

## Influence of Family Functioning and Socioeconomic Factors on Multisite and Chronic Musculoskeletal Pain in Adolescents: Findings from the Generation XXI Cohort Study

Anna M. Kowalska<sup>1</sup>, Piotr Nowak<sup>1\*</sup>, Magdalena Zielinska<sup>1</sup>

<sup>1</sup>Department of Medical Sociology, Faculty of Health Sciences, Jagiellonian University Medical College, Krakow, Poland.

\*E-mail ✉ piotr.nowak@outlook.com

### Abstract

This study investigated the association between family functioning and the occurrence of pain in multiple body sites as well as long-lasting musculoskeletal pain among adolescents, during a crucial developmental period for the onset of persistent pain, while accounting for socioeconomic conditions and adverse experiences in childhood (ACEs). Analyses included data from 1,473 individuals, with pain assessed using the Luebeck Pain Screening Questionnaire when participants reached age 18. Pain affecting multiple sites was classified as occurring in two or more areas; long-term musculoskeletal pain was identified as discomfort in any musculoskeletal area persisting beyond three months. Family functioning was evaluated with the Brief Family Relationship Scale, grouped into poor, moderate, or strong categories. Baseline socioeconomic details were gathered initially, and ACEs were recorded at age 13.

Pain in multiple sites affected 43% of participants, while long-term pain was reported by 23%. Regression models using logistic approaches indicated that strong family functioning correlated with reduced likelihood of pain across multiple sites (OR 0.49; 95% CI 0.37, 0.65) and long-term musculoskeletal pain (OR 0.62; 95% CI 0.45, 0.86). Socioeconomic variables showed minimal influence overall, although elevated maternal occupational level was associated with increased multisite pain (OR 1.38; 95% CI 1.02, 1.87). Analyses by subgroups found no notable moderating effects. Strong family functioning linked to decreased likelihood of pain in adolescence, independent of socioeconomic backgrounds.

**Keywords:** Family functioning, Chronic musculoskeletal pain, Prospective study, Socioeconomic factors, Adolescence

### Introduction

Long-term musculoskeletal pain and discomfort across multiple body regions represent common issues impacting young people and teenagers, potentially resulting in prolonged impairment and diminished well-being [1–3]. Studies indicate that persistent pain arises from intricate combinations of physical, emotional, and environmental elements, consistent with the biopsychosocial perspective on pain [4–6].

Environmental aspects shape how discomfort is expressed and shared, underscoring the need to examine wider contextual influences in pain studies [5].

Within emotional and social elements, household dynamics significantly mold youths' encounters with discomfort [7, 8]. Actions from parents, including imitation, encouragement, and assistance, play a substantial role in pain-related results, as described in the comprehensive model developed by Palermo and Chambers [9]. This approach highlights connections among specific parental actions, interactions between parents and children, and overall household environment as central to youth persistent pain. For example, youths in unified and encouraging home settings often demonstrate improved handling of discomfort and lesser limitations, while those in tense or disputatious households may face heightened persistent pain

Access this article online

<https://smerpub.com/>

Received: 28 February 2021; Accepted: 23 May 2021

Copyright CC BY-NC-SA 4.0

**How to cite this article:** Kowalska AM, Nowak P, Zielinska M. Influence of Family Functioning and Socioeconomic Factors on Multisite and Chronic Musculoskeletal Pain in Adolescents: Findings from the Generation XXI Cohort Study. *Int J Soc Psychol Asp Healthc.* 2021;1:131-43. <https://doi.org/10.51847/LcUXCHKMtA>

difficulties [10, 11]. Nevertheless, links between household dynamics and pain results might differ among youths, since socioeconomic position (SES)—including family earnings, parental schooling, and job status—can modify how household dynamics influence pain [12]. Youths from disadvantaged SES with stressed home settings might endure intensified discomfort, owing not solely to scarce means but also overlapping emotional and relational strains. Conversely, robust household bonds may mitigate drawbacks of lower SES, fostering better adaptation and strength [13, 14]. Furthermore, adverse experiences during childhood (ACEs), involving mistreatment, oversight, and home instability, constitute distinct incidents that, alongside broader socioeconomic difficulties, form early surroundings and future health, with SES reflecting the systemic side of such difficulties [15, 16].

Although growing data connect household dynamics to pain encounters, understanding of variations in these links along the socioeconomic spectrum remains limited in young individuals, a phase marked by major bodily, affective, and relational shifts. Much prior work on household ties and pain has relied on limited samples from clinics or those seeking help, restricting broader applicability. The present investigation fills this void through a sizable, community-representative longitudinal birth group using forward-looking information and established tools for household dynamics, offering a more solid foundation for comprehending these interactions in the wider populace. Earlier findings demonstrate that youths with ongoing discomfort face elevated chances of adult persistent pain [2]. Notably, the later teenage years form a vital transitional window toward maturity, when musculoskeletal discomfort might solidify into enduring forms, rendering this period especially suitable for exploring impacts of household dynamics and socioeconomic surroundings on pain results.

Accordingly, the goal was to explore connections between household dynamics and pain in multiple sites or long-term musculoskeletal types at age 18 in a community-based longitudinal birth group, while assessing potential modifications by socioeconomic measures and ACEs.

## Materials and Methods

### *Study design*

This investigation utilized information from individuals enrolled in the Generation XXI (G21) cohort, a community-based longitudinal birth study conducted in Portugal. Enrollment for G21 occurred from April 2005 to August 2006 across all five public hospitals delivering maternity services in the greater Porto region, Portugal [17]. At the initial stage, 8,647 infants were incorporated into the cohort, with subsequent assessments at ages 4 (2009–2011; 86% retention), 7 (2012–2014; 80% retention), 10 (2015–2017; 74% retention), 13 (2018–2020; 54% retention), and 18 (2022–2025).

Every assessment phase involved clinical evaluations of the participants, including body measurements and biological samples, combined with in-person structured questionnaires administered by qualified personnel to both the young individuals and their primary guardians. These questionnaires gathered details on health conditions, societal factors, and habits, encompassing frequent illnesses and complaints, educational matters, and exposure to challenging events.

### *Ethical considerations*

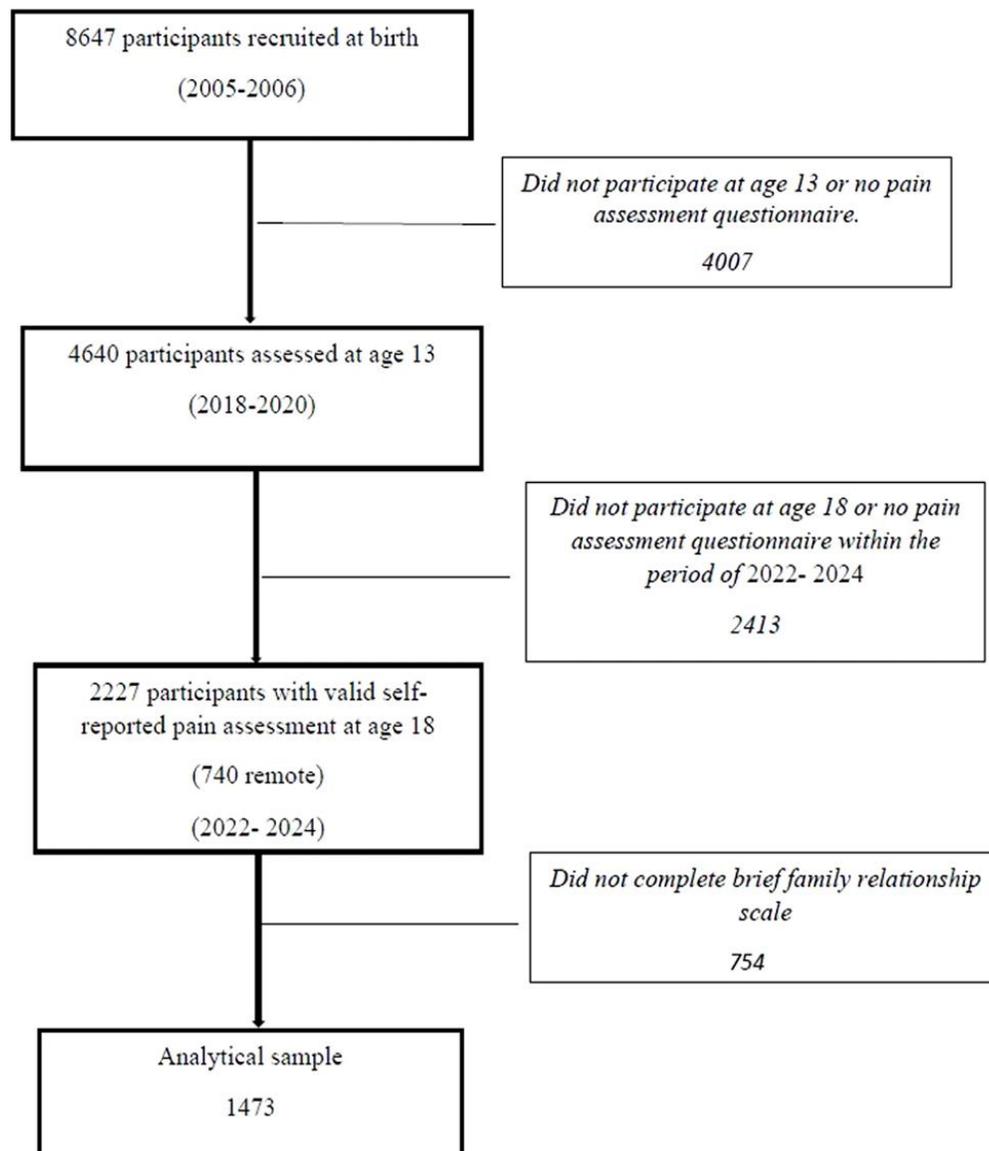
The Generation XXI longitudinal study adheres to the principles of the Helsinki Declaration for human research and relevant national regulations. It received approval from the Ethics Committee of Hospital São João/University of Porto Medical School for waves up to age 10. The current analysis was endorsed by the ethics boards of the Institute of Public Health at the University of Porto (ISPUP) (Reference CE21199) and Hospital Garcia de Orta (Reference 12/2022). Written informed consent was secured from all participants aged 18 or older, and from both guardians and youths when individuals were minors.

### *Study sample and data collection*

The present research drew on pain-related information obtained during the age-18 assessment, a follow-up phase that began remotely in June 2022 via a specialized mobile platform named “SEPIA,” created in partnership with the Institute of Systems and Computer Engineering, Technology and Science (INESC TEC) at the University of Porto. The design, rollout, and analysis of SEPIA incorporated input from patient collaborators, who helped shape the research protocol, execution, and result explanation to ensure alignment with meaningful concerns and lived experiences. The platform aimed to capture details on previous pain episodes from each young person and one primary guardian (92% mothers,

designated as main caregivers from the start). Guardians in the cohort who had shared email contacts received invitations from the study team (5,756 households), and consenting families were provided access links and login details for the application (link: <https://ispup.up.pt/sepia/>). In total, 740 individuals submitted information remotely using the SEPIA platform. In addition to pain details, variables like household dynamics were gathered through this tool. This was supplemented by information from the

continuing in-person G21 assessments, which included individuals completing the pain evaluation by September 2024, employing identical platform and instruments. For this analysis, we incorporated participants who completed the Lübeck Pain Screening Questionnaire and the Brief Family Relationship Scale at age 18, spanning June 2022 to September 2024, through both digital remote and direct in-person approaches, yielding a final cohort of 1,473 (**Figure 1**).



**Figure 1.** Flow diagram of study participants. Generation XXI longitudinal birth cohort, Portugal, 2005/6–2025.

#### *Study variables*

*Pain across multiple sites and long-term musculoskeletal pain*

The Lübeck Pain Screening Questionnaire (LPQ) serves as a tool designed for large-scale studies examining pain features in young individuals and teenagers [18]. It has

been applied to this group starting from age 7 to determine rates, effects, perceived causes of discomfort, and interference with routine activities. In addition, youths were queried about cohabitation with relatives (such as parents, grandparents, brothers/sisters, or others) experiencing recurring or ongoing pain. The opening item of the LPQ inquired about any discomfort in the three months prior to assessment; a no answer skipped remaining items. Positive responses led to details on the episode (self-described at ages 13 and 18), including specific location(s) and the most troubling primary location. Regarding the main location, the LPQ recorded length of episode, categorized as under 3 months, 3–12 months, or over 12 months. The key endpoints involved pain in multiple locations and persistent musculoskeletal discomfort. Pain affecting several areas was classified as discomfort in at least two of twenty-six designated body parts, covering regions like the head, stomach, pelvic area, lower or middle back, neck and shoulders, arms and legs, and hips, during the previous three months. Persistent musculoskeletal discomfort was identified as ongoing ache in a primary musculoskeletal region (lower/middle back, neck/shoulders, arms/legs, or hips) exceeding three months.

#### *Household dynamics*

Assessment of household dynamics employed an adapted Portuguese edition of the Brief Family Relationship Scale (BFRS). This instrument evaluates a youth's view on the overall quality of familial interactions [19, 20]. Comprising 16 statements with yes/no answers, it covers three aspects:

- unity, reflecting the extent of affective closeness, assistance, and loyalty among relatives (7 statements),
- tension, capturing the degree of overt hostility, irritation, and disputes within the home (6 statements),
- openness, gauging the amount of direct dialogue and affective exchange in the household (3 statements).

Following preliminary factor examination and consideration of the cultural nuance of the term “discussion” (“discussão”) in Portuguese, we omitted Item 15 (“In our family, we begin discussions easily”), yielding a 15-item version.

In line with earlier applications of the Brief Family Relationship Scale, a composite household dynamics score was derived [21]. The total ranged from 0 to 15, with subscales for unity (0–7), tension (0–6), and

openness (0–2). The tension component was inverted for the composite, ensuring elevated scores reflected superior household dynamics. The measure's reliability, via Cronbach's alpha, stood at 0.8256.

#### *Socioeconomic Indicators*

Initial information on family monthly earnings, mother's schooling, and parents' jobs were examined. Earnings encompassed salaries plus additional inputs (such as subsidies, rentals, benefits) and were grouped as modest ( $\leq$ EUR 1,000), medium (EUR 1,001–2,000), or elevated ( $>$ EUR 2,000), aligned with the national minimum salary in Portugal [22]. Maternal schooling followed the International Standard Classification of Education 2011: modest ( $\leq$ 9 years), medium (10–12 years), or elevated ( $>$ 12 years) [23]. Occupational categories for parents drew from the National Classification of Occupations, simplified into three tiers: modest (manual roles like agriculture, crafts, machinery work, assembly, or general labor); medium (clerical positions including office roles, services, and retail); and elevated (professional roles such as administrators, executives, experts, mid-level supervisors, and specialists) [22, 24].

#### *Adverse childhood experiences*

Adverse experiences during childhood (ACEs) were evaluated at age 13 through a 15-item questionnaire adapted from the foundational ACEs research [16, 25]. Young individuals filled it out in private, with support from a qualified interviewer if required. Exposure to adversities was calculated by adding up affirmative responses for each item, scored as present or absent (0/1). The cumulative count was divided into three levels: 0–3 adversities, 4–5 adversities, and 6 or more adversities, reflecting established links to pain-related outcomes [26].

#### *Statistical analysis*

Differences between groups were tested with chi-square ( $\chi^2$ ) statistics for categorical data.

Logistic regression models (binary) were constructed to investigate links between household dynamics, socioeconomic markers, and ACEs with the primary pain endpoints (pain across multiple areas and persistent musculoskeletal discomfort). Unadjusted odds ratios (OR) along with 95% confidence intervals (95% CI) were provided to illustrate these relationships.

For clearer presentation of findings, given the score distribution (mean = 11.6, median = 12), the composite household dynamics score was divided into three tiers: low (0–9), moderate (10–12), and high (13–15).

Subgroup examinations using chi-square ( $\chi^2$ ) tests were carried out to detect variations in pain endpoint rates (multisite and long-term musculoskeletal) according to household dynamics categories (0–9, 10–12, 13–15) within different socioeconomic strata and across ACE counts.

## Results and Discussion

Of the 1,473 individuals (52.5% girls), over half came from families with medium or elevated income and had mothers with medium or advanced education. More than half described discomfort in the preceding three months, 43% indicated pain in several locations, and about one-quarter noted long-term musculoskeletal issues. Close to half mentioned sharing a home with a relative suffering from ongoing or recurrent pain, and among these, over two-thirds identified the mother as the affected person (Table 1).

**Table 1.** Sample characteristics (n = 1,473). Generation XXI birth cohort study, Portugal, 2005/6 - 2025.

Characteristics	n (%)
Sex	
Male	699 (47.5)
Female	774 (52.5)
Monthly household income	
<1,000€	412 (31.8)
1,000–2000€	646 (49.9)
>2000€	237 (18.3)
Missing	178
Maternal education	
<10	448 (31.2)
10–12	465 (32.4)
>12	524 (36.4)
Missing	36
Maternal occupation	
Blue collar	262 (18.8)
Lower white collar	622 (44.6)
Upper white collar	511 (36.6)
Missing	78
Paternal occupation	
Blue collar	56 (34.7)
Lower white collar	241 (18.3)
Upper white collar	617 (47.0)
Missing	159
Adverse childhood experiences	
0–3	704 (53.3)
4–5	330 (25.0)
6+	286 (21.7)
Missing	153
Any pain (previous 3 months)	
Yes	750 (50.9)
No	723 (49.1)
Multisite pain (2 or more)	
Yes	629 (42.7)
No	844 (57.3)
Chronic musculoskeletal pain	
Yes	335 (22.8)
No	1,132 (77.2)
Missing	6

Family member with pain		
Yes		648 (44.0)
No		825 (56.0)
Mother with pain		
Yes		464 (31.5)
No		1,009 (68.5)
Father with pain		
Yes		204 (13.9)
No		1,269 (86.1)
Siblings with pain		
Yes		35 (2.4)
No		1,438 (97.6)
Other family members with pain		
Yes		65 (4.4)
No		1,408 (95.6)

*Italic values indicate missing data.*

Gender differences emerged in pain reporting, as boys displayed markedly reduced likelihood of indicating pain across multiple sites (OR 0.40; 95 percent CI 0.32, 0.49) and long-term musculoskeletal discomfort (OR 0.74; 95 percent CI 0.58, 0.95) relative to girls. **Table 2** displays the unadjusted relationships between socioeconomic variables, adverse childhood experiences, household dynamics, and both multisite pain and persistent

musculoskeletal pain. Of the various socioeconomic elements examined, solely maternal occupational category demonstrated a significant link with multisite pain (OR for upper white-collar compared to blue-collar: 1.38; 95 percent CI 1.02, 1.87), while none of the socioeconomic measures exhibited statistically meaningful connections with long-term musculoskeletal pain.

**Table 2.** Crude associations between socioeconomic indicators, ACEs, family functioning, and pain outcomes. Generation XXI birth cohort study, Portugal, 2005/6 - 2025.

Variables	Unadjusted model OR [95%CI]	
	Multisite pain (2 or more sites)	Chronic musculoskeletal pain
Sex		
Female	<i>1<sup>a</sup></i>	<i>1<sup>a</sup></i>
Male	<b>0.40 [0.32, 0.49]</b>	<b>0.74 [0.58, 0.95]</b>
Monthly household income		
<1,000€	<i>1<sup>a</sup></i>	<i>1<sup>a</sup></i>
1,000–2000€	1.15 [0.89, 1.48]	1.13 [0.84, 1.53]
>2000€	1.33 [0.96, 1.84]	1.07 [0.73, 1.58]
Maternal education		
<10	<i>1<sup>a</sup></i>	<i>1<sup>a</sup></i>
10–12	1.24 [0.95, 1.31]	1.12 [0.82, 1.53]
>12	1.20 [0.93, 1.56]	1.23 [0.92, 1.67]
Maternal occupation		
Blue collar	<i>1<sup>a</sup></i>	<i>1<sup>a</sup></i>
Lower white collar	1.33 [0.99, 1.80]	1.34 [0.94, 1.93]
Upper white collar	<b>1.38 [1.02, 1.87]</b>	1.39 [0.96, 2.02]
Paternal occupation		
Blue collar	<i>1<sup>a</sup></i>	<i>1<sup>a</sup></i>
Lower white collar	0.89 [0.65, 1.23]	0.97 [0.66, 1.42]
Upper white collar	1.11 [0.87, 1.41]	1.15 [0.87, 1.54]

ACEs		
0–3	1 <sup>a</sup>	1 <sup>a</sup>
4–5	1.12 [0.86, 1.45]	0.89 [0.65, 1.23]
6+	1.27 [0.97, 1.68]	1.12 [0.82, 1.55]
Cohesion (0–7)	<b>0.83 [0.77, 0.89]</b>	<b>0.88 [0.81, 0.95]</b>
Conflict (0–6)	<b>1.16 [1.09, 1.23]</b>	<b>1.11 [1.03, 1.19]</b>
Expressiveness (0–2)	<b>0.83 [0.69, 0.99]</b>	0.87 [0.71, 1.08]
Family functioning score (total 0–15)	<b>0.91 [0.88, 0.94]</b>	<b>0.93 [0.90, 0.97]</b>
Family functioning		
Poor (0–9)	1 <sup>a</sup>	1 <sup>a</sup>
Fair (10–12)	<b>0.71 [0.53, 0.96]</b>	0.92 [0.66, 1.28]
Good (13–15)	<b>0.49 [0.37, 0.65]</b>	<b>0.62 [0.45, 0.86]</b>

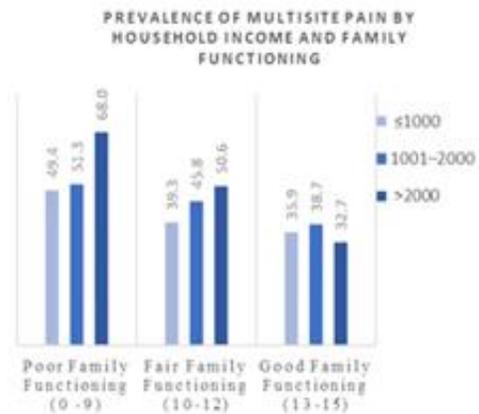
<sup>a</sup> Reference category for each variable is indicated by OR = 1. Bold values indicate statistically significant results.

Individuals experiencing six or more adverse childhood events showed a marginally elevated chance of indicating pain in multiple areas (OR 1.27; 95 percent CI 0.97, 1.68), though this link did not reach statistical significance. No additional meaningful connections emerged between adverse childhood experiences and indications of either multisite pain or long-term musculoskeletal discomfort.

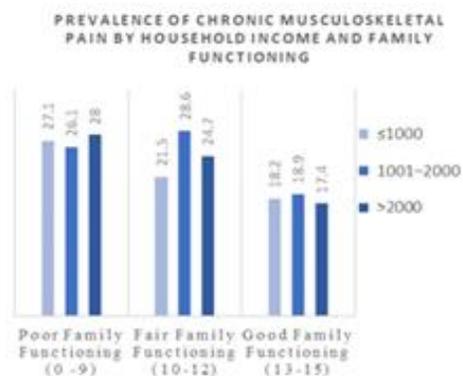
Strong household dynamics markedly reduced the likelihood of reporting pain across several sites and persistent musculoskeletal issues (OR 0.49; 95 percent CI 0.37, 0.65 for multisite; OR 0.62; 95 percent CI 0.45, 0.86 for chronic musculoskeletal). Greater familial unity correlated with diminished risks of these pain endpoints (multisite: OR 0.83; 95 percent CI 0.77, 0.89; chronic musculoskeletal: OR 0.88; 95 percent CI 0.81, 0.95), while elevated household tension raised the risks for both multisite and long-term musculoskeletal pain (OR 1.16; 95 percent CI 1.09, 1.23; OR 1.11; 95 percent CI 1.03, 1.19, respectively).

Subgroup examinations indicated no notable moderating effects of household dynamics with socioeconomic measures or ACEs on the pain results. Nevertheless, youths in homes with robust dynamics uniformly exhibited reduced rates of multisite and persistent musculoskeletal pain irrespective of socioeconomic strata or levels of childhood adversities. Exclusively among those in the ‘strong household dynamics’ category, the link between household dynamics and pain endpoints appeared attenuated for individuals whose mothers had modest education levels (**Figures 2 and 3**). In particular, within this category, those with mothers of lower education displayed a decreased rate of multisite pain (29.7 percent) relative to counterparts with medium

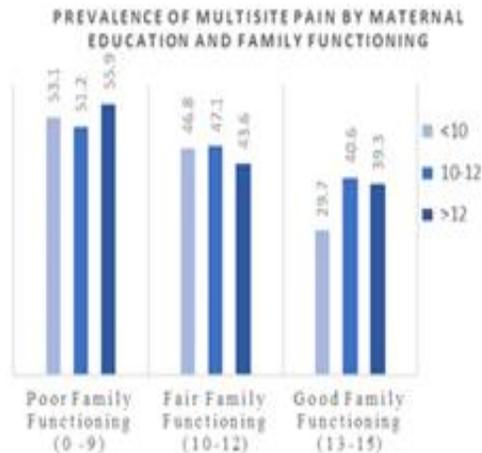
or advanced maternal education (40.6 percent and 39.3 percent, respectively;  $p = 0.030$  across groups). A comparable pattern emerged for long-term musculoskeletal pain in the identical category, approaching significance (14.6 percent, 20.3 percent, and 22.4 percent, respectively;  $p = 0.091$ )



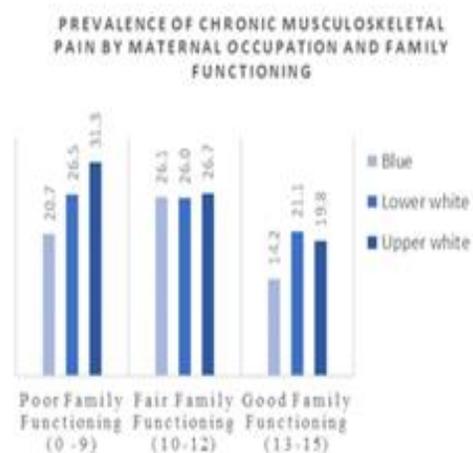
a)



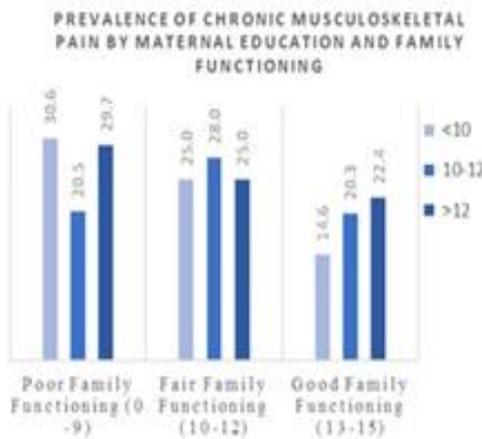
b)



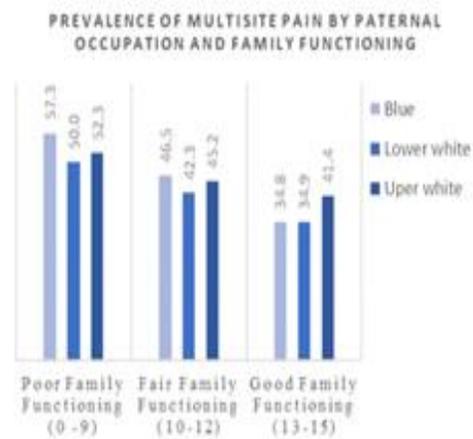
c)



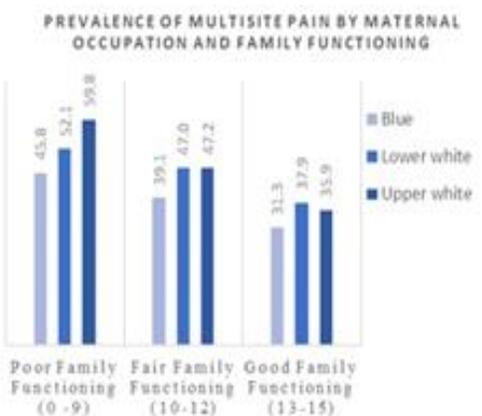
f)



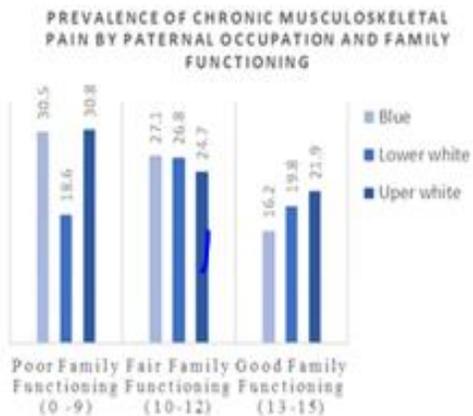
d)



g)

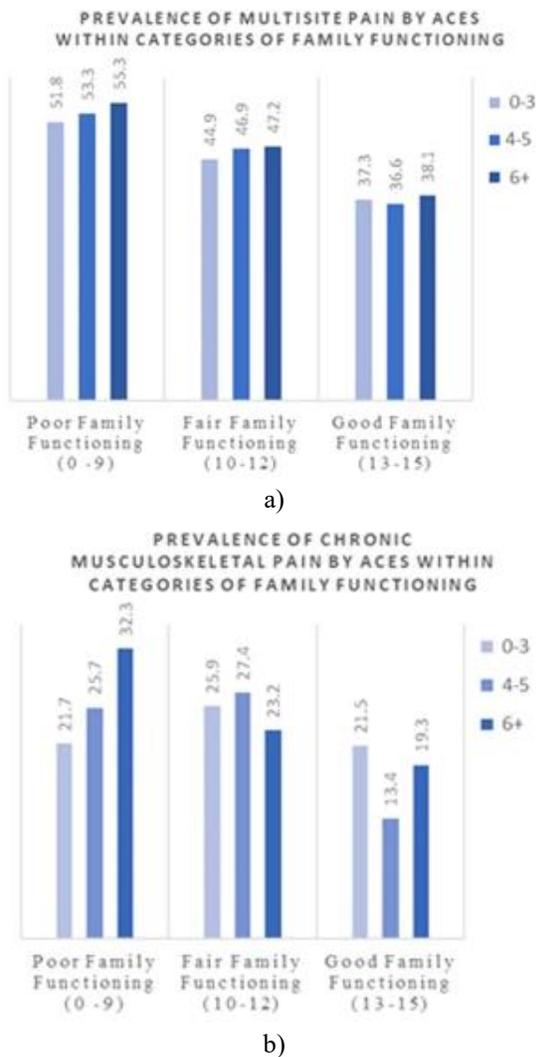


e)



h)

**Figure 2.** Prevalence of multisite and chronic musculoskeletal pain (%) by socioeconomic indicators within categories of family functioning. Generation XXI birth cohort study, Portugal, 2005/6 - 2025.



**Figure 3.** Prevalence of multisite and chronic musculoskeletal pain (%) by ACEs within categories of family functioning. Generation XXI birth cohort study, Portugal, 2005/6 - 2025.

In the present investigation, we explored the links between family functioning and pain-related outcomes, considering various socioeconomic indicators and adverse experiences in childhood. The findings indicate that 18-year-old adolescents reporting suboptimal family functioning—marked by reduced cohesion and expressiveness alongside elevated conflict—had elevated risks of experiencing multisite pain or chronic musculoskeletal pain, irrespective of socioeconomic backgrounds or prior childhood adversities. Environments characterized by strong support and cohesion in families were linked to reduced risks of

multisite and chronic musculoskeletal pain. Conversely, greater levels of family conflict correlated with increased risks. These observations emphasize the significance of familial dynamics in shaping adolescents' pain experiences, aligning with the biopsychosocial model's focus on the influence of proximate social contexts on pain processes [11]. Notably, although socioeconomic variables and adverse childhood experiences contribute substantially to overall health trajectories, they appeared to have a limited moderating effect on these associations at age 18.

These outcomes align with prior research conducted in the United States, where heightened pain levels were linked to greater functional impairment among children aged 7–17 years suffering from recurrent migraines in maladaptive family settings, but not in those with more supportive family structures [10]. In a similar vein, research by Palermo *et al.* revealed that adolescents aged 11–16 experiencing recurrent headaches in families with poorer functioning exhibited increased pain intensity and disability [27]. The emotional dysregulation and stress arising from familial discord may promote amplified central sensitization, thereby intensifying pain processing, which supports the need to target family conflict in therapeutic approaches to pain [28]. Additional insights from studies on juvenile rheumatic conditions highlight the reciprocal aspects of this association: youth with more severe symptoms, including frequent pain and fatigue, often displayed diminished illness-related attitudes and reduced family functioning [29].

The present dataset revealed that female participants had markedly higher probabilities of reporting multisite and chronic musculoskeletal pain compared to males, echoing patterns observed in earlier investigations. For instance, a cross-sectional Danish study indicated that girls aged 12–19 were approximately twice as likely as boys to experience multisite pain [3]. This elevated prevalence could stem from a combination of physiological and psychosocial elements, although the extent to which it is driven predominantly by biological mechanisms or other unmeasured influences remains uncertain [30].

Contrary to earlier research establishing connections between socioeconomic status and pain prevalence, the current study revealed that SES markers, such as household income and parental occupation, exerted minimal impact on the association between family functioning and pain outcomes at age 18 [31]. A

systematic review conducted by Sara King and colleagues similarly identified no consistent link between socioeconomic status and pain prevalence among children and adolescents [32]. Within that review, one investigation noted elevated pain rates in lower SES groups, especially for headaches, whereas others detected no relationship between pain and SES. A separate study from Nordic countries indicated that children aged 7–17 years from families with lower education or income exhibited marginally higher pain prevalence than those from higher-status households [33]. Although not the primary emphasis of our work, the socioeconomic gradient in pain appears more evident in adult populations. A comprehensive pan-European investigation demonstrated greater pain prevalence among adults of lower socioeconomic status, with the most substantial differences for hand and arm pain and the least for back and neck pain [34]. This pronounced gradient in adulthood likely stems from prolonged exposure to socioeconomic stressors and occupational risks. In comparison, the association is weaker in children and adolescents, potentially owing to the overriding influences of developmental processes, growth, and family dynamics on pain.

Intriguingly, when examining multisite pain prevalence according to maternal education and family functioning, adolescents who reported positive family relationships but had mothers with higher education displayed higher pain rates than those with mothers of low or intermediate education. This pattern may be attributable to elevated health literacy commonly linked to higher maternal education, which could foster increased awareness and reporting of pain symptoms [35]. For example, more educated mothers might be more attuned to minor health issues or more inclined to prompt their children to disclose symptoms, thereby elevating reported prevalence in this group. Moreover, greater educational levels may correlate with heightened sensitivity to health concerns and better access to health-related information, which could amplify pain reporting without indicating actual higher morbidity. Alternatively, the demands of high-achievement-oriented households might generate additional stress, leading to greater pain even within supportive family settings, highlighting the intricate interactions among family functioning, SES, and adolescent pain [36]. These interpretations are speculative, and further studies are warranted to explore the underlying psychosocial and contextual factors connecting maternal education to adolescent pain,

including household stress levels, parenting styles, or health-related behaviors.

Although previous investigations have documented robust links between greater numbers of adverse childhood experiences and heightened pain prevalence, our results provided only modest support for this association [16, 37]. We assessed ACEs reported at age 13 in relation to pain at age 18, in contrast to an earlier study in this cohort that linked ACEs in the first decade of life to pain at age 13, focusing particularly on multisite, high-intensity pain [16]. Additionally, the prior study benefited from a larger sample, which may account for differing outcomes. The evolution of pain and its mediating factors—such as coping mechanisms, social support, and mental health—may vary considerably between early childhood and adolescence, further accounting for these discrepancies.

Our results add to the expanding evidence base on the interactions between family functioning and adolescent pain, while illuminating nuances pertinent to the Portuguese setting. In nations like Portugal, where collectivist values emphasize the family's central role in society and child-rearing, family functioning may exert an especially strong influence on health outcomes, potentially differing from observations in more individualistic cultures, where peer and community factors might attenuate family effects [38, 39]. Such cultural variations could constrain direct cross-cultural comparisons or generalizations, especially to populations with greater diversity or less cohesive family structures. Key strengths of this study include its large, population-based cohort design, representing—to our knowledge—the first examination of family functioning's relation to youth pain across the social spectrum, a notably understudied domain. In contrast to much existing research relying on clinical samples of treatment-seeking individuals, our population-based approach encompasses adolescents who may not seek care or face substantial impairment, enabling identification of risk and protective factors prior to clinical escalation. Nonetheless, we regard this pain as clinically relevant, supported by recent cohort evidence linking multisite or chronic musculoskeletal pain in late adolescence to reduced quality of life [40]. This enhances the findings' generalizability and underscores their utility for broad prevention efforts. Limitations include the potential for bidirectional interpretation: while we primarily examined family functioning's impact on pain, results could also suggest pain influencing family functioning. Attrition in

the cohort may have introduced sociodemographic biases between participants and non-participants, though prior analyses detected no notable links between pain traits and sociodemographics, aside from maternal education [41]. Self-reported family functioning measures may be susceptible to recall or social desirability biases, affecting data precision. Generalizability may be restricted to comparable sociocultural, healthcare, and family contexts. Unmeasured residual confounders—such as concurrent psychological distress, personality factors, or broader family member assessments—as well as unexamined physical environmental elements like housing conditions, could also shape the associations.

### Conclusion

In summary, this investigation underscores family functioning's pivotal influence on adolescent pain across socioeconomic strata, with supportive environments offering protection and elevated conflict potentially worsening pain. While socioeconomic factors and adverse childhood experiences affect general health, their direct role in multisite or chronic musculoskeletal pain etiology seems constrained during adolescence. This implies that broad interventions promoting family cohesion and conflict management could benefit youth irrespective of background. Greater insight into these dynamics, especially across varied cultural and socioeconomic landscapes, is essential to advance knowledge and guide future interventions.

**Acknowledgments:** None

**Conflict of Interest:** None

**Financial Support:** None

**Ethics Statement:** None

### References

- Chambers CT Dol J Tutelman PR Langley CL Parker JA Cormier BT et al The Prevalence of Chronic Pain in Children and Adolescents: A Systematic Review Update and Meta-Analysis. *Pain* (2024) 165(10):2215–34. 10.1097/j.pain.0000000000003267
- Kamper SJ Henschke N Hestbaek L Dunn KM Williams CM . Musculoskeletal Pain in Children and Adolescents. *Braz J Phys Ther* (2016) 20(3):275–84. 10.1590/bjpt-rbf.2014.0149
- Rathleff MS Roos EM Olesen JL Rasmussen S . High Prevalence of Daily and Multi-Site Pain – A Cross-Sectional Population-Based Study Among 3000 Danish Adolescents. *BMC Pediatr* (2013) 13:191. 10.1186/1471-2431-13-191
- Gatchel RJ Peng YB Peters ML Fuchs PN Turk DC . The Biopsychosocial Approach to Chronic Pain: Scientific Advances and Future Directions. *Psychol Bull* (2007) 133(4):581–624. 10.1037/0033-2909.133.4.581
- Kapos FP Craig KD Anderson SR Bernardes SF Hirsh AT Karos K et al Social Determinants and Consequences of Pain: Toward Multilevel, Intersectional, and Life Course Perspectives. *J Pain* (2024) 25(10):104608. 10.1016/j.jpain.2024.104608
- Engel GL . The Need for a New Medical Model: A Challenge for Biomedicine. *Science* (1977) 196(4286):129–36. 10.1126/science.847460
- Palermo TM Holley AL . The Importance of the Family Environment in Pediatric Chronic Pain. *JAMA Pediatr* (2013) 167(1):93–4. 10.1001/jamapediatrics.2013.428
- Poppert Cordts KM Stone AL Beveridge JK Wilson AC Noel M . The (Parental) Whole Is Greater than the Sum of Its Parts: A Multifactorial Model of Parent Factors in Pediatric Chronic Pain. *J Pain* (2019) 20(7):786–95. 10.1016/j.jpain.2019.01.004
- Palermo TM Chambers CT . Parent and Family Factors in Pediatric Chronic Pain and Disability: An Integrative Approach. *Pain* (2005) 119(1-3):1–4. 10.1016/j.pain.2005.10.027
- Logan DE Scharff L . Relationships Between Family and Parent Characteristics and Functional Abilities in Children with Recurrent Pain Syndromes: An Investigation of Moderating Effects on the Pathway from Pain to Disability. *J Pediatr Psychol* (2005) 30(8):698–707. 10.1093/jpepsy/jsj060
- Lewandowski AS Palermo TM Stinson J Handley S Chambers CT . Systematic Review of Family Functioning in Families of Children and Adolescents with Chronic Pain. *J Pain* (2010) 11(11):1027–38. 10.1016/j.jpain.2010.04.005
- Bradley RH Corwyn RF . Socioeconomic Status and Child Development. *Annu Rev Psychol* (2002)

- 53:371–99.  
10.1146/annurev.psych.53.100901.135233
13. Conger RD Conger KJ Martin MJ . Socioeconomic Status, Family Processes, and Individual Development. *J Marriage Fam* (2010) 72(3):685–704. 10.1111/j.1741-3737.2010.00725.x
  14. Brown SM Schlueter LJ Hurwich-Reiss E Dmitrieva J Miles E Watamura SE . Parental Buffering in the Context of Poverty: Positive Parenting Behaviors Differentiate Young Children's Stress Reactivity Profiles. *Dev Psychopathol* (2020) 32(5):1778–87. 10.1017/S0954579420001224
  15. Walsh D McCartney G Smith M Armour G . Relationship Between Childhood Socioeconomic Position and Adverse Childhood Experiences (Aces): A Systematic Review. *J Epidemiol Community Health* (2019) 73(12):1087–93. 10.1136/jech-2019-212738
  16. Abrahamyan A Lucas R Severo M Talih M Fraga S . Association Between Adverse Childhood Experiences and Bodily Pain in Early Adolescence. *Stress Health* (2024) 40(4):e3383. 10.1002/smi.3383
  17. Alves E Correia S Barros H Azevedo A . Prevalence of Self-Reported Cardiovascular Risk Factors in Portuguese Women: A Survey After Delivery. *Int J Public Health* (2012) 57:837–47. 10.1007/s00038-012-0340-6
  18. Roth-Isigkeit A Thyen U Stöven H Schwarzenberger J Schmucker P . Pain Among Children and Adolescents: Restrictions in Daily Living and Triggering Factors. *Pediatrics* (2005) 115(2):e152–62. 10.1542/peds.2004-0682
  19. Fok CCT Allen J Henry D , People Awakening Team. The Brief Family Relationship Scale: A Brief Measure of the Relationship Dimension in Family Functioning. *Assessment* (2014) 21(1):67–72. 10.1177/107319111425856
  20. Da Silva AJT . Tradução e validação da escala The Brief Family Relationship Scale para a população portuguesa. [master's thesis]. [Leiria (PT)]: Instituto Politécnico de Leiria (2020). Available online at: <https://iconline.ipleiria.pt/entities/publication/0b1f4176-1573-4c71-9cae-f7ce9feb2eae> (Accessed September 1, 2024).
  21. Mishra A Gibson-Miller J Wood C . The Pandemic Within a Pandemic: Mental Health and Wellbeing of Racially Minoritised Women Experiencing Domestic Abuse During the COVID-19 Pandemic in the UK. *BMC Womens Health* (2024) 24:662. 10.1186/s12905-024-03502-4
  22. Soares S López-Cheda A Santos AC Barros H Fraga S . How Do Early Socioeconomic Circumstances Impact Inflammatory Trajectories? Findings from Generation XXI. *Psychoneuroendocrinology* (2020) 119:104755. 10.1016/j.psyneuen.2020.104755
  23. Sjöberg S . The PISA-Syndrome—How the OECD Has Hijacked the Way We Perceive Pupils, Schools and Education. *Confero* (2020) 7(1). 10.3384/confero.2001-4562.190125
  24. Instituto Nacional de Estatística. Classificação Portuguesa das Profissões: 2010. Lisboa: INE (2011). Available online at: <https://www.ine.pt/xurl/pub/107961853> (Accessed December 13, 2024).
  25. Felitti VJ Anda RF Nordenberg D Williamson DF Spitz AM Edwards V et al Relationship of Childhood Abuse and Household Dysfunction to Many of the Leading Causes of Death in Adults: The Adverse Childhood Experiences (ACE) Study. *Am J Prev Med* (1998) 14(4):245–58. 10.1016/S0749-3797(98)00017-8
  26. Lucas R Talih M Soares S Fraga S . Bullying Involvement and Physical Pain Between Ages 10 and 13 Years: Reported History and Quantitative Sensory Testing in a Population-Based Cohort. *J Pain* (2024) 25(4):1012–23. 10.1016/j.jpain.2023.10.022
  27. Palermo TM Putnam J Armstrong G Daily S . Adolescent Autonomy and Family Functioning Are Associated with Headache-Related Disability. *Clin J Pain* (2007) 23(5):458–65. 10.1097/AJP.0b013e31805f70e2
  28. Raposo B Francisco R . Emotional (Dys)Regulation and Family Environment in (Non)Clinical Adolescents' Internalizing Problems: The Mediating Role of Well-Being. *Front Psychol* (2022) 13:703762. 10.3389/fpsyg.2022.703762
  29. Iobst EA Nabors LA Brunner HI Precht B . Pain, Fatigue, Family Functioning, and Attitude Toward Illness in Children with Juvenile Rheumatic Diseases. *J Dev Phys Disabil* (2007) 19(2):135–44. 10.1007/s10882-006-9028-2
  30. Fillingim RB King CD Ribeiro-Dasilva MC Rahim-Williams B Riley JL 3rd . Sex, Gender, and Pain: A Review of Recent Clinical and Experimental

- Findings. *J Pain* (2009) 10(5):447–85. 10.1016/j.jpain.2008.12.001
31. Dorner TE Muckenhuber J Stronegger WJ Ràsky É Gustorff B Freidl W . The Impact of Socio-Economic Status on Pain and the Perception of Disability due to Pain. *Eur J Pain* (2012) 16(1):125–33. 10.1016/j.ejpain.2010.05.013.32
  32. King S Chambers CT Huguet A MacNevin RC McGrath PJ Parker L et al The Epidemiology of Chronic Pain in Children and Adolescents Revisited: A Systematic Review. *Pain* (2011) 152(12):2729–38. 10.1016/j.pain.2011.07.016
  33. Grøholt EK Stigum H Nordhagen R Köhler L . Recurrent Pain in Children, Socio-Economic Factors and Accumulation in Families. *Eur J Epidemiol* (2003) 18(10):965–75. 10.1023/A:1025889912964
  34. Todd A McNamara CL Balaj M Huijts T Akhter N Thomson K et al The European Epidemic: Pain Prevalence and Socioeconomic Inequalities in Pain Across 19 European Countries. *Eur J Pain* (2019) 23(6):1425–36. 10.1002/ejp.1409
  35. Zaidman EA Scott KM Hahn D Bennett P Caldwell PHY . Impact of Parental Health Literacy on the Health Outcomes of Children with Chronic Disease Globally: A Systematic Review. *J Paediatr Child Health* (2022) 19:12–31. 10.1111/jpc.16297
  36. Luthar SS Latendresse SJ . Children of the Affluent: Challenges to Well-Being. *Curr Dir Psychol Sci* (2005) 14(1):49–53. 10.1111/j.0963-7214.2005.00333.x
  37. Bussi eres A Hancock MJ Elklit A Ferreira ML Ferreira PH Stone LS et al Adverse Childhood Experience Is Associated with an Increased Risk of Reporting Chronic Pain in Adulthood: A Systematic Review and Meta-Analysis. *Eur J Psychotraumatol* (2023) 14(2):2284025. 10.1080/20008066.2023.2284025
  38. Ili eş A Zahid RA . The Impact of Europe’s individualism/collectivism on the International Trade. *Eur J Mark Econ* (2019) 2(1):6. 10.26417/ejme-2019.v2i1-59
  39. Lykes VA Kimmelmeier M . What Predicts Loneliness? Cultural Differences Between Individualistic and Collectivistic Societies in Europe. *J Cross Cult Psychol* (2014) 45(3):468–90. 10.1177/0022022113509881
  40. Pires C Talih M Gomes CF Mateus E Navasardyan N Nielsen CS et al Long-Term Effect of Pain History and Experimental Pain Responses on Adolescents’ Quality-of-Life: A Cohort Study. *J Pain* (2025) 26(9):105540. 10.1016/j.jpain.2025.105540
  41. Lucas R Talih M Monjardino T Guimar es S Barros H . Mother-Reported Pain Experience Between Ages 7 and 10: A Prospective Study in a Population-Based Birth Cohort. *Paediatr Perinat Epidemiol* (2021) 35(3):359–70. 10.1111/ppe.12730