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Literature Review: The Developmental Blindspot in Pain-Psychology Research

Introduction

The comorbidity between chronic pain and psychological distress affects over 100 million adults and costs $600 billion annually in the United States (Institute of Medicine, 2011). Dahlhamer et al. (2018) reported prevalence of chronic pain and high-impact chronic pain among U.S. adults in 2016, with age-stratified data showing increases from 18% in young adults to over 30% in older adults. Their analysis documented prevalence patterns but did not examine whether pain's psychological impact follows the same age trajectory—or a different one entirely.

Decades of research have established associations between pain and depression (Bair et al., 2003), anxiety (McWilliams et al., 2003), and functional impairment (Turk, 2002). What remains unexplored is whether the psychological impact of specific pain patterns changes systematically across the adult lifespan.

No study has used consistent methodology to map how pain-psychology relationships evolve from emerging adulthood through late life. Isolated studies examine pain in specific age groups, but without lifecycle comparisons, current clinical approaches may misidentify at-risk individuals and misallocate intervention resources in ways that are impossible to detect from within any single age bracket.

The Static Pain Paradigm: A Flawed Foundation

Universal Assumptions in an Age-Diverse World

Current pain assessment and treatment guidelines operate on an implicit assumption: that pain's psychological impact is fundamentally similar across ages, varying only in prevalence or severity (Kroenke et al., 2011). The predominant clinical tools—the Brief Pain Inventory (Cleeland & Ryan, 1994), McGill Pain Questionnaire (Melzack, 1975), and Von Korff's (1992) graded chronic pain scale—were validated in age-heterogeneous samples without testing for age-specific psychometric properties or differential psychological impacts.

This assumption persists despite evidence that aging alters pain processing pathways through reduced descending inhibition and increased central sensitization (Gibson & Farrell, 2004; Edwards et al., 2016), psychological coping mechanisms through improved emotional regulation (Charles & Carstensen, 2009), social role expectations across developmental stages (Arnett, 2000), neuroplastic responses to chronic stressors (McEwen, 2017), and endogenous pain modulation systems (Naugle et al., 2013).

The Averaging Fallacy

Meta-analyses of pain-depression comorbidity report pooled odds ratios of 2–4 (Bair et al., 2003; IsHak et al., 2018), but these aggregate estimates may mask age-specific variations. De Heer et al. (2014) found pain and depression mutually reinforce each other with concurrent associations of similar magnitude, but their sample spanned ages 18–93 without stratification, making it impossible to detect developmental differences in these associations.

This pattern recurs in recent work. Aaron et al. (2025) examined prevalence of depression and anxiety among adults with chronic pain using broad age ranges without stratification. Werneck and Stubbs (2024) demonstrated bidirectional associations between chronic pain and depressive symptoms in middle-aged and older adults but combined these distinct developmental periods, missing potential differences between midlife vulnerability and late-life resilience.

Emerging Adulthood: The Understudied Pain Population

Systematic Exclusion from Pain Research

Emerging adults (18–29 years) are both understudied in pain research and, on theoretical grounds, potentially the most vulnerable to pain's psychological effects. Major epidemiological studies consistently report the lowest pain prevalence in this group (15–25%), rising linearly with age (Fayaz et al., 2016; Mills et al., 2019). This low prevalence has contributed to their exclusion from "working age" studies (often beginning at 30+), their absence from geriatric pain research, and their separation into adolescent studies using different measurement tools.

Murray et al. (2021) found age-related differences in cognitive-affective processes in adults with chronic pain, with pain interference varying across age groups. However, their broad age categories prevent identification of specific vulnerability windows within young adulthood.

The Untested Vulnerability Hypothesis

No study has examined whether young adults show disproportionate psychological vulnerability to specific pain patterns—particularly mild but persistent pain that might disrupt developmental tasks. Oosterwijk et al. (2025) found that pain correlates with mental health and psychosocial functioning in young people attending primary mental health care, but studied a clinical population rather than examining age-comparative patterns. Without lifecycle comparisons, we cannot determine whether young adults with mild persistent pain differ in psychological vulnerability from older adults with identical pain profiles.

The hypothesis that a 22-year-old with daily mild pain experiences greater psychological impact than a 72-year-old with identical symptoms has theoretical support but no empirical test. Independent of pain, depressive symptoms follow a U-shaped trajectory across adulthood, with the highest levels in young adulthood declining through midlife before rising again in old age (Sutin et al., 2013). Layering chronic pain onto an already high-distress developmental period could produce compounding effects that disappear in age-averaged analyses.

Several mechanisms could produce age-differential impact: greater violation of age-normative expectations (pain is uncommon in this group and perceived as belonging to older life), disruption of career establishment and relationship formation, a longer projected disability trajectory affecting life planning, less developed coping repertoires, and higher future orientation that may amplify distress about chronic conditions (Carstensen et al., 2003).

Middle Age: Peak Burden, Minimal Investigation

Convergent Demands and Rising Pain

Middle-aged adults (40–65 years) carry maximum productive burden while experiencing rising pain prevalence (40–50%) with accelerating trajectory (Mansfield et al., 2016), peak work disability rates from pain conditions (Perruccio et al., 2007), simultaneous caregiving responsibilities for children and aging parents, hormonal transitions affecting pain processing, and peak prevalence of pain catastrophizing (Ruscheweyh et al., 2011).

Recent studies hint at middle-age vulnerability without directly testing it. Delgado-Gallén et al. (2021) found cognitive reserve protects mental health in middle-aged adults with chronic pain—suggesting this age group needs such protection—though they did not compare across age groups. Thomas et al. (2007) found pain's impact on mental health was strongest in middle age. Yet no research has systematically tested whether this convergence of demands creates peak psychological vulnerability to pain across different pain patterns.

The Work-Life Pain Nexus

The intersection of pain, work demands, and psychological health in middle age remains largely unexamined. Schofield et al. (2008) documented that work disability from pain peaks at 45–54

years, but no research has tested whether pain's psychological impact intensifies during peak career years, whether role strain amplifies pain-mood associations differentially by pain pattern, whether middle age represents a critical intervention window, or whether "sandwich generation" stress multiplies pain's psychological burden.

Late Life: Resilience, Vulnerability, or Measurement Failure?

The Geriatric Pain Paradox

Older adults present a well-documented but poorly explained pattern: highest chronic pain prevalence (over 50% in adults 65+; Patel et al., 2013), greatest disease burden and functional limitation, yet potentially lower psychological impact for equivalent pain (Thomas et al., 2004) and better pain coping despite worse pain (Molton & Terrill, 2014).

Three competing hypotheses address this paradox, none adequately tested.

First, developmental resilience. Socioemotional selectivity theory predicts improved emotion regulation with age (Carstensen, 1992; Carstensen et al., 2003). Burr et al. (2020) demonstrated that older adults are more emotionally stable and better at regulating desires in everyday life. Carstensen et al. (2010) showed emotional experience improves with age based on over 10 years of experience sampling, and Charles (2010) found older adults show reduced emotional reactivity to daily stressors. But the resilience account is incomplete. Longitudinal data from the Baltimore Longitudinal Study of Aging show depressive symptoms increase again after midlife, persisting even after accounting for disease burden, functional limitations, and proximity to death (Sutin et al., 2013). Late-life psychological vulnerability is not reducible to physical decline alone.

Second, survivorship bias. Those reaching old age with chronic pain may represent a resilient subpopulation, with more vulnerable individuals experiencing earlier mortality or institutionalization.

Third, measurement insensitivity. Current tools may miss age-specific manifestations of pain-related distress. Older adults may express distress somatically rather than affectively, or normalize pain as expected in aging (Gagliese & Melzack, 1997). Arola et al. (2010) found temporal relationships between self-reported pain interference and symptoms of anxiety and depression in community-dwelling older adults, suggesting vulnerability persists but may manifest differently than tools are designed to detect.

Daily Mild Pain in Late Life

Epidemiological data show high prevalence of daily mild pain in older adults, often dismissed as normal aging. Denkinger et al. (2014) found that multisite pain, pain frequency, and pain severity are all associated with depression in older adults from the ActiFE Ulm study. No study has

examined whether daily mild pain constitutes a distinct high-risk phenotype in late life—one potentially indicating cumulative allostatic load from chronic low-grade inflammation, depleted reserve capacity that makes mild pain more impactful, prodromal neurodegenerative changes (Whitlock et al., 2017, found pain predicts cognitive decline), or social isolation risk from reduced activity tolerance.

Population-level data reinforce this complexity. Dueñas et al. (2025) found chronic pain prevalence in Spain peaks at 30.6% in the 55–75 age group before declining in older cohorts, a pattern that may reflect survivorship bias, cohort effects, or underreporting among the oldest adults.

The Frequency-Intensity Confusion: Missing the Developmental Dimension

Beyond Von Korff: The Need for Age-Specific Gradients

Von Korff's (1992) graded chronic pain scale advanced the field by combining pain intensity and disability but has three limitations relevant here: it assumes frequency-intensity relationships are age-invariant, it does not separate frequency from intensity effects, and it was validated in mixed-age samples without age-stratified analysis.

Recent methodological work supports separating pain dimensions. Kjøgx et al. (2014) found that pain frequency moderates the relationship between pain catastrophizing and pain, suggesting frequency and intensity operate through distinct psychological pathways. Schneider et al. (2020) demonstrated that different indices of pain intensity derived from ecological momentary assessment detect different treatment effects, while earlier work (Schneider et al., 2012) showed individual differences in day-to-day pain variability relate differently to psychological variables. None of these studies examined whether frequency-intensity relationships vary systematically with age.

Pain Interference: The Missing Mediator?

Pain interference is a plausible but developmentally unexamined pathway between pain and depression. Wicksell et al. (2016) demonstrated that pain interference mediates the pain-depression relationship in pediatric chronic pain, but this mediation pathway has not been tested across adult developmental stages. Young adults might experience greater interference with developmental tasks (career establishment, relationship formation) while older adults might normalize functional limitations. Boggero et al. (2015) found pain intensity moderates the relationship between age and pain interference in chronic orofacial pain patients, suggesting age-pain interactions that require systematic investigation.

Psychological Outcomes: Age-Specific Manifestations?

Depression Subtypes Across Development

Pain-depression comorbidity is well-established (30–54% prevalence; Rayner et al., 2016), but no studies have examined whether pain triggers specific depressive symptoms at different ages. Young adults might show more anhedonia given greater disruption of rewarding activities and future goals. Middle-aged adults could manifest more dysphoria related to role failure and unmet expectations. Older adults may express distress through somatic symptoms as a culturally acceptable idiom.

Preliminary support for age-differentiated patterns comes from Sutin et al. (2013), who found somatic depressive complaints increased more steeply in old age than depressed affect or interpersonal problems, and that women showed higher depressed affect in young adulthood—a gap that disappeared by approximately age 70. Depression's clinical presentation shifts across development in ways that may interact with pain's psychological impact at each stage.

Gerrits et al. (2014) found pain predicted depression onset over 2 years but did not examine whether this varied by age or symptom profile. The bidirectional nature of pain-depression relationships may itself vary with age. Chou (2007) found reciprocal relationships between pain and depression in older adults using the English Longitudinal Study of Ageing, while Lerman et al. (2015) demonstrated longitudinal associations between depression, anxiety, pain, and pain-related disability in chronic pain patients. Neither study tested whether the strength or directionality of these relationships changes across the lifespan.

Comorbidity complexity may further obscure age-specific patterns. Smith et al. (2022) examined physical multimorbidity and depression among 34,129 adults aged 50+ from low- and middle-income countries, finding mediation effects that likely vary by age within their broad range, though age-stratified analyses were not conducted. Tsang et al. (2008) documented chronic pain conditions across developed and developing countries with gender and age differences in depression-anxiety comorbidity—one of the few studies to explicitly consider age. Their categories (18–34, 35–49, 50–64, 65+), however, still combine potentially distinct vulnerability periods.

Anxiety: The Forgotten Comorbidity

Anxiety affects 30–50% of chronic pain patients (McWilliams et al., 2003), yet age-specific patterns remain unexplored. Beesdo et al. (2009) documented anxiety prevalence declining with age in general populations, while Wolitzky-Taylor et al. (2010) found health-related anxiety increases. Thompson et al. (2007) examined anxiety sensitivity across different noxious stimuli, finding generalizability of anxiety responses, but did not examine age differences. Open questions include whether pain-related anxiety peaks in future-oriented young adults facing decades of potential disability, how middle-age role pressures interact with pain-anxiety relationships, and why anxiety might decline in older adults despite worse pain.

Pain Catastrophizing Across the Lifespan

Pain catastrophizing predicts poor outcomes (Sullivan et al., 2001) but shows complex age patterns. Ruscheweyh et al. (2011) found catastrophizing peaks in middle age then declines. Keefe et al. (1989) documented that catastrophizing's impact on disability varies by age. Vowles et al. (2007) examined processes of change in treatment, finding that pain acceptance and catastrophizing contribute differently to outcomes. No study has tested whether catastrophizing mediates age-specific pain-mood relationships or whether different pain patterns trigger catastrophizing differentially across ages.

Early Life Origins of Age-Specific Vulnerabilities

Evidence is accumulating that early pain experiences set developmental trajectories manifesting differently across the lifespan. Victoria and Murphy (2015) reviewed long-term consequences of early life pain exposure and contributing mechanisms. Williams and Lascelles (2020) examined how early neonatal pain affects painful conditions later in life. Beggs et al. (2011) demonstrated that priming of adult pain responses by neonatal pain experience is maintained by central neuroimmune activity. Tidmarsh et al. (2022) examined how adverse childhood experiences influence pain management through various mechanisms. These findings suggest age-specific pain vulnerabilities may have developmental origins, but no studies have traced these trajectories from early experience through late life.

Direct Age Comparisons: Promising but Incomplete

A small number of studies have directly compared age groups, revealing developmental differences while exposing methodological limitations. Rustøen et al. (2005) examined age and the experience of chronic pain across three groups—one of the few studies to do so—finding that younger adults reported higher pain intensity but better physical functioning, while older adults showed the opposite. Their categories (younger: 19–44, middle: 45–64, older: 65–81) combine developmental periods that may have distinct vulnerabilities; emerging adulthood (18–29) is grouped with established adulthood (30–44).

Wijeratne et al. (2001) provided an age-based comparison of chronic pain clinic patients, finding younger patients showed more psychological distress while older patients had more physical pathology. These were clinical samples, however, and the study predates current understanding of pain-mood mechanisms.

Population-level evidence from the HUNT 3 study (N = 46,533) reinforces that pain-related factors operate differently across age groups. Landmark et al. (2011) found recreational exercise was associated with 10–12% lower chronic pain prevalence in working-age adults (20–64 years) but 21–38% lower prevalence among adults 65 and older, with formal interaction tests confirming significant age-group differences. The same protective behavior yielding different effect sizes depending on developmental stage illustrates the broader problem: factors shaping pain outcomes are not age-invariant, and treating them as such obscures clinically meaningful variation.

Neurobiological Mechanisms: Age-Related Changes

Altered Pain Processing Pathways

Aging alters pain neurobiology at multiple levels: reduced nociceptor density but increased sensitization peripherally (Yezierski, 2012), loss of inhibitory interneurons and increased central sensitization at the spinal level (Mackey & Maeda, 2004), and reduced gray matter in pain-processing regions with altered connectivity patterns in the brain (Cruz-Almeida & Fillingim, 2014). Napadow et al. (2012) demonstrated altered brain connectivity in chronic pain, but without age-stratified analyses. These neurobiological changes provide mechanistic reasons to expect pain's psychological impact to vary with age, yet this prediction has not been tested systematically.

Inflammation and Mood: Age Interactions

Chronic pain involves neuroinflammation that interacts with mood regulation (Walker et al., 2014). Age-related increases in baseline inflammation—sometimes termed "inflammaging" (Franceschi et al., 2007)—might alter the relationship between pain and mood across the lifespan. Sibille et al. (2012) found inflammatory markers mediate pain-depression links, but age-specific patterns remain unexplored.

Resilience and Vulnerability Factors

Protective Factors That Change with Age

Several factors that may buffer pain's psychological impact change with age. Social support shifts from quantity to quality (English & Carstensen, 2014; Uchino & Rook, 2020). Older adults use more emotion-focused and acceptance-based coping strategies (Molton & Terrill, 2014). Time horizon changes affect threat appraisal (Carstensen et al., 1999). Accumulated pain experience might provide coping templates—or learned helplessness. Spector et al. (2023) examined chronic life stressors and racial/ethnic identity in relation to chronic pain among middle-aged and older adults, finding that more problems relate to more pain, but did not examine age-specific vulnerability within these broad groups.

Risk Factors with Developmental Trajectories

Vulnerability factors also follow age patterns. Comorbidity burden increases with age, potentially normalizing pain. Functional reserve decreases, making mild pain more impactful on daily activities. Social role complexity peaks in middle age. Economic resources vary across the lifespan, affecting treatment access. None of these trajectories have been studied as moderators of pain-psychology relationships across developmental stages.

Clinical Implications

Screening Gaps

Without age-specific understanding, current screening likely misses high-risk young adults with pain below traditional clinical thresholds, overtreats older adults whose pain patterns are age-normative, fails to identify developmental intervention windows, and applies uniform thresholds across ages where different cutoffs are warranted.

Pain assessment continues to develop, but without age differentiation. Salamon et al. (2014) developed the Pain Frequency-Severity-Duration Scale and validated it in pediatric populations; similar age-appropriate tools for the full adult lifespan do not exist. Gerdle et al. (2023) found that psychological distress in chronic pain patients relates to pain intensity, pain-related interference, and individual coping strategies, but their mixed-age sample obscures whether these relationships hold equally across development.

The US Preventive Services Task Force recommends depression screening in primary care but does not suggest age-specific approaches for pain patients. A uniform approach may systematically underperform for certain age groups.

Treatment Misallocation

Resources may be misdirected: intensive interventions for older adults who are relatively resilient, missed opportunities in young adults dismissed as too young for chronic pain, generic approaches during peak vulnerability periods, and age-inappropriate intervention strategies such as retirement planning for 25-year-olds with chronic pain.

Methodological Challenges and Opportunities

The field faces several barriers to addressing developmental questions in pain research. Cross-sectional studies cannot distinguish age from cohort effects. Longitudinal studies rarely span multiple decades. Different measures used for different age groups prevent direct comparison. Population-weighted age comparisons are scarce.

Recent methodological work offers partial solutions. Das et al. (2023) modeled and classified joint trajectories of self-reported mood and pain in a large cohort study, demonstrating approaches to understanding pain-mood dynamics over time. Frumkin and Rodebaugh (2021) reviewed methodological issues in within-person pain-affect relations, pain catastrophizing, and pain acceptance, making the case for consistent methodology across studies.

The Present Investigation

This study uses the 2019 National Health Interview Survey to conduct the first lifecycle analysis of pain-psychology relationships with consistent methodology across the complete adult lifespan. The analysis examines five questions:

1. Do certain pain profiles (10-category frequency × intensity combinations) produce different psychological impacts across developmental stages?
2. Are young adults with mild frequent pain a high-risk population missed by current screening?
3. Does middle age represent maximum psychological vulnerability to pain despite moderate prevalence?
4. Do older adults show genuine resilience to pain's psychological effects, different vulnerability patterns, or measurement insensitivity?
5. Should pain screening and intervention thresholds be age-stratified?

Significance

This research addresses gaps at the intersection of pain science and developmental psychology. On the scientific side, it is the first study to apply 10-category pain gradients (a frequency × intensity matrix) across all adult ages, identify age-specific pain phenotypes using population-weighted data, quantify developmental vulnerability trajectories with consistent measures, and test competing theories of late-life resilience versus vulnerability versus measurement failure within a single analytic framework.

On the clinical side, findings could inform developmentally-targeted screening that identifies at-risk individuals currently missed by uniform thresholds. If pain-psychology relationships differ by developmental stage—as isolated studies suggest they do—then age-stratified approaches to both screening and intervention allocation would outperform current practice.

On the theoretical side, the study integrates lifespan development theory with pain science in a way that has been discussed conceptually but never tested empirically across the full adult age range.

Conclusion

The absence of developmental perspectives in pain research means the field cannot answer a basic question: does pain's psychological impact change across human development? Current approaches treat pain-psychology relationships as static across the lifespan. If they are not—and isolated findings from multiple research groups suggest they are not—then current screening may fail vulnerable populations while overtreating others.

The convergence of demographic aging, rising pain prevalence, escalating mental health burden, and post-pandemic healthcare strain makes this question urgent. As healthcare systems move toward value-based care models that demand targeted interventions, understanding which age groups are most psychologically vulnerable to which pain patterns

becomes a prerequisite for efficient resource allocation. This investigation uses a developmental framework and population-representative data to provide the first empirical answers.

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