Title: Why and when social support predicts older adults' pain-related disability: A longitudinal study

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ABSTRACT

Pain-related social support has been shown to be directly associated with pain-related disability, depending on whether it promotes functional autonomy or dependence. However, previous studies mostly relied on cross-sectional methodologies precluding conclusions on the temporal relationship between pain-related social support and disability. Also, research on the behavioral and psychological processes that account for such relationship is scarce. Therefore, the present study aimed at investigating longitudinally (1) the direct effects of social support for functional autonomy/dependence on pain-related disability, (2) the mediating role of physical functioning, pain-related self-efficacy and fear, and (3) whether pain intensity and pain duration moderate such mediating processes. One hundred and seventy older adults (M_{age}=78.3; SD_{age}=8.7) participated in a 3-months prospective design, with three moments of measurement, with a 6-week lag in-between them. Participants completed the Formal Social Support for Autonomy and Dependence in Pain Inventory, the Brief Pain Inventory, the 36-SF Health Survey, behavioral tasks from the Senior Fitness Test, the Pain Self-Efficacy Questionnaire and the Tampa Scale for Kinesiophobia. Moderated mediation analyses showed that: 1) formal social support for functional dependence (T1) predicted an increase in pain-related disability (T3), 2) mediated by self-reported physical functioning (T2) and by pain-related self-efficacy (T2); 3) at short/low to moderate pain duration/intensity. Findings emphasized that social support for functional dependence is a risk factor for pain-related disability and uncover the "why" and "when" of this relationship. Implications for the design of social support interventions aiming at promoting older adults' healthy aging despite chronic pain are drawn.

Key words: social support, chronic pain, pain-related disability, functional autonomy, functional dependence, older adults, physical functioning, pain-related self-efficacy, pain-related fear.

1. Introduction

Chronic pain is prevalent and disabling among older adults [49,61,73,78]. Pain-related social support (SS;help that people receive when in pain) has been shown to influence pain-related outcomes, positively [7,31,60] and negatively [17,59,64,66]. Drawing upon operant conditioning [24] and fear-avoidance models [79,37], it has been argued that pain-related SS can reinforce activity engagement or avoidance, by promoting functional autonomy or dependence - the ability or inability to perform activities of daily-living without assistance [41,43,42,33,56] - having different implications for pain-related disability [46,45,54,65,69].

Previous studies have shown that formal pain-related SS (from formal caregivers) by promoting functional autonomy (henceforth, perceived promotion of autonomy) was associated with lower pain-related disability. Conversely, SS promoting functional dependence (henceforth, perceived promotion of dependence) has been associated with higher pain-related disability [41,43,42]. However, the cross-sectional nature of these studies prevented inferences on temporal relationships. Therefore, the first aim of the present study was to test, longitudinally, whether perceived promotion of autonomy/dependence predicts a decrease/increase in older adults' pain-related disability (Figure1, path1).

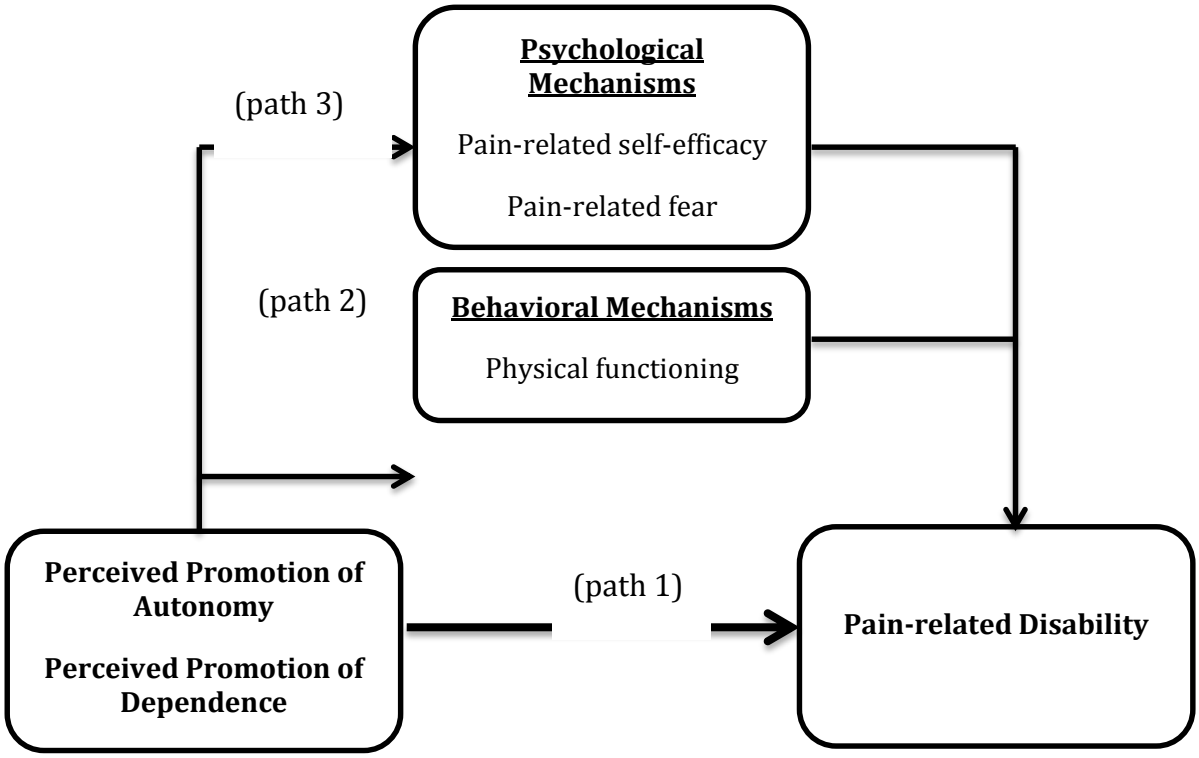
The second aim was to investigate behavioral and psychological mechanisms accounting for the previous effects. A cross-sectional study concluded that older adults' self-reported physical functioning partially accounted for the relationship between perceived promotion of autonomy/dependence and lower/higher pain-related disability [42]. Since self-reports of physical functioning might have been influenced by recall biases or social desirability, we aimed at further exploring the mediating role of physical functioning by using self-report and observational measures (Figure1,path2).

Concerning the psychological path (Figure1,path3), first we aimed to test the mediating role of pain-related self-efficacy (self-confidence to function despite pain[52]) because it is a key determinant of behavioral efforts to actively deal with pain and of lower pain-related disability [2,16,19,20,51,67,68,72,75,76]. Also, research in other health contexts has shown that SS can reinforce or undermine self-efficacy towards influencing health-related outcomes [4]. Therefore, it was hypothesized that perceived promotion of autonomy/dependence would increase/decrease pain-related self-efficacy and, hence, predict lower/higher pain-related disability.

Second, we aimed to investigate the mediating role of pain-related fear (fear of pain/physical activity/(re)injury[35]) because it is a core predictor of avoidance, maladaptive pain behaviors and higher pain-related disability [25,35,37,38,79]. Although SS has been shown to promote more adaptive behaviors [14,78] (e.g.,activity engagement) the mediating role of pain-related fear on the relationship between perceived promotion of autonomy/dependence and pain-related disability has never been tested Therefore, it was hypothesized that perceived promotion of autonomy/dependence would decrease/increase pain-related fear and, hence, predict lower/higher pain-related disability.

Finally, the previously hypothesized relationships might depend on different features and stages of chronic pain. For example, Cano [11] showed a stronger association between catastrophizing and perceived partner pain-related SS among individuals with shorter pain duration. This may suggest that the influence of pain-related SS on individuals' pain experiences may be stronger at earlier stages of the pain course or, eventually, when pain is less severe. To the best of our knowledge, this has not yet been investigated. Therefore, our final aim was to investigate whether the aforementioned mediating processes would be moderated by pain duration and intensity.

Figure 1 – Direct and indirect effects of perceived promotion of autonomy and dependence on pain-related disability



2. Method

2.1. Study Design and Participants

This study consisted of a 3-month prospective design, involving three measurement moments, with a 6-week lag in-between them. Participants were recruited according to the following inclusion criteria: a) having constant or intermittent musculoskeletal pain for at least three months [48]; b) being able to read and write autonomously; c) not having been previously diagnosed with dementia or other cognitive impairments (based on clinical staff assessments); and d) attending a day-care center for at least 6 months.

Table 1 summarizes participants' socio-demographic and pain-related characteristics. One hundred and sixty eight older adults [78] (mostly women), who were users of nine day-care centers in Lisbon metropolitan area, participated in this study at Time 1 (T1). Five participants under 60 years old [78] were, however, included because they fulfilled all inclusion criteria and because suffering from musculoskeletal chronic pain caused their early retirement. The sample was very heterogeneous in terms of participants' age and years of attendance. Most participants were widowed and, on average, presented low educational level. Joints, bones and muscles were the most common pain locations and women (M=1.57; SD=.89) reported more pain sites than men (M=1.23; SD=.54), $t_{(166)}$=2.56, p=.011.

Table 1 – Participants' socio-demographic and clinical characteristics (N=168)

1. Socio-demographic characteristics					
	Min	Max	Mean	SD	%
Age	50	99	78.4	8.7	---
Years of education	2	20	4.9	2.6	---
Duration of institution attendance (years)	.50	30	4.4	5.5	---
Sex	Women	---	---	---	68.5
	Men	---	---	---	31.5
Marital Status	Single	---	---	---	5.4
	Married	---	---	---	22.0
	Divorced	---	---	---	11.3
	Widowed	---	---	---	61.3
2. Clinical characteristics					
Number of pain locations	1	5	1.5	.81	---
Pain Locations	Joints		---	---	39.4
	Bones		---	---	27.1
	Muscles		---	---	20.6
	Tendons		---	---	2.4
	Ligaments		---	---	1.2

At T2, 150 individuals participated in the second wave of data collection. Eighteen dropouts occurred: two participants refused to collaborate (e.g., felt tired and/or did not want to answer to any questions) and sixteen were unreachable due to disease. The sample at T2 did not differ from the T1 sample in terms of its socio-demographic (68.7% women; M_{age}=78.0; SD_{age}=9.0), clinical, and pain-related characteristics.

At T3, 133 individual participated in the third wave of data collection. Since T2, seventeen dropouts occurred: twelve participants were absent due to disease, three refused to

participate (e.g., felt tired and/or did not want to answer to any questions) and one person had died. Also at T3 the sample (70.5% women; M_{age}=78.3; SD_{age}=9.1) did not significantly differ from the samples at T1 and T2, concerning socio-demographic and pain-related variables.

2.2. Measures

2.2.1. Predictors

Social support for functional autonomy and dependence in pain. To measure the perceived frequency of the staff's SS actions for functional autonomy and dependence when in pain, participants completed the revised Formal Social Support for Autonomy and Dependence in Pain Inventory (FSSADI_PAIN) [43] at Time 1, 2 and 3. This instrument has two subscales. The first subscale is Perceived Promotion of Autonomy (PPA; 4 items), which describes emotional/esteem and instrumental support actions that aim to help older adults to function despite pain [41]. Example items are: *"When I am in pain, the employees at this institution encourage me to trust in my ability to keep on going",* "*When I am in pain, the employees at this institution help me to deal with practical aspects (e.g., transportation, reservations, tickets) so I can participate in activities/social outings"*. The second subscale is Perceived Promotion of Dependence (PPD; 4 items), which describes emotional/esteem and instrumental support actions that undermine older adults' ability to accomplish their daily activities autonomously and despite pain [41]. Example items are: "*When I am in pain, the employees at this institution bring me everything so that I don't need to move", "When I am in pain, the employees at this institution tell me not to push myself when I feel unable of handling certain issues"*. The rating scale ranged from 1 (not at all frequent) to 5 (extremely frequent). The revised FSSADI_PAIN presented very good psychometric properties (α_{PPA} = .88; α_{PPD} = .83) [43]. In the present study, both factors showed excellent internal consistency at all measurement points (all alphas above .95). The scores for perceived promotion of

autonomy and perceived promotion of dependence were calculated by computing the average of the respective four items. Higher scores represented higher perceived promotion of autonomy and dependence, respectively.

2.2.2. Mediators

2.2.2.1. Physical functioning

Self-reported physical functioning. To measure self-reported ability to perform daily physical activities, participants answered five items of the physical functioning scale of the Medical Outcomes Study - Short Form 36v2 (SF-36v2) [80], validated for the Portuguese population by Ferreira [22,23], at Time 1, 2 and 3**.** Only the five items (out of 10) that were relevant to older adults' daily context and routines at day-care centers were administered. Participants were asked about their ability to: a) do moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf; b) climb one flight of stairs; c) bend, kneel, or stoop; d) walk one block; e) bathe or dress. Items were answered on a scale ranging from 1 to 3 (1 = yes, limited a lot; 2 = yes, limited a little; 3 = No, not limited at all). The Portuguese version of this scale has good psychometric properties ($\alpha = .87$) [23]. In the present study, this scale presented good internal consistency at all measurement points (all alphas above .93). Participants' answers to the items were transformed into a final score that ranged from 0 (lowest ability) to 100 (highest ability) to perform daily physical activities.

Observed physical functioning

Lower body strength. To measure lower-body strength, participants performed the physical task "30-s chair stand" from the Senior Fitness Test [62,63], at Time 2 and 3. This physical task involved performing full stands in thirty seconds with the arms folded across

the chest. The total number of full stands corresponded to the final score. Higher numbers of full stands represented higher levels of lower-body strength.

Agility. To measure agility, participants performed the physical task "8-foot up-and-go" from the Senior Fitness Test [62,63], at Time 2 and 3. This task involved getting up from seated position, walk 8 feet (≈ 2 meters and 44 centimeters), turn, and return to seated position, on the chair. The score was obtained by the time, in seconds, needed to walk the 8 feet. Consequently, higher agility scores represented more time elapsed and, therefore, lower levels of agility.

2.2.2.2. Pain-related self-efficacy

To measure pain-related self-efficacy, participants were asked to complete, at T2 and T3, the Pain Self-Efficacy Questionnaire (PSEQ) [51], validated for the European-Portuguese population by Ferreira-Valente, Pais-Ribeiro, & Jensen [21]. Participants rated their pain-related self-efficacy beliefs to engage in daily activities despite pain (*e.g., I can enjoy things, despite pain; I can cope with my pain in most situations*) on a scale from 0 (not at all confident) to 6 (completely confident). The Portuguese version presented good psychometric properties (α= .88; [21]). In the present study, the scale showed very good internal consistency, at both measurement points (all alphas above .96). Scale scores were obtained by summing the scores on the 10 items (ranging from 0 to 60). Higher scores indicated stronger self-efficacy beliefs.

2.2.2.3. Pain-related fear

To measure pain-related fear, participants were presented, at T2 and T3, with the Tampa Scale for Kinesiophobia (TSK [35]), validated for the Portuguese population by Cordeiro and colleagues [18]. The TSK is a 13-item scale assessing the excessive and debilitating fear of

physical movement and activity (i.e., Kinesiophobia [35]. Participants were asked to rate their agreement with pain-related fear beliefs (e.g., *My body is telling me I have something dangerously wrong; it's really not safe for a person with a condition like mine to be physically active*) on a 4-point Likert scale, ranging from 1 (strongly disagree) to 4 (strongly agree). The Portuguese version of the TSK has good psychometric properties (α= .88) [18]. The scale showed excellent internal reliability in the present sample at both measurement points (all alphas above .96). A total score was calculated by averaging all item scores; higher scores indicated higher fear of movement/(re)injury.

2.2.3. Moderators

Pain intensity. To measure pain intensity, participants were presented, at T1, T2 and T3, with the pain severity subscale of the Brief Pain Inventory (BPI [12], validated for the Portuguese population by Azevedo and colleagues [3]. Participants were asked to rate their pain severity on a scale from 0 (no pain) to 10 (pain as bad as you can imagine), during the previous week: *e.g. Please rate your pain by circling the number that best describes your pain at its: a) worst, b) least, c) average and d) at the moment*. The Portuguese version has good psychometric properties (α= .98) [3]. In this study, the pain severity scale showed good internal consistency indices at all measurement points (all alphas above .87). The scores for pain intensity were obtained by averaging all item scores; higher scores reflected higher pain intensity.

Pain duration. To measure pain duration, participants were asked "For how long have you been feeling your pain?". Participants' answers were transformed into months.

2.2.4. Outcome variable

Pain-related disability. To measure pain-related disability, participants were presented, at T1, T2 and T3, with the pain interference subscale of the Brief Pain Inventory (BPI) [12], validated for the Portuguese population by Azevedo and colleagues [3]. Participants were asked to rate how pain had interfered, in the previous week, with their general activity/mood/walking ability/normal work/relations with other people/sleep/enjoyment of life, from 0 (does not interfere) to 10 (completely interferes). The Portuguese version has good psychometric properties (α= .84) [3]. In this study, the pain interference scale showed good internal consistency indices at all measurement points (all alphas above .86). The scores for pain-related disability were obtained by averaging all item scores; higher scores reflected higher levels of pain-related disability.

2.3. Procedure

The data presented in this paper are part of a large-scale study on the effects of pain-related SS on older adults' chronic pain-related disability. Other parts of the collected data are available in Matos, Bernardes, Goubert, & Beyers [44].

The present study followed the ethical principles and code of conduct of psychologists concerning research [1,53] and was reviewed and approved by the Ethical Committee of the hosting institution - ISCTE-Instituto Universitário de Lisboa. Furthermore, the boards of all institutions that hosted the data collection approved the research protocol.

Eleven day-care centers were invited to participate in the study on the basis that they were non-profitable organizations and offered several services for older adults: social outings, physical exercise, counselling, meals, help with personal hygiene, laundry and transportation. Generally, older adults attend the day-care center from Monday to Friday, between 4 to 7

hours a day, mainly due to functional disabilities and/or social isolation (so that they were not home alone). Typically, there was a ratio of two caregivers and one director to 30 older adults.

A formal approval of the research protocol was requested to each institutional board, after providing information on: the purpose of the study, expected duration of individuals' participation, description of the procedures (e.g., how participants would be approached, content of questionnaires), identification of potential risks (e.g., becoming tired) and benefits (e.g., enjoying talking to a new person), potential outcomes of the research, and contact details of the research team and of the hosting institution. Furthermore, institutional boards were informed that all data (both individual and institutional) were confidential and anonymous and that participation was voluntary (i.e., with no consequences for individuals who refused to participate or withdrew at any point). Only nine institutions accepted the invitation. One refusal was due to the length of the protocol and the other to the fact that the institution had, very recently, hosted a data collection procedure that was very tiresome for the attendants.

After the institutional board consent, participants were recruited (according to the inclusion criteria) with the help of the day-care center' director and clinical staff. They identified older adults who: were able to read and write autonomously, had not been previously diagnosed with dementia or other cognitive impairments, and were users of the institution for at least 6 months. Subsequently, the researcher (MM) individually screened each older adult (previously identified) for the presence of current musculoskeletal chronic pain (i.e., felt last week). The screening for chronic pain followed the methodological strategy of other (chronic) pain epidemiological studies [8,74], by using yes-or-no questions. More specifically, the questions were: (1) "*Have you ever had constant or intermittent pain for more than three consecutive months?*" (2) "*Did you feel this pain last week?*" and (3) "*Did you feel any pain last week?*". In addition, the presence of musculoskeletal pain was

assessed by asking older adults where their pain was located. Older adults were only included if they reported pain in at least one of the following body locations: muscles, ligaments, joints, tendons and/or bones. After checking for all of the above-mentioned inclusion criteria, older adults were invited to participate in a study on the topic of pain-related SS. Prior to data collection each participant was informed about the purpose of the study, the expected duration, the confidential and anonymous treatment of all data, and that participation was voluntary with no consequences for the participant if he/she refused to participate or withdrew at any point. Upon agreement to participate and prior to data collection, participants signed a written informed consent, containing all above information. At T1, all older adults who were approached accepted to take part in the study. However, two participants were excluded from the sample because they rated their pain intensity at T1 as 0, which was incongruent with the screening for the presence of current musculoskeletal chronic pain (having felt chronic pain last week).

Data collection occurred at three different time points, with a six-week lag in-between. At time 1, all participants completed the revised version of the FSSADI_PAIN, the Portuguese version of the BPI, the SF-36v2 and a questionnaire assessing socio-demographic and clinical characteristics. At time 2 and 3, participants filled out the revised FSSADI_PAIN and the Portuguese versions of the BPI, the SF-36v2, the PSEQ and the TSK; and performed the physical tasks. To facilitate the participation of seniors with low levels of education or visual impairments, the data collection protocols were all administered individually and in face-to-face interviews, conducted by the first author (M.M.) in a quiet room of the institution. On average, each interview took about 35 minutes. After the data collection, all participants and institutions were thanked and orally debriefed.

2.4. Data Analysis

First, using IBM SPSS v22 [32] we analyzed the descriptive statistics of the sample and the distribution of the variables in the models to be tested. Since none of the variables in the models presented a normal distribution (see Table 2), a non-parametric bootstrapping approach was used in the mediation and moderated-mediation analyses [58].

Second, we analyzed Spearman correlations between the model variables. Furthermore, using ANOVA tests, t-tests, and Spearman correlations we examined the relationships between these variables and participants' pain-related characteristics (number of pain locations and pain location) and socio-demographic characteristics (sex, age, education level, marital status, institution and duration of attendance). Since no significant relationships were found, socio-demographic and clinical variables were not included in the remaining analyses.

Third, using the PROCESS macro [28] in IBM SPSS v22 [32], four multiple mediation models were tested: Model 1, with perceived promotion of autonomy as the predictor representing the behavioral pathway (physical functioning variables, Figure 1, paths 1 and 2); Model 2, with perceived promotion of dependence as the predictor representing the behavioral pathway (physical functioning variables, Figure 1, paths 1 and 2); Model 3, with perceived promotion of autonomy as the predictor representing the psychological pathway (pain-related self-efficacy and fear; Figure 1, paths 1 and 3); and Model 4, with perceived promotion of dependence as the predictor representing the psychological pathway (pain-related self-efficacy and fear; Figure 1, paths 1 and 3). A bootstrapping approach was used to test the indirect effects from a 5000 estimate and 95% bias corrected confidence intervals, using the cut-offs for the 2.5% highest and lowest scores of the empirical distribution. The indirect effects were considered significant when the confidence interval did not include zero.

Finally, also using the PROCESS macro [28] in IBM SPSS v22 [32], moderated-mediation analyses were conducted using pain duration and pain intensity as the moderators, respectively. The interpretation of moderated-mediation was done: by (1) examining the significance of the B estimates (unstandardized regression coefficients) of the indirect effects at different values of the moderators (i.e., –1SD, Mean, +1SD); and (2) by confirming the significance of the index of moderated mediation [29], which allowed confirming the moderated-mediation. For both procedures, their significance was inferred by the observation of the bias corrected 95% confidence interval using the cut-offs for the 2.5% highest and lowest scores of the empirical distribution. When the confidence interval did not include zero, the coefficients (B estimates and the index of moderated mediation) were deemed significant.

3. Results

3.1. Descriptive analyses and variable distribution

Table 2 shows the descriptive statistics and distribution of all variables in the study. Regarding the predictors, participants reported moderately frequent promotion of autonomy and infrequent promotion of dependence. Concerning the mediators, participants showed low levels of self-reported and observed physical functioning, namely, low lower-body strength and agility, moderate levels of pain-related self-efficacy and low to moderate levels of pain-related fear. As for the moderators, participants reported low mean levels of pain intensity and an average pain duration of 7.40 years. Finally, for the outcome variable, participants reported, on average, a low level of pain-related disability.

Since none of the variables followed a normal distribution a non-parametric bootstrapping approach was used in the mediation and moderated-mediation analyses. Indeed, some variables – perceived promotion of dependence, pain duration, pain intensity, self-reported physical functioning, lower-body strength, agility and pain-related disability – showed quite an asymmetric distribution (skewness/SE of skewness > 1.96) indicating that participants' answers concentrated on the lower end of the scales. Other variables – perceived promotion of autonomy, pain-related self-efficacy and pain-related disability – showed a flat distribution (kurtosis/SE of kurtosis <-1.96). Finally, pain duration, lower-body strength, agility and pain-related fear showed a leptokurtic distribution (kurtosis/SE of kurtosis > 1.96).

Table 2 – Descriptive statistics and distribution of all model variables

		Min	Max	Mean	SD	Skewness/SE	Kurtosis/SE	K-S
Predictors (T1)	Perceived Promotion of Autonomy	1	5	2.88	1.32	-1.23	-3.18	.000
	Perceived Promotion of Dependence	1	5	1.81	.91	4.83	0.34	.000
Moderators (T1)	Pain Duration	3	624	88.9	121.01	13.68	18.29	.000
	Pain Intensity	.025	10	3.01	1.94	4.63	1.47	.000
Mediators (T2)	Self-reported physical functioning	0	100	31.68	33.1	3.84	-1.39	.000
	Lower body strength[1]	0	20	4.51	3.53	5.51	5.75	.000
	Agility[2]	3.14	54.6	14.5	6.5	9.91	5.50	.000
	Pain-related Self-Efficacy	0	60	33.85	19.38	-1.36	-2.98	.000
	Pain-related Fear	1	4	2.29	.59	-.05	2.89	.000
Outcome (T3)	Pain-related disability	0	10	3.79	3.23	2.57	-2.12	.000

Note. [1]24 participants were not able to perform the lower body strength task; [2]27 participants were not able to perform the agility task; the agility score is reversed, i.e., the higher the score the lower the agility.

3.2. Spearman correlations

Table 3 shows that, except for perceived promotion of autonomy and pain duration (T1), all other variables were significantly correlated with pain-related disability (T3).

Higher pain-related disability (T3) was moderately [13] associated with higher perceived promotion of dependence and pain intensity (T1) and strongly [13] associated with lower self-reported and observed physical functioning (agility and lower-body strength), lower pain-related self-efficacy and higher pain-related fear (T2).

Table 3 – Spearman correlations between all model variables

	Variables	1	2	3	4	5	6	7	8	9
Predictors	1. Perceived Promotion of Autonomy (T1)	--	--	--	--	--	--	--	--	--
	2. Perceived Promotion of Dependence (T1)	.47***	--	--	--	--	--	--	--	--
Moderators	3. Pain duration (T1)	.18*	-.10	--	--	--	--	--	--	--
	4. Pain intensity (T1)	.16*	.32***	-.14	--	--	--	--	--	--
Mediators	5. Self-reported physical functioning (T2)	-.06	-.28**	-.07	-.46***	--	--	--	--	--
	6. Lower-body strength (T2)	-.04	-.12	-.08	-.36***	.56***	--	--	--	--
	7. Agility[1] (T2)	-.16	.01	.04	.26**	-.60***	-.70***	--	--	--
	8. Pain-related Self-Efficacy (T2)	-.05	-.26**	-.03	-.42***	.71***	.47***	-.45***	--	--
	9. Pain-related Fear (T2)	-.05	.13	.07	.15	-.32***	-.28**	.28*	-.36***	--
Outcome	10. Pain-related disability (T3)	.04	.22*	.03	.40***	-.61***	-.51***	.46***	-.67***	.41**

***$p \leq 0.001$ **$p \leq 0.01$ * $p \leq 0.05$; [1]The agility score is reversed, i.e., the higher the score the lower the agility.

3.3. The relationship between perceived promotion of autonomy/dependence and pain-related disability: the mediating role of physical functioning

The longitudinal mediation models included perceived promotion of autonomy/dependence (T1) as the predictors, respectively, pain-related disability (T3) as the outcome variable and self-reported and observed physical functioning (lower-body strength and agility) as the mediators (T2). As shown in Table 4, perceived promotion of autonomy at T1 did not predict pain-related disability at T3 (total effect) nor showed significant effects through any of the behavioral mediators, i.e., self-reported and observed physical functioning (indirect effects).

Perceived promotion of dependence at T1 predicted higher levels of pain-related disability at T3 (total effect) - accounting for 7.0% of its variance ($F_{(1, 124)} = 9.75$, $p = .003$). This relationship was fully mediated by self-reported physical functioning (T2), as shown by the decrease in the unstandardized regression coefficients and the loss of significance of the direct effect of perceived promotion of dependence on pain-related disability (B = .893, $p = .003$ to B =.378, $p = .139$) (see Table 4). The indirect effect of perceived promotion of dependence on pain-related disability through self-reported physical functioning (B=.468) was corroborated by the bias corrected confidence interval of the empirical distribution (95% CI=.230, .782). More specifically, higher perceived promotion of dependence at T1 predicted a higher level of pain-related disability at T3 by decreasing older adults' self-reported physical functioning at T2. The indirect effects of perceived promotion of dependence on pain-related disability through lower-body strength (B=.064; 95% CI=-.060, .214) and agility (B=-.017; 95% CI=-.199, .050) were not significant. Overall, this mediation model accounted for 39.6% of the variance of older adults' pain-related disability at T3, ($F_{(4, 121)} = 19.871$, $p < .001$).

3.4. The relationship between perceived promotion of autonomy/dependence and pain-related disability: the mediating role of pain-related self-efficacy and fear

In these longitudinal mediation models perceived promotion of autonomy/dependence (T1) were the predictors, respectively, pain-related disability (T3) was the outcome variable and pain-related self-efficacy and fear (at T2) were the mediators. As shown in Table 4, perceived promotion of autonomy at T1 did not predict pain-related disability at T3 (total effect) nor showed significant effects through any of the psychological mediators, i.e., pain-related self-efficacy and fear (indirect effects).

Perceived promotion of dependence at T1 predicted higher pain-related disability at T3 (total effect) - accounting for 6.8% of its variance ($F_{(3, 131)} = 9.63$, $p = .002$). This relationship was fully mediated by pain-related self-efficacy (T2), as shown by the decrease in the unstandardized regression coefficients and the loss of significance of the direct effect of perceived promotion of dependence on pain-related disability (B = .897, $p = .002$ to B =.311, p =.167). The indirect effect of perceived promotion of dependence on pain-related disability through pain-related self-efficacy (B=.508; 95% CI=189, .906) was corroborated by the bias corrected confidence interval of the empirical distribution. More specifically, higher perceived promotion of dependence predicted a higher level of pain-related disability by decreasing older adults' pain-related self-efficacy. The indirect effect of perceived promotion of dependence on pain-related disability through pain-related fear was not significant (B=.078; 95% CI=-.006, .251).

Overall, this mediation model accounted for 48.8% of the variance of pain-related disability ($F_{(3\ 129)} = 5.48$, $p < .001$).

Table 4 – The relationship between perceived promotion of autonomy/dependence (T1) and pain-related disability (T3): Multiple mediation models

Outcome (O)	Predictors (P)	Mediators (M)	Effect of P on M (a)	Effect of M on O (b)	Direct Effect (c')	Indirect Effect ab	95%CI	Total Effects (c)
Pain-related disability	Perceived Promotion of Autonomy (Behavioral Path)	Self-reported physical functioning	-2.02	-.046***	.001	.094	-.122;.363	.099
		Lower-body strength	.009	-.203*		-.002	-.110;.096	
		Agility[1]	-2.03	-.003		.006	-.035;.116	
					R^2=.385***			R^2=.002
	Perceived Promotion of Dependence (Behavioral Path)	Self-reported physical functioning	-11.02***	-.042***	.378	**.468**	.230;.782	.893**
		Lower-body strength	-.291	-.219*		.064	-.060;.214	
		Agility[1]	4.14	-.004		-.017	-.199;.050	
					R^2=.396***			R^2=.070**
	Perceived Promotion of Autonomy (Psychological Path)	Pain-related self-efficacy	-.575	-.102***	.104	.058	-.211;.307	.131
		Pain-related fear	-.033	.953*		-.031	-.163;.041	
					R^2=.482***			R^2=.003
	Perceived Promotion of Dependence (Psychological Path)	Pain-related self-efficacy	-5.14**	-.099***	.311	**.508**	.189;.906	.897**
		Pain-related fear	.087	.902*		.078	-.006;.251	
					R^2=.488***			R^2=.068**

* $p<.05$ ** $p<.01$ *** $p<.001$; Values in the table refer to unstandardized regression coefficients (B); [1]The agility score is reversed, i.e., the higher the score the lower the agility; values in bold are significant indirect effects

3.5. Moderating effects of pain duration and intensity on the mediating role of physical functioning

First, pain duration (T1) was included as the moderator. Results showed that pain duration was not a significant moderator of any of the indirect effects of perceived promotion of autonomy/dependence on pain-related disability through self-reported and observed physical functioning (see Table 5).

Pain intensity (T1), however, significantly moderated the effect of perceived promotion of dependence (but not perceived promotion of autonomy) on only one of the mediators (self-reported physical functioning but not lower-body strength nor agility). More specifically, the indirect effect, of perceived promotion of dependence on pain-related disability (T3) through the level of self-reported physical functioning, was only significant at low (-1SD; B=.809, SE=.249, 95% CI=.384, 1.37) and moderate (Mean; B=.391, SE=.144, 95% CI=.147, .726) levels of pain intensity but not when pain was most severe (+1SD; B= -.027, SE=.129, 95% CI=-.286, .232). The moderator effect of pain intensity was corroborated by the index of moderated mediation (B=-.207, SE=.068, 95% CI=-.355, -.086), as shown in Table 5. No other indirect effects through the behavioral pathway were moderated by pain intensity.

3.6. Moderating effect of pain duration and pain intensity on the mediating role of pain-related self-efficacy and fear

First, pain duration (T1) was included as the moderator. Results showed that pain duration significantly moderated the effect of perceived promotion of dependence (but perceived promotion of autonomy) on only one of the mediators (pain-related self-efficacy

but not pain-related fear). Specifically, the indirect effect of perceived promotion of dependence on pain-related disability through self-efficacy was only significant at low (-1SD; B=.898, SE=.232, 95% CI=.474, 1.40) and moderate levels of pain duration (Mean; B=.504, SE=.181, 95% CI=.177, .900) but not at higher levels of pain duration (+1SD; B=-.054, SE=.282, 95% CI=-.589, .525). The moderated mediation was corroborated by the index of moderated mediation (B=-.005, SE=.002, 95% CI=-.008, -.001). No other indirect effects through the psychological pathway were significantly moderated by pain duration.

Second, pain intensity (T1) was included as the moderator. Results showed that pain intensity significantly moderated the effect of perceived promotion of dependence (but not perceived promotion of autonomy) on only one of the mediators (pain-related self-efficacy but not pain-related fear). More specifically, the indirect effect of perceived promotion of dependence on pain-related disability through self-efficacy was only significant at lower (-1SD; B=.896, SE=.266, 95% CI=.337, 1.42) and moderate levels of pain intensity (Mean ; B=.431, SE=.167, 95% CI=.100, .787) but not at higher levels of pain intensity (+1SD; B=-.034, SE=.219, 95% CI=-.434, .421). The moderator effect of pain intensity was corroborated by the index of moderated mediation (B=-.234, SE=.089, 95% CI=-.389, -.059), as shown in Table 5. No other indirect effects through the psychological pathway were significantly moderated by pain intensity.

Table 5 - Conditional indirect effects of perceived promotion of autonomy/dependence on pain-related disability: at three levels of pain duration and intensity

	Pain Duration				Pain Intensity			
Outcome: Pain-related disability	IMM	Low	Moderate	High	IMM	Low	Moderate	High
Indirect effects of perceived promotion of autonomy through:								
self-reported physical functioning	.000	.094	.097	.101	-.067	.114	-.023	-.159
lower-body strength	.000	.003	-.003	-.010	.000	-.036	-.036	-.036
agility[1]	.000	.007	.005	.004	-.004	.015	.007	.000
Indirect effects of perceived promotion of dependence through:								
self-reported physical functioning	-.001	.571	.464	.317	**-.207**	.809	.391	-.027
lower-body strength	.000	.058	.064	.072	.020	-.097	-.056	-.016
agility[1]	.000	-.022	-.016	-.007	-.007	.007	-.007	-.021
Indirect effects of perceived promotion of autonomy through:								
pain-related self-efficacy	-.003	.255	.022	-.308	-.132	.181	-.082	-.344
pain-related fear	.000	-.036	-.025	-.006	.015	-.078	-.047	-.016
Indirect effects of perceived promotion of dependence through:								
pain-related self-efficacy	**-.005**	.898	.504	-.054	**-.234**	.896	.431	-.034
pain-related fear	.000	.058	.074	.097	.023	-.025	.021	.067

Note. IMM=Index of moderated mediation: Values in bold are IMM values, i.e, when the 95% confidence interval did not include the zero; Low/Moderate/High values correspond to unstandardized regression coefficients; [1]The agility score is reversed, i.e., the higher the score the lower the agility; values in bold are significant indirect effects

4. Discussion

This study investigated the (in)direct effects of formal pain-related SS for functional autonomy/dependence on older adults' pain-related disability. Our first aim was to investigate whether perceived promotion of autonomy (T1) would predict a decrease in pain-related disability (T3), and whether perceived promotion of dependence (T1) would predict an increase (T3).

Contrary to expectations, perceived promotion of autonomy at baseline did not predict older adults' pain-related disability after twelve weeks. The association between perceived promotion of autonomy and lower pain-related disability has been inconsistently supported [41,42], suggesting that it might be dependent on other factors, such as recipient's needs [40] or support preferences [5,9,46,47]. For example, this effect might only exist for people who prefer this type of support, but not for those who would prefer support for functional dependence.

As expected, perceived promotion of dependence at baseline predicted older adults' higher pain-related disability after twelve weeks. This confirms, longitudinally, previous cross-sectional results [41,42] and it is congruent with research showing a positive association between solicitousness, and pain-related disability [34,65,64,66]. This study is, to the best of our knowledge, the only one that provides support for the detrimental influence of pain-related support for functional dependence on older adults' pain-related disability across time.

Our second aim was to investigate the role of behavioral (physical functioning) and psychological (pain-related self-efficacy and fear) mechanisms in accounting for the influence of perceived promotion of autonomy/dependence on pain-related disability. First, contrary to expectations, perceived promotion of autonomy did not influence pain-related disability through behavioral or psychological mechanisms. This raises the possibility that

perceived promotion of autonomy, rather than influencing pain-related disability through (in)direct pathways, might act as a buffer [44,14,15,30,36,81]. Indeed, it has been shown that spouse distracting responses buffered the negative impact of pain intensity on pain-related disability [26,27].

As expected, perceived promotion of dependence predicted higher levels of pain-related disability by decreasing older adults' self-reported (but not observed) physical functioning, corroborating previous cross-sectional findings [43,42]. These findings are partially in line with studies demonstrating associations between SS and self-reported physical functioning of individuals with other chronic diseases [39,70], and between solicitousness and worse self-reported functioning [66]. Furthermore, these results corroborate the operant conditioning model [24] that argues that support from others can reinforce pain behaviors and activity avoidance, and the fear-avoidance model [79,37] that established that avoiding activity has detrimental effects on pain-related disability.

The reasons as to why observed physical functioning scores, despite strongly correlated with self-reported physical functioning, were not associated with perceived promotion of dependence nor mediated its relationship with pain-related disability are unclear. Scores of observed physical functioning were highly asymmetric and, although non-parametric approached have been used, floor effects might have contributed to the lack of association with pain-related SS. It is also possible that this pattern of results is partly due to common-method variance (between self-report measures) and/or the lack of ecological validity of the physical tasks; which were not executed within older adults' normal daily activities. Future research could incorporate observational measures of physical functioning within older adults' daily living contexts, for example using ambulatory activity monitoring [10], or include different informants on physical functioning measures [57] to overcome these potential biases.

Regarding the psychological mechanisms, as expected, perceived promotion of

dependence (T1) predicted higher pain-related disability (T3), by decreasing older adults' pain-related self-efficacy. This is consistent with the argument that SS can have detrimental effects on health-related outcomes by disenabling self-efficacy [4], resulting in activity disengagement when in pain [75], ultimately predicting higher pain-related disability.

Pain-related fear did not mediate the effect of perceived promotion of dependence on pain-related disability, mainly because perceived promotion of dependence at baseline did not predict higher pain-related fear six weeks later (T2). This might be due to the fact that older adults generally reported feeling pain for a long time. Since pain-related fear is an important predictor of how acute pain transforms into chronic pain (by avoiding activity), the influence of pain-related SS on pain-related fear might be more relevant in the acute stages of pain experiences. More research is needed on the relationship between pain-related SS and fear over the different stages of development of chronic pain.

Our final aim was to examine whether pain duration and intensity moderated the effects of perceived promotion of autonomy/dependence on pain-related disability through the behavioral and psychological paths. Only indirect effects of perceived promotion of dependence (but not perceived promotion of autonomy) on pain-related disability where moderated by pain duration and pain intensity. More specifically, findings showed that only for older adults with short to moderate pain duration (i.e. below average pain duration of 7.40 years), but not for those who reported longer pain duration (i.e., above + 1SD, namely, 17.28 years), perceived promotion of dependence predicted an increase in pain-related disability, through the decrease of pain-related self-efficacy. Similarly, only for those who reported low to moderate levels of pain intensity (i.e., below average pain intensity of 3.08, on a scale from 0 to 10), but not for those with higher levels of pain intensity (i.e., above + 1 SD, namely 5.10), perceived promotion of dependence predicted an increase in pain-related disability, through the decrease of self-reported physical functioning and pain-related self-efficacy. In

sum, these results demonstrate that for people with shorter and less intense pain experiences, perceived promotion of dependence is a risk factor. However, when pain is more intense and/or longer, perceived promotion of dependence does not influence pain-related disability. This is congruent with the stronger association found in earlier research between catastrophizing and perceived partner solicitousness among individuals with shorter pain duration [11]. Perhaps, for people with more severe pain experiences other factors might be important to deal with pain-related disability, e.g., psychological flexibility [45]. An alternative explanation might be that people with longer pain duration and more severe pain might be receiving SS from other sources (*e.g.*, hospitals, pain units or even informal sources) that were not accounted for in the present study.

4.5. Limitations and directions for future research

Limitations should be pointed out to inform further research on the topic.

First, this study did not include measures of distress (*e.g.*, depression, anxiety), which is often a central dimension of pain experiences [52] that might influence self-reports of SS [6]. Therefore, future research on psychosocial determinants of pain-related disability should incorporate distress measures.

Second, although bivariate tests showed no significant differences between institutions on the variables of the models, sampling limitations did not allow us to account for the nested nature of the data of individuals within institutions. Institutions may indeed present different characteristics that may influence SS interactions (e.g., staff/attendant ratio). Therefore, future multicentre studies should be able to account for the nested nature of the data.

Third, future research should consider performing cross-lagged analyses to ascertain whether the baseline level of physical functioning, pain-related self-efficacy and fear

influenced the type/frequency of pain-related SS for functional autonomy/dependence, since individual pain-related (behavioural and psychological) functioning might elicit different kinds of pain-related SS.

Finally, this study focused exclusively on older adults who attended day-care centers instead of other types of formal care institutions like nursing homes or residential long-term care. Therefore, the present sample was comprised of relatively functional older adults who were living at home and possibly had relevant informal SS networks. This raises the question of whether the present results could be generalized to a more heterogeneous sample of older adults, namely, older adults with lower levels of functional autonomy who mostly relied on formal sources of support.

4.6. Theoretical and practical implications

The present research proposes and empirically supports an innovative conceptualization of different functions of pain-related SS. Moreover, its longitudinal design allowed drawing conclusions about the temporal relationship between perceived promotion of dependence and pain-related disability, and highlights that it is a risk factor for older adults in pain. Furthermore, this is one of the few longitudinal studies that examined behavioral and psychological mechanisms accounting for the effects of formal pain-related support on pain-related disability.

From a practical perspective, the present findings have the potential to inform the development of future training programs for formal caregivers. Such programs could raise caregivers' awareness about the detrimental effects of promoting older adults' functional dependence when they are in pain. The present results also emphasize that pain-related SS has highest relevance in the context of relatively recent and less severe pain experiences. Caregivers should aim at the provision of individual and tailored care, targeting the

maintenance of physical/social functioning and activity engagement in order to prevent pain-related disability. Overall, caregiver practices should promote healthy ageing and well-being despite chronic pain.

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