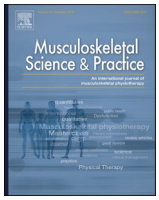
Musculoskeletal Science and Practice 63 (2023) 102723

Contents lists available at ScienceDirect

Musculoskeletal Science and Practice

journal homepage: www.elsevier.com/locate/msksp



Original article

Social determinants of health and physical activity are related to pain intensity and mental health in patients with carpal tunnel syndrome

Rodrigo Núñez-Cortés [a,b,c], Carlos Cruz-Montecinos [a,b,d], Serghio Torreblanca-Vargas [e], Lars Louis Andersen [f], Claudio Tapia [b], Maritza Ortega-Palavecinos [c], Rubén López-Bueno [f,g,h], Joaquín Calatayud [f,g,*], Sofía Pérez-Alenda [a]

[a] Physiotherapy in Motion Multispeciality Research Group (PTinMOTION), Department of Physiotherapy, University of Valencia, Valencia, Spain
[b] Department of Physical Therapy, Faculty of Medicine, University of Chile, Santiago, Chile
[c] Section of Clinical Research, Hospital Clínico La Florida, Santiago, Chile
[d] Section of Research, Innovation and Development in Kinesiology, Kinesiology Unit, San José Hospital, Santiago, Chile
[e] Service of Rehabilitation, Hospital Provincia Cordillera, Santiago, Chile
[f] National Research Centre for the Working Environment, Copenhagen, Denmark
[g] Exercise Intervention for Health Research Group (EXINH-RG), Department of Physiotherapy, University of Valencia, Spain
[h] Department of Physical Medicine and Nursing, University of Zaragoza, Zaragoza, Spain

ARTICLE INFO

Keywords:
Nerve compression syndromes
Educational level
Socioeconomic factors
Depression
Anxiety
Preoperative period

ABSTRACT

Background: Carpal tunnel syndrome (CTS) is the most common peripheral neuropathy of the upper limb and a frequent cause of disability.
Objective: To analyze the association between social determinants of health (SDH) and physical activity with pain intensity and mental health in patients with CTS.
Design: A cross-sectional study was conducted in patients with CTS awaiting surgery in two public hospitals in Chile.
Methods: The SDH collected included: employment status, educational level and monetary income. The level of physical activity was defined according to compliance with WHO recommendations. Outcome measures included: Pain intensity (Visual Analog Scale), Symptoms of anxiety and depression (Hospital Anxiety and Depression Scale), and catastrophic thinking (Pain Catastrophizing Scale). The adjusted regression coefficient (β) for the association between SDH and physical activity with each outcome was obtained using multivariable linear regression models controlling for age, sex, body mass index and symptom duration.
Results: Eighty-six participants were included (mean age 50.9 ± 10 years, 94% women). A high level of physical activity was associated with a 12.41 mm decrease in pain intensity (β = −12.41, 95%CI: −23.87 to −0.95) and a 3.29 point decrease in depressive symptoms (β = −3.29, 95%CI: −5.52 to −1.06). In addition, being employed was associated with a 2.30 point decrease in anxiety symptoms (β = −2.30; 95%CI: −4.41 to −0.19) and a high educational level was associated with a 7.71 point decrease in catastrophizing (β = −7.71; 95%CI: −14.06 to −1.36).
Conclusion: Multidisciplinary care teams should be aware of the association between SDH and physical activity with physical and mental health.

1. Introduction

Carpal tunnel syndrome (CTS) is a symptomatic condition caused by compression of the median nerve and is the most common peripheral neuropathy of the upper limb and a frequent cause of disability (Aroori and Spence, 2008; Nora et al., 2005; Núñez-Cortés et al., 2022). Population prevalence ranges from 6.3% to 11.7% and is more frequent in women (Dale et al., 2013; Thiese et al., 2014). Patients with CTS often present pain, paraesthesias and tingling sensations in the region of the median nerve, resulting in a significant impairment of quality of life and physical function (Bickel, 2010; Thiese et al., 2014). In severe cases with persistent hypoaesthesia and motor impairment, carpal tunnel release

* Corresponding author. C/ Gascó Oliag 5. PC, 46010, Valencia, Spain.
E-mail address: joaquin.calatayud@uv.es (J. Calatayud).

https://doi.org/10.1016/j.msksp.2023.102723
Received 26 October 2022; Received in revised form 24 January 2023; Accepted 30 January 2023
Available online 31 January 2023

(CTR) is usually indicated (Chandra et al., 2013). Literature has demonstrated that symptom severity and pain may be modulated by different social and mental health variables such as anxiety, depression and catastrophizing (De et al., 2013; Jerosch-Herold et al., 2017; Nunez et al., 2010). In addition, a recent meta-analysis concluded that depressive symptoms, anxiety, and catastrophic thinking were important indicators of poor postoperative outcomes in CTR (Núñez-Cortés et al., 2021). Likewise, it has been reported that social determinants of health (SDH) and physical activity may be related to mental health in several musculoskeletal and neurological diseases (Kim, 2014; Strube et al., 2019; Tan et al., 2014; Tawashy et al., 2009). However, little information exists about how the SDH and physical activity affects the mental health variables in CTS. Furthermore, a recent scoping review identified that physiotherapists lack the confidence and ability to identify psychosocial factors (Henning and Smith, 2022). Therefore, the approach to patients with CTS requires a broader understanding of how the SDH and physical activity may affect their health (physical and psychological), moving away from the biomedical bubble (The Lancet, 2018).

The SDH include the conditions in which people are born, grow, live, learn, work and age, as well as the social inequalities that are responsible for disparities in health outcomes (e.g., educational level, income and occupational status) (WHO Commission on Social Determinants of HealthWorld Health Organization, 2008). The literature has shown that SDH, such as low educational level, are related to negative beliefs associated with pain in women with CTS (i.e., catastrophizing) (Núñez-Cortés et al., 2020). Adults with pain who have a low level of education may also be less likely to exhibit good mental health (Axon and Chien, 2021). On the other hand, SDH such as low educational level and unemployment were associated with higher levels of pain in patients with musculoskeletal disorders in the shoulder and low back region (Fliesser et al., 2017; Karran et al., 2020; Strube et al., 2019). A recent meta-analysis found that low socio-economic status (in terms of educational level, income or occupational status) had a moderate association with increased risk of chronic pain, albeit none of the included studies focused on patients with painful hand conditions (Prego-Domínguez et al., 2021).

On the other hand, physical activity (as a lifestyle indicator) is an environmental health behavior that could also be influenced by SDH (Gidlow et al., 2006), such as having the financial means to sign up for an exercise class or having the appropriate education or health literacy to understand the benefits of physical activity. Physical activity has been shown to have a protective relationship for mental health among adults (Choi et al., 2019) and promotes positive coping strategies (e.g. self-efficacy) (Kandola et al., 2019). In addition, in other neurological conditions (e.g., spinal cord injury), whereas healthier lifestyles (e.g., higher physical activity) were associated with lower levels of pain and depressive symptoms (Tawashy et al., 2009).

Clinical assessment of more severe CTS cases (e.g. those awaiting surgery) should also take full account of social stressors, especially their impact on pain, depression, and anxiety. However, it is not fully known whether SDH and physical activity may be related to pain intensity, mental health and catastrophizing in CTS patients awaiting surgical intervention (i.e, CTR). Therefore, a preoperative assessment of these variables could be useful to identify the most vulnerable individuals and thus develop more specialized perioperative interventions to reduce pain and improve mental health. The aim of our study was to analyze the association between SDH and physical activity with pain intensity and mental health in patients with CTS awaiting surgery.

2. Methods

2.1. Study setting, design and participants

A cross-sectional study was conducted in patients with CTS who were awaiting surgery in two public hospitals in Chile (Hospital Clínico La Florida and Hospital Provincia Cordillera), between February and July 2022. Both institutions were located in an urban area composed mainly of families of middle socioeconomic status. Inclusion criteria were the following: over 18 years of age, medical diagnosis of moderate or severe CTS according to the clinical practice guideline of the Academy of Orthopaedic Physical Therapy and the Academy of Hand and Upper Extremity Physical Therapy (i.e. history, medical examination and tests/measurements) (Erickson et al., 2019), remain on the hospital's official waiting list for CTR for at least 3 months or more, and accept to participate in the study. Exclusion criteria were: inability to understand instructions (e.g. illiteracy), neurological conditions of the central nervous system (e.g. stroke, spinal cord injury), and previous surgery in the upper limb. The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board of the two participating hospitals. Written informed consent was obtained from all participants after explanation of the objectives of the study. This study was conducted in accordance with the guidelines "Strengthening the Reporting of Observational Studies in Epidemiology" (STROBE) (von Elm et al., 2014).

2.2. Social determinants of health

Participants were interviewed face-to-face at each hospital. Data collected included: I) Employment status: employed versus unemployed (only for working-age participants); II) Educational level: participants were assigned to the lower educational level if they had not completed secondary education and to the higher educational level if they had completed secondary education or university studies; III) Monetary income was categorized according to individual monthly taxable income. The cut-off point was set at a value equal to or less than USD 320, which determines the degree of coverage provided by the Chilean public health system.

2.3. Physical activity

Participants reported the minutes and type of physical activities (moderate or vigorous) they performed as part of their daily life during the last seven days. Participants were classified according to the recommendations of the World Health Organization (WHO) 2020 guidelines on physical activity (Bull et al., 2020). Therefore, a level $\geq$150 min of moderate-intensity physical activity per week, or $\geq$75 min of vigorous-intensity physical activity per week, was used as the cutoff point (high vs. low level) (Bull et al., 2020).

2.4. Outcomes

Outcome measures included the following self-report assessments: I) Pain intensity, assessed using the Visual Analog Scale (VAS), a valid and reliable measure for pain assessment and widely used in patients with CTS (Ceceli et al., 2018; Kahl and Cleland, 2005). Participants were asked to rate their average pain during the seven days prior to assessment on a scale defined from 0 to 100 mm, where 0 is "no pain" and 100 is "the worst pain imaginable". II) Mental health, assessed with the Spanish version of the Hospital Anxiety and Depression Scale (HADS) (Herrero et al., 2003), which evaluates the level of anxiety and depression by means of two subscales of 0–21 points each. Higher values represent a worse outcome. In addition, catastrophic thinking in response to pain was assessed using the Spanish version of the Pain Catastrophizing Scale (PCS) (García Campayo et al., 2008). PCS has 13 items of four possible choices from 1 ″not at all" to 4 ″all the time," a higher score indicating greater catastrophic thinking, with a maximum score of 52 points (Sullivan et al., 1995).

2.5. Covariates

Data collected included: I) Sociodemographic variables (age and

sex); II) Body Mass Index was obtained from the ratio between weight and height squared (kg·m^2); III) Duration of symptoms associated with CTS (years).

2.6. Sample size

The sample size calculation was determined by considering a minimum of 10 participants for each independent variable entered in the multivariable linear regression. Considering a total of eight independent variables (four exposure factors and four covariates), the minimum sample size was set at 80 patients. Post-hoc power was calculated in the G*Power software, version 3.1.9.2 (Universität Düsseldorf, Germany) using the statistical test of multiple linear regression, one-tailed with an α err prob = 0.05. The post-hoc power was >80% for each of the models tested.

2.7. Statistical analyses

The normality of the data was tested using the Shapiro-Wilk test. Means and standard deviations (SD) were calculated for quantitative variables and percentages for categorical variables. For the employment status variable, only cases of working age (n = 75) were considered for the analysis. Considering the aim of our study, multivariable linear regression analysis was performed for each dependent variable (pain intensity, depressive symptoms, anxiety symptoms, catastrophizing). Dummy codes were used for the exposure factors, and unemployed, low educational level, low income and low physical activity were established as reference categories. Multivariable linear regression analysis examined the association of each of the exposure factors (educational level, employment status, monetary income, and physical activity) with each outcome (pain intensity, depressive symptoms, anxiety symptoms, catastrophizing), while controlling for each of the other exposure factors (i.e., mutually adjusted) and possible confounders (age, sex, body mass index, and symptom duration). For each analysis, the crude and adjusted regression coefficient (β) was obtained, with a 95% confidence interval (95% CI). All statistical analyses were performed in SPSS version 22.0 (IBM Corporation, Armonk, New York). Statistical significance was set at $p < 0.05$.

3. Results

A total of 92 patients were assessed for eligibility. Six participants were excluded for the following reasons: refusal to participate (n = 4), previous upper extremity surgery (n = 2). Finally, a total of 86 subjects were included in this study (Fig. 1). Ninety-four percent were women and the mean age was 50.9 ± 10 years. The mean duration of symptoms was 3.2 ± 2.5 years. The socio-demographic data, the SDH and the outcomes of the total sample are summarised in Table 1.

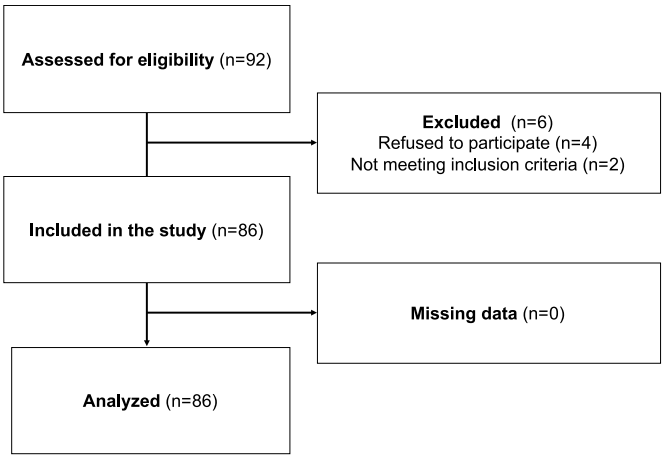


Fig. 1. Patient flow diagram.

Table 1
Characterization of patients (n = 86).

Characterics	Value
Age (years)	50.9 ± 10.0
Sex	
Male	5 (5.8%)
Female	81 (94.2%)
BMI (kg/m^2)	31.7 ± 6.2
Duration of CTS (years)	3.2 ± 2.5
Educational level	
Low level	43 (50%)
High level	43 (50%)
Employment status	
Unemployed	31 (36.0%)
Employed	44 (51.2%)
Non-working age	11 (12.8%)
Monetary Income	
≤320 USD	49 (57%)
>320 USD	37 (43%)
Physical Activity	
Low level	66 (76.7%)
High level	20 (23.3%)
VAS (0–100)	66.0 ± 20.8
HADS-D (0–21)	8.0 ± 4.5
HADS-A (0–21)	9.0 ± 4.2
PCS (0–52)	27.3 ± 13.0

Abbreviations: BMI, Body Mass Index; HADS, Hospital Anxiety and Depression Scale (D, depression; A, anxiety); PCS, Pain Catastrophizing Scale; USD, US dollar; VAS, Visual Analog Scale. Data are expressed as percentages or mean ± SD.

3.1. Pain intensity

Multivariable linear regression analysis for pain intensity showed that a high level of physical activity was significantly associated with a 12.41 mm decrease in VAS ($R^2 = 0.101$; β = −12.41; CI 95%: −23.87 to −0.95). No significant associations were found for the other exposure factors (Table 2).

3.2. Mental health

Depressive symptoms: Multivariable linear regression analysis for depressive symptoms showed that a high level of physical activity was significantly associated with a decrease of 3.29 points on the HADS (Depression subscale) ($R^2 = 0.264$; β = −3,29; CI: 95%: −5,52 to −1,06). No significant associations were found for the other exposure factors (Table 3).

Anxiety symptoms: Multivariable linear regression analysis for

Table 2
Multivariable associations for Pain Intensity (Visual Analog Scale 0–100).

Category	Crude β [95%CI]	Adjusted β [95%CI] [a]
Unemployment	ref.	ref.
Employment	−3.41 [-12.94 to 6.12]	0.96 [-9.38 to 11.31]
Low education	ref.	ref.
High education	−7.21 [-16.05 to 1.63]	−2.83 [-13.31 to 7.64]
Low income	ref.	ref.
High income	−5.5 [-14.49 to 3.49]	−2.60 [-13.04 to 7.84]
Low physical activity	ref.	ref.
High physical activity	**−12.64 [-22.91 to -2.37]** *	**−12.41 [-23.87 to -0.95]** *

Data are shown as regression coefficient (β) and 95% confidence intervals (95% CI).
Notes: ref. = reference category.
Significant values are in bold; *Statistically-significant difference ($p < 0.05$).
[a] Mutually adjusted and controlling for age, sex, body mass index and duration of symptoms.

Table 3
Multivariable associations for Depressive Symptoms (Hospital Anxiety and Depression Scale 0–21).

Category	Crude β [95%CI]	Adjusted β [95%CI] [a]
Unemployment	ref.	ref.
Employment	0.15 [-1.9 to 2.21]	1.01 [-1.01 to 3.03]
Low education	ref.	ref.
High education	−1.16 [-3.07 to 0.74]	−0.51 [-2.56 to 1.53]
Low income	ref.	ref.
High income	−0.90 [-2.83 to 1.03]	−0.36 [-2.39 to 1.67]
Low physical activity	ref.	ref.
High physical activity	**−3.39 [-5.54 to -1.23]** **	**−3.29 [-5.52 to -1.06]** **

Data are shown as regression coefficient (β) and 95% confidence intervals (95% CI).
Notes: ref. = reference category.
Significant values are in bold; **Statistically-significant difference ($p < 0.01$).
[a] Mutually adjusted and controlling for age, sex, body mass index and duration of symptoms.

Table 4
Multivariable associations for Anxiety Symptoms (Hospital Anxiety and Depression Scale 0–21).

Category	Crude β [95%CI]	Adjusted β [95%CI] [a]
Unemployment	ref.	ref.
Employment	**−2.06 [-4.00 to -0.12]** *	**−2.30 [-4.41 to -0.19]** *
Low education	ref.	ref.
High education	−1.07 [-2.86 to 0.72]	0.14 [-1.99 to 2.28]
Low income	ref.	ref.
High income	0.09 [-1.74 to 1.91]	0.68 [-1.45 to 2.81]
Low physical activity	ref.	ref.
High physical activity	−0.95 [-3.08 to 1.18]	0.12 [-2.22 to 2.45]

Data are shown as regression coefficient (β) and 95% confidence intervals (95% CI).
Notes: ref. = reference category.
Significant values are in bold; *Statistically-significant difference ($p < 0.05$).
[a] Mutually adjusted and controlling for age, sex, body mass index and duration of symptoms.

anxiety symptoms showed that being employed was significantly associated with a decrease of 2.30 points on the HADS (Anxiety subscale) ($R^2 = 0.142$; β = −2.30; 95% CI: −4.41 to −0.19). No significant associations were found for the other exposure factors (Table 4).

Catastrophizing: Multivariable linear regression analysis for catastrophizing showed that a high educational level was significantly associated with a decrease of 7.71 points on the PCS scale ($R^2 = 0.216$; β = −7.71; 95% CI: −14.06 to −1.36). No significant associations were found for the other exposure factors (Table 5).

Table 5
Multivariable associations for Catastrophizing (Pain Catastrophizing Scale 0–52).

Category	Crude β [95%CI]	Adjusted β [95%CI] [a]
Unemployment	ref.	ref.
Employment	0.55 [-5.66 to 6.75]	3.08 [-3.20 to 9.35]
Low education	1.0	ref.
High education	**−7.47 [-12.85 to -2.09]** **	**−7.71 [-14.06 to -1.36]** *
Low income	ref.	ref.
High income	−2.02 [-7.67 to 3.64]	−2.91 [-9.24 to 3.42]
Low physical activity	ref.	ref.
High physical activity	−4.67 [-11.25 to 1.89]	−3.92 [-10.86 to 3.03]

Data are shown as regression coefficient (β) and 95% confidence intervals (95% CI).
Notes: ref. = reference category.
Significant values are in bold; *Statistically-significant difference ($p < 0.05$).
[a] Mutually adjusted and controlling for age, sex, body mass index and duration of symptoms.

4. Discussion

This cross-sectional study aimed to analyze the association between SDH and physical activity with pain intensity and mental health in patients with CTS awaiting surgery. Although linear regression models explain only a small proportion of the variance of each outcome, a significant association of physical activity with pain intensity and depressive symptoms was identified. Likewise, a significant association was obtained between employment status and anxiety symptoms, and between low educational level and catastrophizing. Therefore, identifying SDH, such as employment status, educational level and physical activity level, could help clinicians develop more specialized perioperative interventions for pain and mental health management of patients with CTS.

4.1. Pain intensity

According to our results, a high level of physical activity was associated with a decrease in pain intensity. These results are consistent with the available literature in people with chronic pain. For example, Polaski et al. (2019) in a meta-analysis identified that physical activity and exercise (as a subset of physical activity) would be related to the analgesic effect in patients with chronic pain. Thus, one possible mechanism that could explain our results is the relationship between physical activity levels and descending pain modulatory function (Naugle and Riley, 2014). In fact, in healthy adults greater self-reported physical activity is associated with a greater pain inhibitory response through the conditioned modulatory pain response (Naugle and Riley, 2014).

On the other hand, our results disagree with the available literature on the association between educational level and income with pain intensity. In other conditions affecting the hand (e.g. rheumatoid arthritis), subjects with a high level of education, according to Swedish records, experience less pain than those with a low level of education (Jiang et al., 2015). In other surgical populations evaluated in North America (e.g. joint replacement), lack of university education was associated with higher pain scores before and after surgery (Goodman et al., 2018). The discrepancies found in our results could be explained in part by the differences in the educational systems and realities of each country. Therefore, multinational studies may be necessary to evaluate these associations in greater depth. Additionally, previous studies have identified that income (in terms of annual household income) is also related to pain and coping strategies in people with musculoskeletal pain (Palmlöf et al., 2012; Whitley et al., 2021). This could be explained by the fact that monetary income was classified according to individual monthly taxable income and there was no information on household income.

4.2. Mental health

Regarding depressive symptoms, it was observed that patients who met the WHO physical activity recommendations had lower levels of depressive symptoms. In fact, these patients had a reduction of up to 3.29 points in the depression subscales of the HADS (taking as a reference the patients with a low level of physical activity). This difference exceeds the minimal clinically important difference (MCID) of 1.7 points on the HADS, established for other health conditions (Lemay et al., 2019). These results are consistent with the available literature in the general population. For example, Choi et al. found a protective relationship between accelerometer-based activity and depression among adults (Choi et al., 2019). The antidepressant effects of physical activity could be explained by several neuroplastic processes related to depression (e.g., activation of the endocannabinoid system, optimisation of brain-derived neurotrophic factor) and by the ability to reduce inflammation and increase resistance to oxidative and physiological stress (Heyman et al., 2012; Kandola et al., 2019; Phillips, 2017). In addition, exercise promotes self-esteem, social support and self-efficacy (Kandola

et al., 2019). Therefore, our results reinforce the hypothesis that the promotion of physical activity (e.g., physical activity programs guided by WHO recommendations) could be a valuable strategy to reduce the risk of mental health issues (Mammen and Faulkner, 2013), which could be relevant for patients with CTS while awaiting surgery. Moreover, being employed was associated with a decrease of 2.30 points on the HADS anxiety subscale scores, which was also higher than the MCID reported in the literature of 1.7 points (Lemay et al., 2019). Previous research indicates that the negative effect of unemployment on mental health is mainly explained by distress (Paul and Moser, 2009). Our study also raises the need for policies to focus on the welfare of the unemployed, including support for re-employment.

On the other hand, according to our results, educational level was significantly associated with catastrophizing. In fact, having a high level of education was associated with a reduction of 7.71 points on the PCS, which was higher than the MCID of 6.71 points on the PCS for patients with chronic low back pain (Suzuki et al., 2020). Thus, for patients with CTS awaiting surgery, a comprehensive approach that takes into account both physical limitations due to pain and psychosocial challenges may be necessary.

We should be aware that the association between SDH and outcomes might be affected in our study, as patients were evaluated during the COVID-19 outbreak. The pandemic has highlighted pre-existing inequalities in terms of gender and socio-economic status (Bernardini et al., 2021). In this context, the SDH as mediators of the impact caused by the pandemic (e.g., job insecurity or economic concerns), amplified the consequences on the mental health of the most vulnerable populations (Bernardini et al., 2021; Campo-Arias and De Mendieta, 2021; Vindegaard and Benros, 2020; Wilson et al., 2020). Furthermore, although CTR is a common surgical procedure (Pourmemari et al., 2018), during the COVID-19 pandemic, hospitals around the world suspended elective or non-urgent hand surgeries to cope with the high demand for capacity caused by the health crisis (Picardo et al., 2021). The cancellation of elective surgeries and limited access to quality pain management care resulted in a greater focus on biomedical treatment (e.g., pharmacological management), with less consideration of psychological aspects (Karos et al., 2020). In this context, the implementation of physical activity programmes in the pre-surgical phase could help to reduce pain and improve mental health in this population.

4.3. Strengths and limitations

Our study has certain limitations. Firstly, these results should be interpreted with caution, as a cross-sectional design does not allow us to establish a cause-effect relationship between the variables studied. In addition SDH and physical activity were presented as dichotomous variables, which may lead to potential bias due to residual confounding. However, our study is consistent with the available literature on the importance of SDH in patients with CTS (Bernstein et al., 2022; Wright et al., 2019), and provides additional information in the context of non-North American/Western European countries. Furthermore, using these cutoff points could help clinicians to more clearly identify vulnerable groups that require further attention (e.g., unemployed, patients who have not completed secondary education). Therefore, our findings pave the way for future longitudinal investigations that may establish the directionality of the observed relationships. Second, we examined self-reported physical activity (i.e minute per week), and not based on an objective measure (e.g., accelerometer-based). However, the method used is valid and easy to apply at the clinical/hospital setting (Bull et al., 2020), and allows specific recommendations to be provided to healthcare teams (e.g., design physical activity programs guided by WHO criteria). Third, it is also important to mention that, although the results are in line with previous literature, our results only apply to the reality of one country. In addition, the high percentage of women in the sample is a limitation for the generalisability of the results. Future studies should include a larger population with follow-up over time to investigate how SDH might also affect clinical outcomes after surgery.

5. Conclusions

A high level of physical activity was associated with a decrease in pain intensity and depressive symptoms in patients with CTS awaiting surgery. In addition, being employed was associated with a decrease in anxiety symptoms and having a high educational level was associated with a decrease in catastrophizing. Multidisciplinary care teams should be aware of the association between SDH and physical activity with physical and mental health. Therefore, a comprehensive assessment of these variables may be relevant to identify cases of increased psychosocial risk and to plan strategies to reduce pain and improve the mental health of patients with CTS awaiting surgery, e.g., physical activity programs guided by WHO recommendations.

Ethics

All study procedures were approved by the Institutional Review Board of the Hospital Clínico la Florida and Hospital Provincia Cordillera (Santiago, Chile).

Declaration of competing interest

Rodrigo Núnez-Cortés is supported by a grant from the National Research and Development Agency of Chile (ANID/2020–72210026). Rubén López-Bueno is supported by European Union—NextGeneration-EU. The other authors have nothing to disclose.

References

Aroori, S., Spence, R.A.J., 2008. Carpal tunnel syndrome. Ulster Med. J. 77, 6–17.
Axon, D.R., Chien, J., 2021. Predictors of mental health status among older United States adults with pain. Behav. Sci. 11 https://doi.org/10.3390/bs11020023.
Bernardini, F., Attademo, L., Rotter, M., Compton, M.T., 2021. Social determinants of mental health as mediators and moderators of the mental health impacts of the COVID-19 pandemic. Psychiatr. Serv. 72, 598–601.
Bernstein, D.N., Kurucan, E., Fear, K., Hammert, W.C., 2022. Evaluating the impact of patient social deprivation on the level of symptom severity at carpal tunnel syndrome presentation. Hand 17, 339–345.
Bickel, K.D., 2010. Carpal tunnel syndrome. J. Hand Surg. https://doi.org/10.1016/j.jhsa.2009.11.003.
Bull, F.C., Al-Ansari, S.S., Biddle, S., Borodulin, K., Buman, M.P., Cardon, G., Carty, C., Chaput, J.-P., Chastin, S., Chou, R., Dempsey, P.C., DiPietro, L., Ekelund, U., Firth, J., Friedenreich, C.M., Garcia, L., Gichu, M., Jago, R., Katzmarzyk, P.T., Lambert, E., Leitzmann, M., Milton, K., Ortega, F.B., Ranasinghe, C., Stamatakis, E., Tiedemann, A., Troiano, R.P., van der Ploeg, H.P., Wari, V., Willumsen, J.F., 2020. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. Br. J. Sports Med. 54, 1451–1462.
Campo-Arias, A., De Mendieta, C.T., 2021. Social determinants of mental health and the COVID-19 pandemic in low-income and middle-income countries. Lancet Global Health 9 (8), e1029–e1030.
Ceceli, E., Gumruk, S., Okumus, M., Kocaoglu, S., Goksu, H., Karagoz, A., 2018. Comparison of 2 methods of neuropathic pain assessment in carpal tunnel syndrome and hand functions. Neurosciences 23, 23–28.
Chandra, P.S., Sarat Chandra, P., Singh, P.K., Goyal, V., Chauhan, A.K., Thakkur, N., Tripathi, M., 2013. Early versus Delayed Endoscopic Surgery for Carpal Tunnel Syndrome: Prospective Randomized Study. World Neurosurgery. https://doi.org/10.1016/j.wneu.2012.08.008.
Choi, K.W., Chen, C.-Y., Stein, M.B., Klimentidis, Y.C., Wang, M.-J., Koenen, K.C., Smoller, J.W., Major Depressive Disorder Working Group of the Psychiatric Genomics Consortium, 2019. Assessment of bidirectional relationships between physical activity and depression among adults: a 2-sample mendelian randomization study. JAMA Psychiatr. 76, 399–408.
Dale, A.M., Harris-Adamson, C., Rempel, D., Gerr, F., Hegmann, K., Silverstein, B., Burt, S., Garg, A., Kapellusch, J., Merlino, L., Thiese, M.S., Eisen, E.A., Evanoff, B., 2013. Prevalence and incidence of carpal tunnel syndrome in US working populations: pooled analysis of six prospective studies. Scandinavian Journal of Work. https://doi.org/10.5271/sjweh.3351. Environment & Health.
De, S.D., Vranceanu, A.-M., Ring, D.C., 2013. Contribution of kinesophobia and catastrophic thinking to upper-extremity-specific disability. J. Bone Joint Surg. https://doi.org/10.2106/jbjs.l.00064.
Erickson, M., Lawrence, M., Jansen, C.W.S., Coker, D., Amadio, P., Cleary, C., 2019. Hand pain and sensory deficits: carpal tunnel syndrome. J. Orthop. Sports Phys. Ther. 49. CPG1–CPG85.

Fliesser, M., De Witt Huberts, J., Wippert, P.-M., 2017. The choice that matters: the relative influence of socioeconomic status indicators on chronic back pain- a longitudinal study. BMC Health Serv. Res. 17, 800.
García Campayo, J., Rodero, B., Alda, M., Sobradiel, N., Montero, J., Moreno, S., 2008. [Validation of the Spanish version of the pain catastrophizing scale in fibromyalgia]. Med. Clin. 131, 487–492.
Gidlow, C., Johnston, L.H., Crone, D., Ellis, N., James, D., 2006. A systematic review of the relationship between socio-economic position and physical activity. Health Educ. J. https://doi.org/10.1177/0017896906069378.
Goodman, S.M., Mandl, L.A., Mehta, B., Navarro-Millan, I., Russell, L.A., Parks, M.L., Dey, S.A., Crego, D., Figgie, M.P., Nguyen, J.T., Szymonifka, J., Zhang, M., Bass, A. R., 2018. Does education level mitigate the effect of poverty on total knee arthroplasty outcomes? Arthritis Care Res. https://doi.org/10.1002/acr.23442.
Henning, M., Smith, M., 2022. The ability of physiotherapists to identify psychosocial factors in patients with musculoskeletal pain: a scoping review. Muscoskel. Care. https://doi.org/10.1002/msc.1725.
Herrero, M.J., Blanch, J., Peri, J.M., De Pablo, J., Pintor, L., Bulbena, A., 2003. A validation study of the hospital anxiety and depression scale (HADS) in a Spanish population. Gen. Hosp. Psychiatr. 25, 277–283.
Heyman, E., Gamelin, F.-X., Goekint, M., Piscitelli, F., Roelands, B., Leclair, E., Di Marzo, V., Meeusen, R., 2012. Intense exercise increases circulating endocannabinoid and BDNF levels in humans—possible implications for reward and depression. Psychoneuroendocrinology. https://doi.org/10.1016/j.psyneuen.2011.09.017.
Jerosch-Herold, C., Houghton, J., Blake, J., Shaikh, A., Wilson, E.C., Shepstone, L., 2017. Association of psychological distress, quality of life and costs with carpal tunnel syndrome severity: a cross-sectional analysis of the PALMS cohort. BMJ Open 7, e017732.
Jiang, X., Sandberg, M.E.C., Saevarsdottir, S., Klareskog, L., Alfredsson, L., Bengtsson, C., 2015. Higher education is associated with a better rheumatoid arthritis outcome concerning for pain and function but not disease activity: results from the EIRA cohort and Swedish rheumatology register. Arthritis Res. Ther. https://doi.org/10.1186/s13075-015-0836-6.
Kahl, C., Cleland, J.A., 2005. Visual analogue scale, numeric pain rating scale and the McGill pain Questionnaire: an overview of psychometric properties. Phys. Ther. Rev. https://doi.org/10.1179/108331905x55776.
Kandola, A., Ashdown-Franks, G., Hendrikse, J., Sabiston, C.M., Stubbs, B., 2019. Physical activity and depression: towards understanding the antidepressant mechanisms of physical activity. Neurosci. Biobehav. Rev. 107, 525–539.
Karos, K., McParland, J.L., Bunzli, S., Devan, H., Hirsh, A., Kapos, F.P., Keogh, E., Moore, D., Tracy, L.M., Ashton-James, C.E., 2020. The social threats of COVID-19 for people with chronic pain. Pain 161, 2229–2235.
Karran, E.L., Grant, A.R., Moseley, G.L., 2020. Low back pain and the social determinants of health: a systematic review and narrative synthesis. Pain 161, 2476–2493.
Kim, H.-J., 2014. Influence of educational attainment on pain intensity and disability in patients with lumbar spinal stenosis: mediation effect of pain catastrophizing. Spine J. https://doi.org/10.1016/j.spinee.2014.08.360.
Lemay, K.R., Tulloch, H.E., Pipe, A.L., Reed, J.L., 2019. Establishing the minimal clinically important difference for the hospital anxiety and depression scale in patients with cardiovascular disease. J. Cardiopulm. Rehabil. Prev. 39, E6–E11.
Mammen, G., Faulkner, G., 2013. Physical activity and the prevention of depression: a systematic review of prospective studies. Am. J. Prev. Med. 45, 649–657.
Naugle, K.M., Riley 3rd, J.L., 2014. Self-reported physical activity predicts pain inhibitory and facilitatory function. Med. Sci. Sports Exerc. 46, 622–629.
Nora, D.B., Becker, J., Ehlers, J.A., Gomes, I., 2005. What symptoms are truly caused by median nerve compression in carpal tunnel syndrome? Clin. Neurophysiol. 116, 275–283.
Núñez-Cortés, R., Cruz-Montecinos, C., Antúnez-Riveros, M.A., Pérez-Alenda, S., 2020. Does the educational level of women influence hand grip and pinch strength in carpal tunnel syndrome? Med. Hypotheses. https://doi.org/10.1016/j.mehy.2019.109474.
Núñez-Cortés, R., Cruz-Montecinos, C., Tapia, C., Pommer, P.P., Pérez-Alenda, S., 2022. Carpal tunnel syndrome and pain. Features and Assessments of Pain, Anaesthesia, and Analgesia. https://doi.org/10.1016/b978-0-12-818988-7.00031-5.
Núñez-Cortés, R., Cruz-Montecinos, C., Torres-Castro, R., Tapia, C., Püschel, T.A., Pérez-Alenda, S., 2021. Effects of cognitive and mental health factors on the outcomes following carpal tunnel release: a systematic review and meta-analysis. Arch. Phys. Med. Rehabil. https://doi.org/10.1016/j.apmr.2021.10.026.
Nunez, F., Vranceanu, A.-M., Ring, D., 2010. Determinants of pain in patients with carpal tunnel syndrome. Clin. Orthop. Relat. Res. 468, 3328–3332.
Palmlöf, L., Skillgate, E., Alfredsson, L., Vingård, E., Magnusson, C., Lundberg, M., Holm, L.W., 2012. Does income matter for troublesome neck pain? A population-based study on risk and prognosis. J. Epidemiol. Community Health 66, 1063–1070.
Paul, K.I., Moser, K., 2009. Unemployment impairs mental health: meta-analyses. J. Vocat. Behav. https://doi.org/10.1016/j.jvb.2009.01.001.
Phillips, C., 2017. Brain-derived neurotrophic factor, depression, and physical activity: making the neuroplastic connection, 2017 Neural Plast., 7260130
Picardo, N.E., Walker, H., Vanat, Q., Nizar, B., Madura, T., Jose, R., 2021. Service reconfiguration in the department of hand surgery during the UK COVID-19 lockdown: birmingham experience. Postgrad. Med. https://doi.org/10.1136/postgradmedj-2020-139280.
Polaski, A.M., Phelps, A.L., Kostek, M.C., Szucs, K.A., Kolber, B.J., 2019. Exercise-induced hypoalgesia: a meta-analysis of exercise dosing for the treatment of chronic pain. PLoS One 14, e0210418.
Pourmemari, M.-H., Heliövaara, M., Viikari-Juntura, E., Shiri, R., 2018. Carpal tunnel release: lifetime prevalence, annual incidence, and risk factors. Muscle Nerve 58, 497–502.
Prego-Domínguez, J., Khazaeipour, Z., Mallah, N., Takkouche, B., 2021. Socioeconomic status and occurrence of chronic pain: a meta-analysis. Rheumatology 60, 1091–1105.
Strube, P., Schöpe, T., Hölzl, A., Brodt, S., Matziolis, G., Zippelius, T.K., 2019. Influence of anxiety and depression, self-rated return-to-work problems, and unemployment on the outcome of outpatient rehabilitation after shoulder arthroscopy. Am. J. Phys. Med. Rehabil. 98, 1118–1124.
Sullivan, M.J.L., Bishop, S.R., Pivik, J., 1995. The Pain Catastrophizing Scale: Development and Validation. Psychological Assessment. https://doi.org/10.1037/1040-3590.7.4.524.
Suzuki, H., Aono, S., Inoue, S., Imajo, Y., Nishida, N., Funaba, M., Harada, H., Mori, A., Matsumoto, M., Higuchi, F., Nakagawa, S., Tahara, S., Ikeda, S., Izumi, H., Taguchi, T., Ushida, T., Sakai, T., 2020. Clinically significant changes in pain along the Pain Intensity Numerical Rating Scale in patients with chronic low back pain. PLoS One 15, e0229228.
Tan, B.-K., Smith, A.J., O'Sullivan, P.B., Chen, G., Burnett, A.F., Briggs, A.M., 2014. Low back pain beliefs are associated to age, location of work, education and pain-related disability in Chinese healthcare professionals working in China: a cross sectional survey. BMC Muscoskel. Disord. https://doi.org/10.1186/1471-2474-15-255.
Tawashy, A.E., Eng, J.J., Lin, K.H., Tang, P.F., Hung, C., 2009. Physical activity is related to lower levels of pain, fatigue and depression in individuals with spinal-cord injury: a correlational study. Spinal Cord 47, 301–306.
The Lancet, 2018. UK life science research: time to burst the biomedical bubble. Lancet 392, 187.
Thiese, M.S., Gerr, F., Hegmann, K.T., Harris-Adamson, C., Dale, A.M., Evanoff, B., Eisen, E.A., Kapellusch, J., Garg, A., Burt, S., Bao, S., Silverstein, B., Merlino, L., Rempel, D., 2014. Effects of varying case definition on carpal tunnel syndrome prevalence estimates in a pooled cohort. Arch. Phys. Med. Rehabil. https://doi.org/10.1016/j.apmr.2014.08.004.
Vindegaard, N., Benros, M.E., 2020. COVID-19 pandemic and mental health consequences: systematic review of the current evidence. Brain Behav. Immun. 89, 531–542.
von Elm, E., Altman, D.G., Egger, M., Pocock, S.J., Gøtzsche, P.C., Vandenbroucke, J.P., Strobe Initiative, 2014. The strengthening the reporting of observational studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Int. J. Surg. 12, 1495–1499.
Whitley, M.D., Herman, P.M., Aliyev, G.R., Sherbourne, C.D., Ryan, G.W., Coulter, I.D., 2021. Income as a predictor of self-efficacy for managing pain and for coping with symptoms among patients with chronic low back pain. J. Manip. Physiol. Ther. 44, 433–444.
WHO Commission on Social Determinants of Health, World Health Organization, 2008. Closing the Gap in a Generation: Health Equity through Action on the Social Determinants of Health : Commission on Social Determinants of Health Final Report. World Health Organization.
Wilson, J.M., Lee, J., Fitzgerald, H.N., Oosterhoff, B., Sevi, B., Shook, N.J., 2020. Job insecurity and financial concern during the COVID-19 pandemic are associated with worse mental health. J. Occup. Environ. Med. 62, 686–691.
Wright, M.A., Beleckas, C.M., Calfee, R.P., 2019. Mental and physical health disparities in patients with carpal tunnel syndrome living with high levels of social deprivation. J. Hand Surg. Am. 44, 335 e1–335.e9.