Topical Review

PAIN 166 (2025) 1223–1229

PAIN

OPEN

Social determinants of health in pediatric chronic postsurgical pain research

Wendy Gaultney[a,*], Nathalia Jimenez[b], Abraham Correa-Medina[c], Claudia M. Campbell[d], Jennifer Anne Rabbitts[e]

1. Introduction

Chronic postsurgical pain (CPSP) is experienced by 1 in 4 children after major surgery.[28] Recent literature documenting the magnitude of this problem stimulated a surge in research to understand risk factors for pediatric CPSP. The recent addition of CPSP to International Classification of Diseases 11th Revision pain diagnoses opened avenues for epidemiologic studies.[43] While some progress is being made in understanding biological and psychological determinants of pediatric CPSP,[31] knowledge on how social determinants of health (SDOH) may influence development and impact of CPSP is lagging. Further, children from minoritized backgrounds have a lower incidence of surgery and are underrepresented in perioperative research; thus, the prevalence rates of CPSP are based on predominantly White samples.[11]

More than 2 decades have passed since "The Unequal Burden of Pain: Confronting Racial and Ethnic Disparities in Pain" called attention to pervasive social inequities in health care that manifest as disparities in pain outcomes.[10] Social inequities are likely intensified in the perioperative setting. Medical decision-making and surgical referral patterns delay surgical care for patients from minoritized backgrounds.[13] Racial differences exist in analgesic prescriptions to children, with providers' race and ethnicity playing a substantial role in variability.[12] Given that poorly controlled postoperative pain is the strongest risk factor for development of CPSP,[37] undertreatment of pain may lead to disparities in CPSP for minoritized children.

The National Institutes of Health (NIH) announced its vision to enhance diversity, equity, inclusion, and accessibility across NIH[23] including in pain and opioid research.[24] Recently, the Antiracism CoaliTION in Pain Research (ACTION-PR) identified challenges in pain research, including inadequate conceptualization of SDOH in pain research and a resultant lag in concerted efforts across pain research to integrate SDOH.[21] The perioperative context has unique opportunities to engage diverse populations and investigate SDOH. The Conceptual Model of Biopsychosocial Mechanisms of Transition from Acute to CPSP in Children and Adolescents[31] provides a framework on which to demonstrate potential influence of social factors on key drivers of CPSP and to guide CPSP research in conceptualizing and incorporating SDOH.

The objectives of this review are to (1) identify barriers and facilitators to examining SDOH in existing pediatric CPSP research, using the National Institute on Minority Health and Health Disparities (NIMHD) Research Framework, and (2) provide recommendations to examine SDOH in the context of perioperative CPSP research, supported by an updated conceptual model to guide study conceptualization, design, and reporting, with the goal of increasing inclusivity and generalizability of pediatric CPSP research. Noting that implementation is beyond the scope of this article, we refer the reader to the NIMHD framework[25] and ACTION-PR series[21] for comprehensive guidelines for developing research teams, research design, implementation, dissemination, and ongoing evaluation.

2. Social determinants of health in pediatric chronic postsurgical pain: review of current state

2.1. Methods

We reviewed studies published in the past 10 years included in the recently updated systematic review examining risk factors for pediatric CPSP.[28,36] Fifteen prospective studies examining biological, psychological, and social risk factors for pain at 3 to 12 months after surgery in children 6 to 18 years of age were included. We applied the NIMHD Framework[25] to evaluate consideration of SDOH as contributors to CPSP, providing a structure for evaluation of the compounding effects of biological, behavioral, environmental, sociocultural, and health-care factors on individual health outcomes. This framework highlights the cumulative longitudinal effect and defines factors that are protective or deleterious on an individual's health outcomes. It aligns with the aforementioned conceptual model of CPSP that describes the longitudinal trajectory from surgical injury, and risk and resiliency mechanisms including the role of emotion, cognition, and behavioral factors of the patient and family, in impacting postoperative pain and health outcomes.[31]

Two reviewers independently read the full text of each manuscript to examine the inclusion of SDOH in 3 phases of research: (1) study conceptualization (explicitly hypothesized as possible risk factors for CPSP), (2) study design (eligibility criteria,

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Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

[a] *Department of Anesthesiology, University of Colorado School of Medicine, Aurora, CO, United States,* [b] *Department of Anesthesiology and Pain Medicine, University of Washington School of Medicine, Seattle, WA, United States,* [c] *School of Medicine, University of Washington, Seattle, WA, United States,* [d] *Department of Psychiatry and Behavioral Sciences, Johns Hopkins University School of Medicine, Baltimore, MD, United States,* [e] *Department of Anesthesiology, Perioperative, and Pain Medicine, Stanford University School of Medicine, Stanford, CA, United States*

**Corresponding author. Address: Department of Anesthesiology, University of Colorado School of Medicine, 13123 East 16th Ave, Aurora, CO 80045, United States. Tel.: (720)7779038; fax: (720) 777-7275. E-mail address: wendy.gaultney@cuanschutz.edu (W. Gaultney).*

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.painjournalonline.com).

http://dx.doi.org/10.1097/j.pain.0000000000003510

measurement of SDOH, inclusive implementation methods, and statistical analysis of SDOH), and (3) reporting of results (or acknowledging SDOH in the limitations section).

2.2. Results

Table 1 presents findings of the 15 manuscripts meeting inclusion criteria.[2–4,6,7,16,23,28,34–36,39–42,45] Overall, most studies did not consider SDOH in study aims; thus, examination and interpretation of SDOH was limited. Further, eligibility criteria and implementation methods introduced significant barriers to participation of minoritized children in CPSP research, reflected by low diversity in study samples, with few studies reporting these limitations.

2.2.1. Study conceptualization

Two studies incorporated SDOH as part of the evaluation of risk factors of CPSP in study aims/hypotheses. In these studies, SDOH evaluated were limited to parental education, income, and family functioning.[7,33]

2.2.2. Study design

Of the 15 studies included in this review, all included limited language proficiency as an exclusion (12 required English proficiency, one French/English, and one Dutch proficiency; one listed "insufficient understanding" as exclusionary); 10 reported excluding participants with a disability diagnosis and 8 excluded for medical complexity. Further potential participation barriers included exclusive use of digital data capture methods (2 studies). Although data shows access to digital devices is ubiquitous across sociodemographic status, overcoming participation barriers for many, for others, access may be unreliable, presenting a barrier to participation requiring alternative methods to bridge the digital gap experienced primarily by minoritized racial and ethnic populations.[1] Nine studies report the race and ethnicity of their participants, 4 measured at least one socioeconomic characteristic, and 2 included these in their analyses as potential risk factors.[6,7] Given the limited diversity of the study populations and measurement of SDOH, further evaluation of SDOH analyses was not possible.

2.2.3. Reporting of results

In the majority of studies, aggregate data for groups from minoritized backgrounds were presented in a single "Other" category, potentially introducing bias into results by condensing heterogenous groups. Only 2 studies reported lack of diversity in the study population as a limitation.[22,33]

3. Recommendations for examining social determinants of health in pediatric chronic postsurgical pain research

Proactively emphasizing diversity and inclusion is important at all stages of research, and while we provide specific recommendations for research design and implementation in the perioperative context (**Table 2**), the NIMHD framework[25] and ACTION-PR series[21] provide comprehensive implementation guidelines.

3.1. Study conceptualization

The Conceptual Model of Biopsychosocial Mechanisms of CPSP[31] depicts the continuum of transition from acute nociceptive pain to CPSP. The updated model, presented here with integration of SDOH, highlights changes that may occur in psychological, behavioral, and social factors, as well as epigenetic, immune, and endocrine responses after surgery, occurring in the context of premorbid patient and environmental factors (**Fig. 1**). Social determinants of health affect individuals at all levels (ie, individual, interpersonal, community, and societal) and across a multitude of systems (ie, biological, psychological, behavioral, physical, and socio-cultural environment, and heazlthcare).[19,25] In the perioperative setting, children and their families' socio-cultural (language, sociodemographic, identities, social support) and socio-economic (income, education, transportation, distance to hospital) environments intersect with healthcare system factors (eg, surgery access, health insurance), to influence treatment factors (eg, delay in surgical care, preoperative medical decision making, patient-clinician interaction) and impact perioperative experience (eg, ability for parent to be at bedside) and quality of clinical care (eg, preoperative preparation, pain treatment, postoperative education, and monitoring). Further, SDOH such as the experience of racism and experience of early life trauma may result in biological (eg, increased allostatic load expressed by metabolic, immune, and neuroendocrine changes) and psychological and behavioral vulnerabilities, which influence recovery from surgery.[9,20] Together the intersection of environmental and healthcare factors, biological, psychological and other social processes, and perioperative treatment experiences have significant potential for lasting impact on postoperative pain and health outcomes.

A growing body of research aims to probe the mechanisms by which SDOH influence pain risk, experience, and impact across populations[17]; however, research examining mechanisms of social determinants of pain *in children* has lagged. Current models indicate a complex interplay of biological, psychological, and social factors. For example, SDOH have been found to moderate the relationship between biological risk and mental health outcomes (a psychological factor) amongst motor vehicle collision survivors, where protective SDOH (based on neighborhood, education, social support) improved post-traumatic stress and depression for individuals with high genetic risk.[20] Emerging research hypothesizes that early life experiences of trauma modify the relationship between allostatic load and mental health outcomes.[9] It is critical that research examining the influence of SDOH on CPSP in children not only characterizes the problem but probes contributory mechanisms.

3.2. Study design

To engage children undergoing surgery in research, it is important to understand families' experience from the first discussion regarding surgery through full recovery. The perioperative period is a stressful time during which families face significant personal, financial, and emotional burdens that could be amplified for families with socioeconomic vulnerability. To better serve families from minoritized groups, who may have personally or vicariously experienced discrimination in the health care, it is key to have research teams that better reflect the participants' own backgrounds. Having a diverse group of contributors, including representatives from groups affected by SDOH, engaged throughout the study process brings varied perspectives, reduces biases, fosters trust, and can encourage research participation. Research teams may consider establishing patient/family advisory boards to inform research design and implementation and adequately reimbursing for their time as research advisors. Solutions for Kids in Pain provides online resources for

Table 1

Summary of social determinants of health in pediatric factors in pediatric chronic postsurgical pain research papers.

Study	N	Mean age in years (range)	Sex (F/M)	Surgery type	Race/Ethnicity (as reported by authors)	Socioeconomic characteristics	Summary of inclusive practices (N=15 studies)		
Bailey et al.[2]	220	14.6 (10-20)	189/31	Spinal fusion	NR	NR	Inclusion of SDOH in Study Hypothesis Considered SDOH as risk factors for CPSP: N = 2	Inclusion of SDOH in Study Design Population eligibility: Exclusion by language proficiency: N = 15 Exclusion by disability status: N = 10 Exclusion by medical complexity (ASA > 2): N = 8 Measurement of SDOH: Included race or ethnicity: N = 9 Included socioeconomic factors: N = 4 Inclusive implementation methods reported in manuscript: N = 0 Data analysis including SDOH variable: N = 2	Inclusion of SDOH in Outcomes and Reporting Reporting of SDOH as risk factor: N = 1 Acknowledgement of low diversity: N = 2
Batoz et al.[3]	258	12.07 (6-18)	102/156	Elective surgery	NR	NR			
Beeckman et al.[4]	100	15.19 (12-18)	77/23	Spinal fusion	White 99%, Asian 1%	Education: Primary school 2%, high school 98%			
Chidambaran et al.[6]	144	14.4 (10-18)	106/38	Spinal fusion	Caucasian 84.9%* No mention of other races	NR			
Connelly et al.[7]	50	14.5 (11-17)	41/9	Spinal fusion	Caucasian 87%, African-American 13%*	Family income: Median annual combined family income = $60,000			
Julien-Marsollier et al.[16]	36	15 (<18)	31/5	Spinal fusion	NR	NR			
Narayanasamy et al.[22]	144	14.88 (>8)	93/51	Spinal fusion Nuss procedure	Caucasian 81%, African-American 12%, other 7%* Non-Hispanic 96%	NR			
Perry et al.[27]	36	14 (10-17)	27/9	Spinal fusion	White 58.3%, Black 11.1%, Asian 5.6% Other/Missing 25%	NR			
Rabbitts et al. (2015)[35]	60	14.7 (10-18)	40/20	Spinal fusion Nuss procedure	White 83.4%, African-American 3.3%, Asian 3.3%, Other/NR 10% (race), non-Hispanic 88.3% Hispanic 1.7%, NR 10% (ethnicity)	Family income <$29,000 = 13%, $30,000-$69,000 = 25.1%, >$70,000 = 55.8%, not reported = 6.6%			
Rabbitts et al.[33]	119	14.9 (10-18)	75/44	Spinal fusion Nuss procedure Hip/Femur osteotomy	White 78.2%, African-American 4.2%, Asian 3.4%, Other/NR 14.2% (race), non-Hispanic or Latino 86.6% Hispanic or Latino 8.4%, NR 5% (ethnicity)	Family income <$29,000 = 6.7%, $30,000-$69,000 = 25.2%, >$70,000 = 63.0%, not reported = 5.0% Parental education High school or less 13.4%, some college 26.1%, Bachelor's degree or higher 58.0%, not reported 2.5%			
Rosenbloom et al.[38]	265	14.1 (8-18)	155/110	Orthopedic surgery General surgery	Caucasian 65.95%, African Canadian 6.03%, South Asian 5.60%, East Asian 4.35%, African Caribbean 1.72%, Hispanic 1.72%, Aboriginal 1.29%, other 11.64%*	NR			
Rosenbloom et al.[39]	79	14.56 (8-18)	46/33	Orthopedic surgery General surgery	NR	NR			
Sieberg et al.[40]	32	13.9 (10-17)	25/7	Spinal fusion	White 87.5%, Black 9.375%, Asian 3.125%	NR			

(*continued on next page*)

Table 1 *(continued)*

Study	N	Mean age in years (range)	Sex (F/M)	Surgery type	Race/Ethnicity (as reported by authors)	Socioeconomic characteristics	Summary of inclusive practices (N=15 studies)
Siemer et al.[41]	76	NR (10-17)	59/17	Spinal fusion	NR	NR	
Voepel-Lewis et al.[44]	95	14.07 (10-17)	72/23	Spinal fusion	NR	NR	

Sample size (N) represents the number of participants included in analysis.
Socioeconomic factors include family income, insurance, education, health literacy, and employment status.
* Indicates terms used by the original authors.
NR, none reported; SDOH, social determinants of health.

partnering with patients for a variety of activities, including patient-partner compensation guides for research teams to adapt for their own research.[42] Further, pragmatic research designs generally have broader inclusion criteria and fewer participation barriers, potentially facilitating greater inclusivity and generalizability.

Incorporating SDOH a priori in study design is vital to understanding the impact of disparities across the pediatric perioperative experience, in particular disparities in acute pain management, a known risk factor for CPSP. For example, differences have been documented in acute pain management provided to children from minoritized racial and ethnic backgrounds. Black and Latino children are less likely to receive opioids for surgical pain including the postoperative period as inpatients and at home.[8,15] Disparities in postsurgical pain management also exist because of communication barriers among children and families who speak a language other than English,[14] and addressing language barriers has been shown to decrease disparities in pain treatment. In a pediatric surgical cohort, children of families with limited English proficiency who received interpretation at least 2 times a day received the same analgesic treatment compared to English-speaking children; those who did not receive interpretation received fewer opioids.[14] Education and health literacy are also important SDOH. Understanding of illness and treatments is associated with higher levels of self-efficacy when managing pain.[18]

Given that children from minoritized backgrounds are underrepresented in surgical populations because of disparities in access to care,[29] it is imperative for studies to prioritize participation of patients from minoritized backgrounds. Exclusion based on language proficiency results in a significant gap in the diversity of the research cohorts, skewing the sample, and limiting ability to study populations that may be at heightened risk for CPSP. This is also true for exclusion based on disability and medical complexity. For example, language is a key sociocultural factor that affects an individual's health outcomes.[25] Patients and caregivers who cannot communicate in the language of the healthcare system face barriers in communication that affect access to care (ie, their ability to obtain surgery for their child). Once they access care, communication barriers with clinical providers may influence communication of pain needs and reporting on the adequacy of pain treatment, both key aspects of the quality of acute pain management. Chronic postsurgical pain researchers are encouraged to expand inclusivity to major languages spoken in their community. While hiring bilingual coordinators is ideal, sometimes this may not be feasible. In those situations, researchers should investigate other resources that may exist to include language diverse families. For example,

Table 2

Recommendations for incorporating social determinants of health in pediatric chronic postsurgical pain research projects.

Recommendation	Examples
Include SDOH in study conceptualization	Develop and test research questions investigating SDOH on CPSP outcomes (eg, examining sociocultural factors in addition to commonly measured individual and family psychological and social variables in perioperative research)
Integrate SDOH in study design	Hire language bilingual research staff and include researchers and coordinators representing diverse cultures, including representatives from groups affected by SDOH Include patient-partner input in research design, and patient partners (eg, surgical patients, caregivers, and siblings) in research teams. Center these voices in all aspects of design Include participants with limited language proficiency in investigator's primary language, considering local population and using available resources (eg, hospital language interpreters, written translation services) Consider inclusion of participants with disabilities and high medical complexity as appropriate Prioritize research recruitment sites that serve more diverse populations Consider inclusion of broader surgery populations Consider potential participation barriers. For example, provide transportation, provide alternative methods to participation in electronic studies (eg, provide devices to families where needed and feasible; optional written daily diaries of symptoms)
Report SDOH in publications	Describe inclusive methods and barriers faced to inclusion Report all racial and ethnic identities instead of one aggregate "other" category. List multiracial identities with all self-described terms Acknowledge low diversity of sample if the sample does not reflect the general population Disseminate research findings equitably (eg, appropriate outlets and in languages spoken by those affected)

CPSP, chronic postsurgical pain; SDOH, social determinants of health.

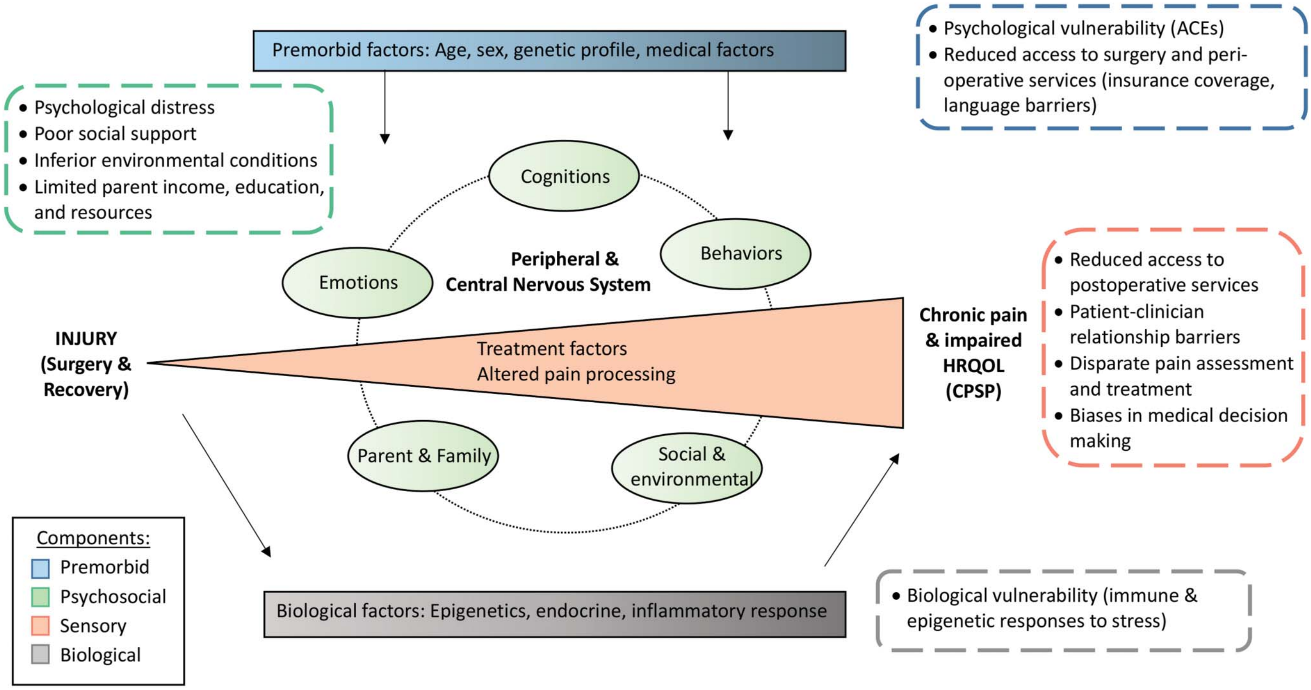

Figure 1. Conceptual model of biopsychosocial mechanisms of transition from acute to chronic postsurgical pain (CPSP): influence of social determinants of health (SDOH).

hospital translators may be available for communication with non–English-speaking parents,[18] or artificial intelligence software may facilitate initial drafting before refining with translators. One common concern among investigators is the availability of instruments in languages other than English, and ensuring these are culturally and health literacy appropriate.[5] Based on our review, we have generated a list of available language translations and validation studies of the measures included in the review of risk factors in pediatric CPSP research (see Supplemental table, http://links.lww.com/PAIN/C197). The NIH Help End Addiction Longterm Initiative Common Data Elements Repository also provides some translations of measures commonly used in pediatric pain research (see https://heal.nih.gov/data/common-data-elements-repository).

Another potential opportunity to enhance diversity is to prioritize research recruitment sites that serve more diverse populations; for example, recruitment from surgery centers located in socio-economically diverse geographic locations. A further strategy is to incorporate broader groups of surgical procedures. To illustrate, in one longitudinal study with children undergoing spine and chest wall surgeries, 83.4% of the sample were White, non-Hispanic.[30] In a separate longitudinal study, by the same investigators at the same institution during a similar timeframe, including children undergoing general inpatient surgeries, 56% of the sample were White, non-Hispanic.[32] While various factors may have contributed to sample composition, expanding studies to broader surgeries when it aligns with study aims may contribute to increased representation and our overall understanding of the role of SDOH in CPSP outcomes. Illustrating another creative solution in study design, access to a smart device was initially a criterion for inclusion in a clinical trial testing an mHealth intervention for prevention of CPSP[34]; however, this criterion was subsequently removed by providing devices to participants who would otherwise not be able to participate.

In terms of measurement, gathering of data on race and ethnicity continues to be relevant, as is measurement of socioeconomic and sociocultural factors, which may influence the perioperative experience and drive disparities in the perioperative pain and health outcomes. Although, as a sociopolitical construct, race cannot be considered a risk factor for CPSP, race is an important aspect of an individual's identity, affecting the social experience, the environment, and in some cases, socio-economic status and education, which in turn affect children's healthcare experiences.

3.3. Reporting of results

Several improvements can be made in study reporting in CPSP research. First, clear acknowledgement of diversity of samples or lack thereof is a critical step. Given that the "other" racial category represents heterogenous groups, aggregation limits ability to understand SDOH in this context. Rather, standard practice is to report racial and ethnic identities as reported by participants.[26] Recognizing the improbability that researchers will overcome all barriers to inclusion, acknowledging limitations such as low diversity of the sample highlights for readers the common invisibility of minoritized populations and ensures limitations to generalizability of the study findings are considered. In addition, dissemination back to minoritized populations is a step that is seldom taken. It is crucial to ensure that access to study outcomes is equitable across study sample and populations of interest (eg, language translations of study results).

4. Conclusions

Despite knowledge that risk factors for CPSP are higher among minoritized populations, a chasm exists regarding SDOH and CPSP. Progress is currently hindered by a lack of diversity in CPSP study populations. Research examining the influence of SDOH on development of CPSP in representative samples of children and adolescents is urgently needed.

Conflict of interest statement

The authors have no conflicts of interest to declare.

Acknowledgments

J.A.R. was supported by National Institutes of Health National Institutes of Arthritis, Musculoskeletal, and Skin Diseases under award number by K24AR080786-02 (PI: Rabbitts). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Supplemental digital content

Supplemental digital content associated with this article can be found online at http://links.lww.com/PAIN/C197

Article history:
Received 25 July 2024
Received in revised form 31 October 2024
Accepted 7 November 2024
Available online 5 February 2025

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