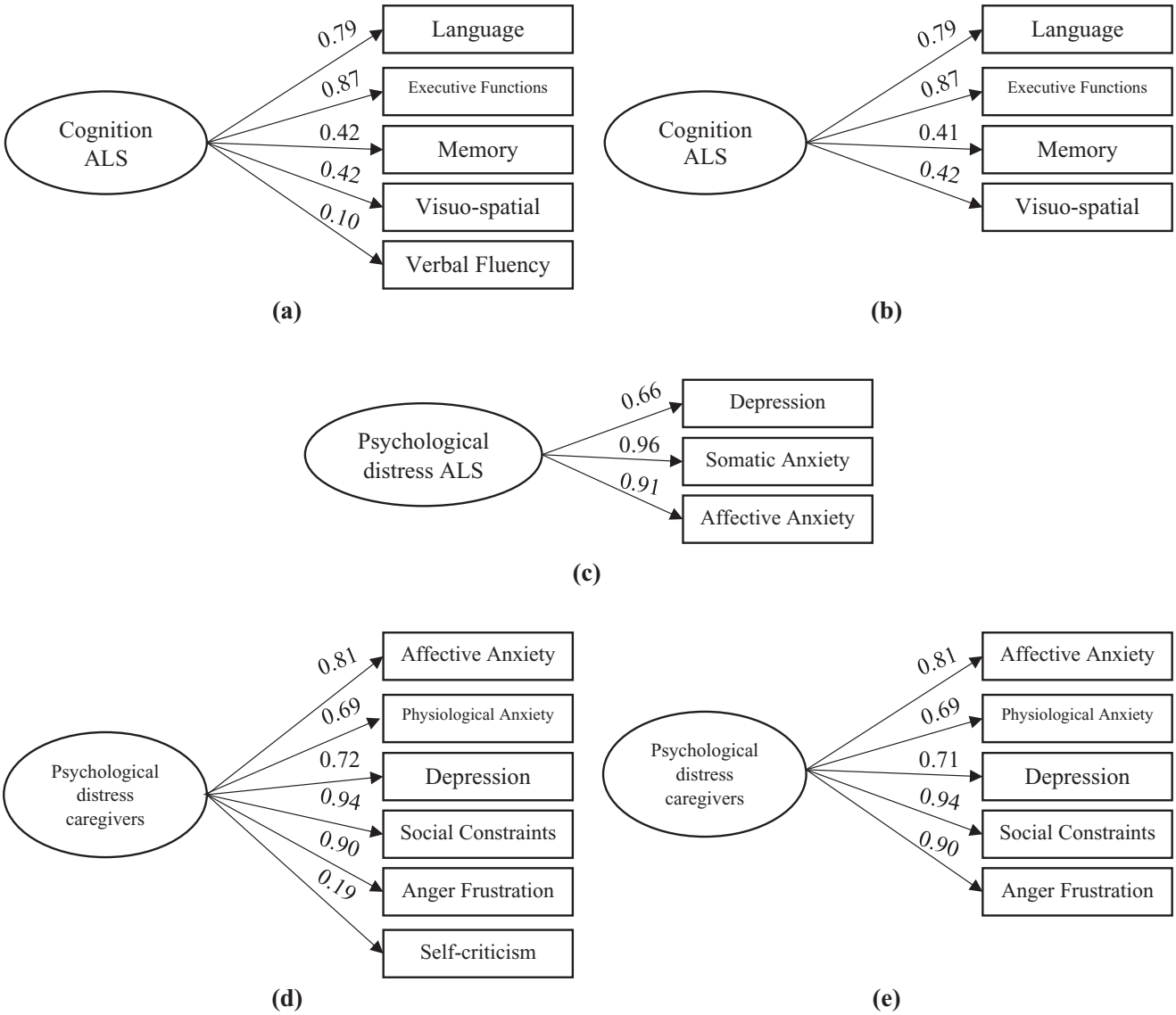
Discussion

The severity of the disease, along with the unpredictable progression of physical deterioration, explains the high emotional distress exhibited by ALS patients (Olsson et al., 2011), characterized by anxiety and depression (Carvalho et al., 2016) which are linked to cognitive decline in ALS (Carelli et al., 2018). In turn, this loss of well-being in patients has been associated not only with the progression of the disease (Prell et al., 2019) but also with the well-being of the caregiver (Olsson et al., 2010).

Given this association between the well-being of patients and caregivers, it seems relevant to identify patient variables that most predict this distress. This could help develop coping strategies to improve the quality of life for both caregivers and ALS patients. This is why the aim of this study was to establish a predictive model of the psychological distress of caregivers of ALS patients based on the type of ALS, gender, cognitive level, and psychological distress of the patients themselves. Unlike previous studies, our team used multiple predictors of caregivers' psychological distress in ALS and focused on predictors related to the patients. Using a confirmatory predictive model, it was seen that the predictors related to ALS patients explained 31% of the total variance in caregivers' psychological distress. The most significant predictor of caregivers' psychological distress was the psychological distress of the ALS patients themselves ($\beta = .46$), indicating that when patients experience high psychological distress, caregivers also experience distress at a psychological level. Some studies have focused on the distress

Figure 1

Confirmatory Factor Analyses for Cognition and Psychological Distress in ALS and Psychological Distress in Caregivers



Note. Part labels (a-e) represent different models resulting from the conformational analysis. ALS = amyotrophic lateral sclerosis.

experienced by ALS caregivers (Andrews et al., 2017; Bock et al., 2016; Costa et al., 2021; Foley et al., 2016; Siciliano et al., 2017), but the impact of ALS patients' own psychological distress on their caregivers has not been addressed. Previous studies have explored the relationship between psychological distress in Alzheimer's patients and its impact on caregivers, finding a positive association similar to our results (Byeon, 2019). Similarly, in ALS patients, a positive relationship between these data has been found in line with our research (Burke et al., 2018).

Type of ALS

Regarding the type of ALS, spinal ALS causes greater psychological distress in caregivers than bulbar ALS ($\beta = .38$). This result contradicts others where patients with bulbar ALS produce more emotional distress on their carers (Hagiwara et al., 2019). However, previous studies have shown that patients with spinal ALS have poorer gross motor function (Lillo et al., 2012) and that they produce more burden on the caregiver (Nakagawa et al., 2010; Pagnini et al., 2010). Additionally, in our study, patients with bulbar ALS have better preserved cognitive status, contrary to previously published data (Yang et al., 2021). These results could suggest that the greater awareness in patients with bulbar ALS, due to better cognitive preservation, the higher their psychological distress.

Sex of the Patient

Regarding the sex of the patient, male patients cause greater psychological distress to their caregivers than female patients

Table 3
Goodness-of-Fit Indices for the Confirmatory Factor Analyses and the Predictive Model

Models	χ^2/df	GFI	NFI	CFI	TLI	RMSEA	SRMR	Residues $\geq \lvert\pm 2.58\rvert$
Model a	2.629	.913	.784	.840	.680	.181	.111	6.67%
Model b	0.289	.994	.988	1.000	1.010	.000	.020	0.00%
Model c	0.000	1.000	1.000	1.000		.000	.000	0.00%
Model d	1.620	.924	.944	.977	.950	.111	.063	0.00%
Model e	2.569	.943	.961	.975	.916	.177	.052	0.00%
Predictive model	0.819	.987	.949	1.000	1.081	.000	.048	0.00%

Note. GFI = goodness-of-fit index; NFI = normed fit index; CFI = comparative fit index; TLI = Tucker–Lewis index; RMSEA = root-mean-square error of approximation; SRMR = standardized root-mean-square residual.

($\beta = -.33$). This could be due to the higher demand of physical care required by male patients and the greater severity of their symptoms. Most previous studies have primarily focused on differences in caregiver psychological distress based on sex (Phukan et al., 2012), but another study (Lian et al., 2022) was in line with our data, finding that male ALS patients had a moderate impact on caregivers' emotional distress, while female patients had no impact.

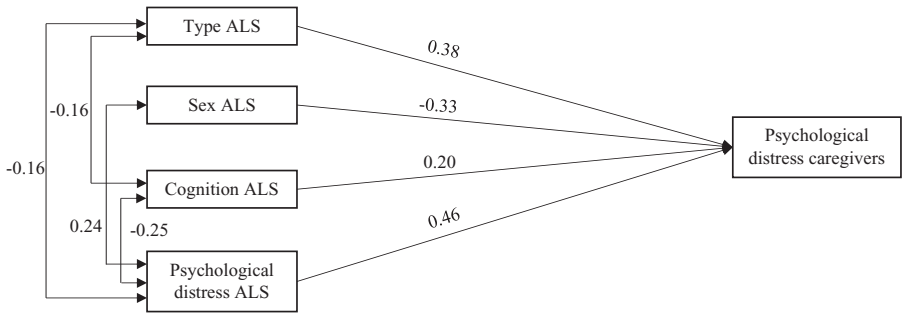
Cognitive Levels of the Patients

In our study, we also found that patients with higher cognitive levels transmit greater psychological distress to caregivers ($\beta = .20$). In other words, having higher cognitive capacity makes patients more aware of their condition, leading to increased distress in caregivers. However, interestingly, patients with better cognition experience less psychological distress ($\beta = -.25$). Cognitive impairment is relevant in ALS patients, as a high percentage of them have cognitive alterations directly related to disease progression due to frontotemporal impairments, which contribute to progressive cognitive and executive function decline (Ratnavalli et al., 2002), both linked to shorter survival time (Elamin et al., 2011). In Figure 1a, executive function is the indicator that contributes to the cognitive factor in ALS the most (0.87), followed by language (0.79) and memory (0.42), whose impairments tend to occur in these patients (Phukan et al., 2012). Some previous studies have not found a relationship between the cognitive level of ALS patients and their caregivers (Tremolizzo et al., 2016), concluding that cognitive level is not relevant when seeking to alleviate caregivers' emotional burden. However, other studies have found a relationship between the cognitive level of patients with chronic conditions and the psychological distress experienced by their caregivers. Unlike our findings, these studies have found a negative relationship between the patients' cognitive level and caregivers' psychological distress in cases of Alzheimer's (Byeon, 2019), Parkinson's (Mosley et al., 2017), and ALS (Andrews et al., 2017; Bock et al., 2016; Mioshi et al., 2014). Additionally, in line with previous studies (Tard et al., 2017), a relationship was found (−0.25) between cognition and psychological distress in ALS patients.

Limitations of the Study

The main limitation of this research is the low number of participants ($n = 51$), which may prevent the findings from being extrapolated. However, the indicator/factor ratio and the communalities obtained in the study suggest that our results should converge more than 87% with the reference population based on previous simulations conducted in other studies (MacCallum et al., 1999). Another limitation is derived from the type of cross-sectional design used. It would be advisable to see if the results can be replicated in future longitudinal studies. It would also be advisable to try to match the two types of ALS considered in the sample, since in our case there are more patients of the spinal type. Finally, it would be interesting to measure well-being in patients, in order to study their prediction on caregiver distress.

Figure 2
Predictive Model of Caregiver Psychological Distress From Measures of ALS Patients



Note. Correlations below $\lvert\pm 0.15\rvert$ were eliminated to simplify the model. ALS = amyotrophic lateral sclerosis.

Conclusions

In conclusion, our study stands out for its novelty in using various predictors associated with ALS patients to evaluate their impact on caregivers' psychological distress. Cognitive factors or the type of ALS are some of the factors related to distress.

Using a predictive methodology through a confirmatory model, we found that the psychological distress of ALS patients is the best predictor of psychological distress in their caregivers. These results could help develop coping strategies that are intended to improve the quality of life of caregivers and nursing staff responsible for attending ALS patients. Therefore, these interventions should be directed toward both caregivers and ALS patients, as reducing distress would yield beneficial effects for both, such as improvements in coping with the disease.

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