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Review article

Physical pain and suicide-related outcomes across the lifespan: systematic review and meta-analysis

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ABSTRACT

Suicide is a complex and multifactorial phenomenon, with increasing evidence highlighting the link between physical pain and suicidal thoughts and behaviors. This meta-analysis examines suicide-related outcomes among individuals with and without physical pain. We searched PubMed, PsycINFO, and Cochrane databases, including 91 studies in the review and 88 in the meta-analysis. Data were analyzed using Comprehensive Meta-Analysis software (version 3.7). The findings revealed that people experiencing physical pain were significantly more likely to have suicide-related outcomes than those without pain. The strongest associations were found for lifetime death wish (OR = 2.10), current suicidal ideation (OR = 1.93), and lifetime suicide attempts (OR = 1.94). Among adolescents, self-harm was notably higher among those with pain, while adults showed a higher risk of lifetime suicide attempts and suicide death. In older adults, suicidal ideation and suicide attempts were more strongly linked to pain. Females had higher odds of suicidal ideation compared to males. Specific painful conditions, like fibromyalgia, abdominal pain, and migraines, were also linked to increased suicide risk. Limitations include high heterogeneity and lack of data on some suicide-related outcomes. Pain is a significant risk factor for suicidality across all ages and in specific populations, as conceptualized by ideation-to-action framework suicide models.

1. Introduction

Suicide represents a major public health issue across all ages and countries. Indeed, more than 700,000 people die by suicide every year, and suicide is the fourth leading cause of death among young people aged 15–29 (World Health Organization, 2021). For many years, research in suicidology has focused on identifying the major risk factors for suicide to implement increasingly effective preventive strategies and treatments. The most established risk factors in the literature include past suicide attempts (Bostwick et al., 2016), psychiatric disorders

(Moitra et al., 2021), adverse childhood experiences (Sahle et al., 2022), lack of social support (Sahle et al., 2022), and impulsive or aggressive tendencies (Gvion and Apter, 2011). Moreover, in recent years, there has been a notable increase in attention paid to the physical pain experienced by individuals and its association with suicidal thoughts and behaviors (Calati et al., 2015; Fishbain et al., 2014).

Physical pain may be attributed to acute, transient suffering or conditions that cause chronic physical discomfort (e.g., arthritis, migraine, fibromyalgia, sciatica, etc.). It affects a large portion of the general population worldwide, and its chronic forms are positively

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correlated with age, increasing from 14 % in the 18–25-year-old population to 62 % in the over-75 age group (Fayaz et al., 2016). Considering the accelerating aging pace of the world population, physical pain and its impacts will increasingly become a relevant issue for public health in the years to come.

Although scientific literature is showing an increasing interest in the link between pain and suicidal thoughts and behaviors, there is a paucity of robust meta-analytic data on this topic. The present study aimed to update the first meta-analysis about the physical pain-suicidality association (Calati et al., 2015), with an additional focus on specific populations and including the latest research on this topic. Particularly, the present systematic review and meta-analysis analyzes suicide-related outcomes (death wish, DW; suicidal ideation, SI; suicidal planning, SP; deliberate self-harm, DSH; suicide attempt, SA; suicide death, SD) among adolescents, adults, and older adults with and without physical pain. Furthermore, additional analyses were conducted to identify differences between genders, pain severity, and physical pain phenotypes.

2. Methods

2.1. Search strategies and inclusion/exclusion criteria

To note, as an initial step, a literature search was conducted to ensure that previous meta-analyses had not been published after 2015. A total of three previously published works were identified, which were then utilized for cross-checking included studies: a meta-analysis (Calati et al., 2015) and two systematic reviews (Hinze et al., 2019; Santos et al., 2020), all examining the relationship between physical pain and suicide-related outcomes. We updated the search to include studies published in the period not covered by these three works. We followed the referred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines (Page et al., 2021), and we registered the protocol on PROSPERO (available at: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42023440259). We searched PubMed, Scopus, PsycINFO, Web of Science, and Cochrane for articles up to April 2023 using the following search query: ("pain" OR "physical pain" OR "chronic pain" OR "acute pain" OR "headache" OR "back pain" OR "neck pain" OR "musculoskeletal pain" OR "arthritis" OR "fibromyalgia") AND ("suicid*" OR "self-harm") (Supplementary Table 1). Additionally, we examined references from selected studies, reviews, and meta-analyses for further papers.

For each article, we first screened the abstract, and if the paper was potentially eligible, we read the full text. We established specific inclusion and exclusion criteria to discern studies suitable for inclusion in our meta-analysis. Observational cohort, cross-sectional, and case-control studies were included if they reported odds ratio (ORs) or raw numbers of suicide-related outcomes (DW, SI, SP, DSH, SA, SD) for both participants with and without physical pain. Physical pain categories included chronic pain, acute pain, headache, migraine, back, neck, chest, musculoskeletal, abdominal, and stomach pain, arthritis, fibromyalgia, neuropathic pain, psychogenic pain, medically unexplained pain, and other unspecified pain. "Unspecified pain" refers to all types of physical pain not specifying a site in the body (e.g., "somatic pain", "general pain", or "chronic pain"); while "different types of pain" refers to combinations of physical pain in two or more sites (e.g., back and neck pain; arthritis, fibromyalgia, and migraine).

Conversely, articles were excluded if they focused on suicide-related outcomes in pain-related conditions without a control group with no pain, involved overlapping samples, did not precisely define the suicide-related outcome, concerned euthanasia/assisted suicide or homicide-suicide, involved pain-related to different conditions (e.g., cancer, major burn survivors, HIV, stroke survivors), the control group consisted of general hospital patients, adopted a prospective cohort study design without baseline physical pain data, or if the event rate was 0 % or 100 % in both physical pain and control groups.

2.2. Study outcomes

The key suicide-related outcomes were examined in all age groups: adolescents (up to 18 years old), adults (from 19 to 65 years old), and older adults (over 65 years old) suffering from any physical pain, and compared to a control group without pain. Studies that included participants from more than one age population (e.g., adolescents and adults) were classified as "mixed ages." Among suicide-related thoughts, we considered DW, SI, and SP: DW corresponds to wanting to die or passive suicidal ideation; SI corresponds to thinking about attempting suicide; and SP indicates any detailed plan of action leading to suicide.

Among suicide-related behaviors, we considered DSH, SA, and SD: DSH includes any type of self-injurious behavior irrespective of the apparent purpose of the act; SA is a self-inflicted potentially injurious behavior with the deliberate intention to procure one's death but has a non-fatal outcome; while SD corresponds to self-inflicted death. Moreover, we separately considered current (up to 24 months) and lifetime (over 24 months) suicide-related outcomes. For potentially eligible articles that did not report our key outcomes, we contacted the authors on three occasions.

2.3. Data extraction and quality assessment

Three reviewers (GT, MR, and ES) independently extracted data from the included studies. This process was preceded by training and standardization among the reviewers regarding agreed-upon methods. For each article, we extracted the following variables: country, study design, study year, population, setting, hazard period, total sample size, number of participants with pain, number of cases with pain and the outcome of interest, number of participants without pain, number of cases without pain and the outcome of interest, pain type, acute or chronic pain, suicide-related outcome, risk measure (including crude risk, the lower confidence interval for the unadjusted risk measure, the upper confidence interval for the unadjusted risk measure, and any adjusted risk measure with the associated intervals and variables adjusted for), as well as socio-demographic and clinical features. In case of disagreements or discordant data among the reviewers, we discussed and resolved them during a cross-check comparison until a unique conclusion was reached regarding the collected numbers and variables.

The methodological quality of the included studies was assessed using the National Institutes of Health (NIH) Quality Assessment Tool (National Institutes of Health, 2013), according to different criteria for observational cohort, cross-sectional, and case-control studies.

Twelve studies (Boska et al., 2021; Breslau et al., 1991; Fuller-Thomson et al., 2013a; Fuller-Thomson et al., 2013b; Fuller-Thomson et al., 2016; Hagberg et al., 2016; Ilgen et al., 2008; Jang et al., 2022; Jolly et al., 2022; Kim et al., 2012; Liu et al., 2018; Morin et al., 2019; Park et al., 2012) were excluded because they included overlapping samples (Supplementary Table 2). In such cases, we considered the following criteria in order of priority: largest sample size, most recently published results, or case-by-case evaluation.

2.4. Statistical analysis

Data were entered into and analyzed with Comprehensive Meta-Analysis software (CMA) version 3.7, using a random effects model to perform our meta-analyses. As only three articles had calculated effect sizes other than the ORs (e.g., hazard ratio and risk ratio) without specifying raw data (Ilgen et al., 2013; Koenig et al., 2015; Singhal et al., 2014), only studies that had reported the raw data or the ORs were included in the analyses. Individual and pooled ORs with associated 95 % confidence intervals (CIs) were calculated. Between-study heterogeneity was assessed with the χ^2 test of fit and I^2 (inconsistency). The pooled effect size's significance (p -value ≤ 0.05) was determined using a Z test. Cut-offs for the interpretation of I^2 in Cochrane meta-analyses are as follows: 0 % to 40 %: might not be important; 30 % to 60 %: may

represent moderate heterogeneity; 50 % to 90 %: may represent substantial heterogeneity; 75 % to 100 %: considerable heterogeneity (Higgins et al., 2019). To reduce between-study heterogeneity, post-hoc or sensitivity analyses were conducted on specific subgroups according to their characteristics and the outcomes they examined (e.g., population age, gender differences, pain severity, and pain phenotype). Furthermore, when possible, we included in our meta-analysis risk measures that were adjusted for variables. Articles mainly controlled for the following variables: sociodemographic status (age, sex, ethnicity, education level, working status, marital status, income), mental health status (psychiatric comorbidities, alcohol use, drug use, smoking status), and physical health status (medical comorbidities). Moreover, to reduce statistical bias, in the case of studies that investigated more than one type of physical pain but used the same control group, we divided the total number of participants in the control group with and without suicide-related outcomes by the number of physical pains investigated.

3. Results

3.1. Study characteristics

We initially identified 8224 studies through database search, and after discharging duplicates and excluding ineligible studies, we ended up including 91 studies in the review. Of these, 88 provided raw data or ORs and were included in the analyses (see the flowchart in Fig. 1). The main features of each included study are shown in Table 1. Among the 91 studies, 53 (58.24 %) were cross-sectional studies, 24 (26.37 %) were cohort studies, and 14 (15.39 %) were case-control studies. Regarding the study setting, 56 articles (61.54 %) were focused on the general population or community samples, while 35 studies (38.46 %) were based on a clinical population. One study (Magni et al., 1998) was split in two since it reported data referring to two different samples:

Mexican–Cuban Americans (a) and Puerto Ricans (b). The majority of trials involved adults ($n = 31$, 34.07 %), followed by older adults ($n = 21$, 23.08 %) and adolescents ($n = 13$, 14.29 %). However, 26 studies (28.56 %) included participants with more than one population age. Moreover, no significant flaws in study methods or implementation were detected for most included articles, as all of them appeared to satisfy most of the internal validity criteria required by the tools used (see Supplementary Tables 3 and 4).

3.2. Death wish

Eleven studies examined current or lifetime DW (Table 2). Individuals with physical pain were more likely to have experienced both current DW (OR = 1.50) and lifetime DW (OR = 2.10). However, high heterogeneity was detected among current DW ($p(\chi^2) < 0.0001$, $I^2 = 74$ %) but not among lifetime DW ($p(\chi^2) = 0.051$, $I^2 = 58$ %) studies. In terms of age group, adults experiencing pain were more likely to have had current DW (OR = 1.79) than those without pain, as were older adults (OR = 1.64). However, when only studies with participants of mixed ages were considered, only a weak association was detected between pain and current DW (OR = 1.01).

3.3. Suicidal ideation

Fifty-two studies reported current or lifetime SI (Table 2). Individuals with physical pain were more likely to have had both current (OR = 1.93) and lifetime SI (OR = 1.85), respectively. High heterogeneity was detected among current SI ($p(\chi^2) < 0.0001$, $I^2 = 98$ %) and lifetime SI ($p(\chi^2) < 0.0001$, $I^2 = 97$ %) studies. Adolescents were more likely to have had current SI (OR = 2.26), followed by mixed ages (OR = 1.92), adults (OR = 1.86), and older adults (OR = 1.75). Regarding age group differences within lifetime SI, older adults with pain were more

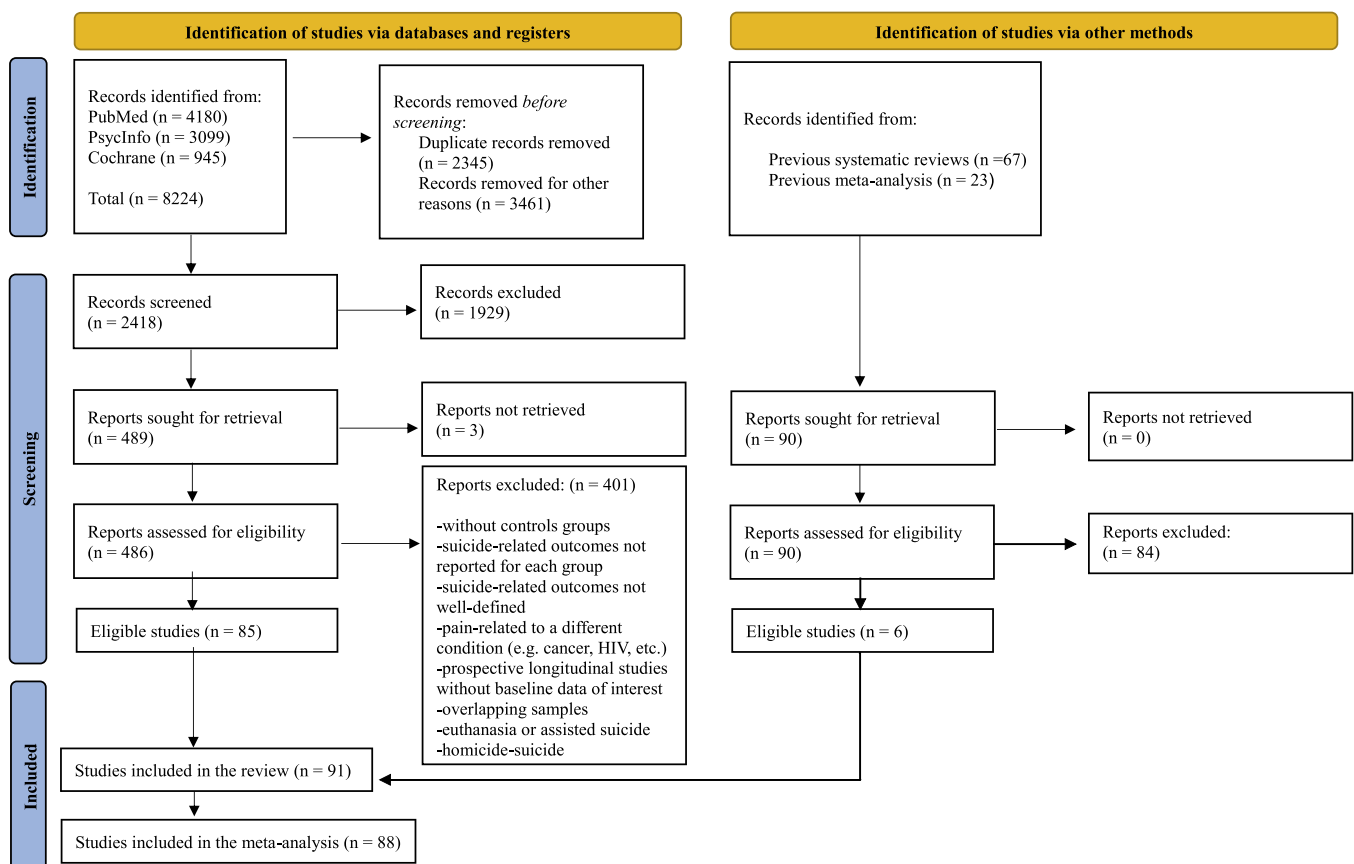


Fig. 1. PRISMA 2020 flow diagram of the selection process.

Table 1
Descriptive features of the included studies.

Study (country)	Design	Setting	Hazard period/duration	Suicidal outcome	Physical pain type	Population age	Special population	Main results
Almeida et al., 2012 (Australia)	Cross-sectional	Clinical population		SI (current)	Unspecified pain	Older adults	Primary care practices	↑ SI and pain
Ashrafioun et al., 2019 (USA)	Cohort (retrospective)	Population based	2 years	SA (current)	-Unspecified pain (Moderate) -Unspecified pain (Severe) -Arthritis -Back pain -Fibromyalgia -Migraine	Mixed ages (adults and older)	Veterans	↑ SA in moderate and severe pain, arthritis, back pain (-) Fibromyalgia, migraine
Awata et al., 2005 (Japan)	Cross-sectional	Population-based		SI (current)	Unspecified pain	Older adults		↑ SI and pain (univariate analysis) (-) SI with and without pain (multivariate analysis)
Berhane et al., 2018 (Ethiopia)	Cross-sectional	Population-Based		-SA (current) -SI (current) -SP (current)	Migraine	Adults	Outpatients	↑ SA, SI, SP in migraine
Birkie et al., 2021 (Ethiopia)	Cross-sectional	Population-based		-SI (current) -SA (lifetime)	Migraine	Adults		↑ SI, SA in migraine
Braden and Sullivan, 2008 (USA)	Cross-sectional	Population-Based	2 years	-SI (current) -SI (lifetime) -SP (current) -SP (lifetime) -SA (current) -SA (lifetime)	-Unspecified pain -Arthritis -Headache -Different types of pain (back/neck pain)	Adults		↑ Lifetime and current SI, SP and SA in all pain groups (unadjusted) ↑ Lifetime SI and SP in any pain group (adjusted for: Sociodemographic and medical factors, lifetime mood or anxiety disorder, lifetime alcohol or drug abuse/dependence, K10 scale score, personality screen) (-) Lifetime SA in any pain group (adjusted for: Sociodemographic and medical factors, lifetime mood or anxiety disorder, lifetime alcohol or drug abuse/dependence, K10 scale score, personality screen) (-) Current SI, SP, and SA in any pain group (adjusted for: Sociodemographic and medical factors, lifetime mood or anxiety disorder, lifetime alcohol or drug abuse/dependence, K10 scale score, personality screen)
Breslau and Davis, 1993 (USA)	Cohort	Population-based	14 months	SA (lifetime)	Migraine	Adults	People with depression	↑ SA in individuals with migraine history
Breslau et al., 2012 (USA)	Cohort	Population-based	2 years	SA (lifetime)	-Migraine -Headache	Adults		↑ SA in migraine and non-migraine severe headache
Brietzke et al., 2012 (Brazil)	Cross-sectional	Clinical population		SA (lifetime)	Migraine	Adults	People with bipolar disorder	↑ SA in migraine
Bromberg et al., 2017 (USA)	Case-control	Clinical population		SI (current)	Unspecified pain	Adolescents		(-) SI in chronic pain

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Table 1 (continued)

Study (country)	Design	Setting	Hazard period/duration	Suicidal outcome	Physical pain type	Population age	Special population	Main results
Calati et al., 2017 (France)	Cohort	Population-based	2 years	SA (lifetime)	-Non-migrainous headache -Migraine -Headache	Older adults		↑ SA in migraine and headache
Campbell et al., 2015	Cross-sectional	Population-based	5 months	-SI (lifetime) (current) -SP (lifetime) -SP (current) -SA (current) -SA (lifetime)	-Arthritis -Migraines -Back/neck pain -Any pain (any one chronic pain condition)	Mixed ages (adolescents, adults, and older adults)		↑ SI in any pain ↑ SP in any pain ↑ SA in any pain
Cattell, 1988 (UK)	Cross-sectional	Clinical population		SD	Unspecified pain	Older adults		↑ SD in pain
Chan et al., 2009 (China)	Cross-sectional	Population-based		SI (lifetime)	Unspecified pain	Adolescents		↑ SI in pain
Chan et al., 2011 (Taiwan)	Cross-sectional	Population-based		SI (current)	-Joint pain -Neck pain -Lower back pain -Sciatica -Headache	Older adults		↑ SI in joint pain, neck pain, lower back pain, sciatica and headache
Cheung et al., 2017 (New Zealand)	Case-control	Clinical population		DW (current)	-Unspecified pain (present but not exhibited in the last 3 days) -Unspecified pain (exhibited on 1-2 of the last 3 days) -Unspecified pain (exhibited daily in the last 3 days)	Older adults	Older New Zealanders assessed for home support and long-term aged residential care	↑ DW in pain
Choong et al., 2017 (USA)	Cohort (retrospective)	Population-based	1 year	-DSH (current) -SI (current)	Cluster headache	Adults		↑ DSH, SI in headache
Colman et al., 2016 (Canada)	Cohort	Population-based	7.3 years	-SI (current) -SI (lifetime)	Migraine	Adults		↑ SI (current and lifetime) in migraine
Dean-Boucher et al., 2020 (USA)	Cross-sectional	Population-based		-SI (lifetime) -SP (lifetime) -SA (lifetime)	-Arthritis -Headache -Back and Neck pain -Unspecified pain	Adolescents		(-) SI in arthritis, unspecified pain ↑ SI in headache, back and neck ↑ SP (among ideators) in arthritis, headache (-) SP (among ideators) in unspecified pain (-) SA in arthritis, headache, back and neck, unspecified pain (-) SD in both mild and severe psoriasis
Egeberg et al., 2016 (Denmark)	Cohort (retrospective)	Clinical population	15 years	SD	Psoriasis	Mixed ages (adults and older adults)		↑ SI with chest pain
Eliacik et al., 2017 (Turkey)	Case-control	Clinical population		SI	Chest pain	Adolescent		↑ SI with chest pain
Fishbain et al., 2009 (USA)	Cohort	Clinical population		-DW (current) -DW (lifetime) -SI (current) -SP (current) -SA (lifetime)	-Unspecified acute pain -Unspecified chronic pain	Adults		↑ DW, SI and SP in chronic pain patients ↑ DW, SI, SP, and SA in acute pain patients
Friedman et al., 2016 (USA)	Cross-sectional	Clinical population		SI (current)	-Migraine -Probable migraine	Mixed ages (adolescents and adults)	Pregnant women	↑ SI in migraine and probable migraine

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Table 1 (continued)

Study (country)	Design	Setting	Hazard period/duration	Suicidal outcome	Physical pain type	Population age	Special population	Main results
Fuller-Thomson and Hodgins, 2020 (Canada)	Cross-sectional	Population-Based		SA (lifetime)	Migraine	Adults		↑ SA in migraine
Ganesh Kudva et al., 2021 (Singapore)	Cross-sectional	Population-Based		-SI (current) -SP (current) -SA (current)	Unspecified pain	Mixed ages (adults and older adults)		↑ SI, SP, SA In chronic pain
Gensichen et al., 2010 (Germany)	Cross-sectional	Clinical population		SI (current)	Unspecified pain	Mixed ages (adults and older adults)	People with depression	↑ SI in physical pain
Halvorsen et al., 2012 (Norway)	Cross-sectional	Population-based		SI (current)	Different types of pain (1 or 2 pain sites: head, neck/shoulder, arms/legs/shoulders, stomach, and back; 3 to 5 pain sites: head, neck/shoulder, arms/legs/shoulders, stomach, and back)	Adolescents		↑ SI in all the pain groups
Hamada et al., 2021* (Japan)	Cross-sectional	Population-based		DSH (lifetime)	-Abdominal pain	Adolescents		↑ DSH (lifetime) in pain groups
Harnod et al., 2018 (Taiwan)	Cohort (retrospective)	Clinical population	12 years	SA (lifetime)	-Headache -Status migrainosus -Migraine	Adults		↑ SA in status migrainosus (-) SA in migraine
Hogstedt et al., 2018 (Sweden)	Cohort (retrospective)	Population-based	36 years	-SA (lifetime) -SD	-Headache -Stomach problems	Adolescents		(-) SD, SA in pain
Huginin et al., 2021 (USA)	Cross-sectional	Population-based		SI (current)	Unspecified pain	Adults	Residents newly admitted to a nursing home	↑ SI in the pain group
Huh et al., 2021 (Korea)	Cross-sectional	Population-based		SI (current)	Arthritis	Adults		↑ SI in arthritis
Ilgen et al., 2013** (USA)	Cohort (retrospective)	Population-based	3 years	SD	-Arthritis -Back pain -Migraine -Headache -Neuropathic pain -Fibromyalgia -Unspecified pain	Mixed ages (adults and older adults)	Veterans	↑ SD for each pain condition except arthritis and neuropathy ↑ SD in back pain, migraine and psychogenic pain when analyses controlled for psychiatric comorbidity
Jacob et al., 2018 (UK)	Cross-sectional	Population-based		-SI (current) -SA (current)	Unspecified pain	Adults		↑ SI and SA in pain
Jeong et al., 2014 (Korea)	Cross-sectional	Population-based		SI (current)	Unspecified pain (mild and severe symptoms)	Older adults (*60-96 years old)	The majority of participants (62 %) suffered from depression	↑ SI in unspecified pain (mild and severe symptoms)
Jiang et al., 2019 (China)	Cross-sectional	Population-based		SI (current)	Abdominal pain	Adolescents		(-) SI with and without acute abdominal pain ↑ SI in chronic abdominal pain
Jimenez-Rodríguez et al., 2014 (Spain)	Cross-sectional	Clinical population		-DW (current) -SI (current)	-Fibromyalgia -Low Back Pain	Adults		(-) SI and DW with and without low back pain ↑ SI and DW in fibromyalgia
Jones et al., 2022 (Canada)	Cohort	Population-based	20 years	SI (current)	-Different types of pain (any pain) -Arthritis	Adults	People living in precarious housing or homelessness	↑ SI with any pain
Jorm et al., 1995 (Australia)	Case-control	Population-based		DW (current)	Unspecified pain	Older adults		↑ DW in pain
Juurink et al., 2004 (Canada)	Case-Control	Population-based		SD	-Unspecified pain (moderate and severe)	Older adults		↑ SD in moderate and severe pain
Kang et al., 2014 (South Korea)	Cohort study	Population-based	2 years	SI (lifetime)	-Unspecified pain (mild and moderate)	Older adults		↑ SI and moderate pain
Kim et al., 2012 (USA)	Case-control	Population-based		SD	Unspecified pain (chronic or acute)	Mixed ages (adults and older adults)	Veterans with depression	(-) SD with and without pain
Kim and Park, 2014 (Korea)	Cross-sectional	Population-based		SI (current)	Migraine	Mixed ages (adolescents and adults)		↑ SI in migraine

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Table 1 (continued)

Study (country)	Design	Setting	Hazard period/duration	Suicidal outcome	Physical pain type	Population age	Special population	Main results
Kim et al., 2022a (USA)	Cross-sectional	Clinical population		DSH (lifetime)	Unspecified pain	Adults	People with depression	↑ NSSI and pain
Kim et al., 2022b (Korea)	Cohort study (retrospective)	Clinical population	9 years	DSH (lifetime)	-Unspecified pain -Arthritis	Older adults	Inpatients	(-) DSH and unspecified pain (-) DSH and arthritis
Kim et al., 2023 (Korea)	Cohort study (retrospective)	Clinical population	10 years	-SI (lifetime) -SA (lifetime) -SD	-Psoriasis -Psoriatic arthritis	Mixed ages (adults and older adults)		↑ SI, SA, SD in both psoriasis and psoriatic arthritis (suicidality adjusted HR was higher in the psoriatic arthritis group than in the psoriasis-alone group) ↑ DSH, SA in all pain groups
Koenig et al., 2015** (Germany)	Cross-sectional	Population-based	4 months	-DSH (current) -SA (lifetime)	-General pain -Headache -Abdominal pain	Adolescents		
Koo et al., 2021 (USA)	Case-control	Population-based		-DW (lifetime) -SI (lifetime) -SP (lifetime) -SA (lifetime)	Headache	Adults		↑ DW and headache ↑ SI and headache ↑ SP and headache (-) SA pain and control groups
Lapierre et al., 2012 (Canada)	Cross-sectional	Population-based		DW (current)	-Arthritis/rheumatism -Back pain -Migraine/headache	Older adults		↑ DW in all pain groups
Lin et al., 2019 (Taiwan)	Case-control	Clinical population		-SI (lifetime) -SA (lifetime)	-Migraine with and without aura (1-4 days/month, 5-8 days/month, 9-14 days/month, ≥15 days/month)	Adults		↑ SI and SA in migraine
Liu et al., 2021 (China)	Cohort	Population-based	1 year	-SP (lifetime) -SA (lifetime) -SI (lifetime)	-Headache -Stomachache -Unspecified pain	Adolescents		↑ SP, SA, SI in pain groups
Lutz et al., 2016 (USA)	Cross-sectional	Population-based		DW (current)	Arthritis/rheumatism	Mixed ages (adults and older adults)		↑ DW in arthritis/rheumatism
Lutzman et al., 2021 (Israel)	Cross-sectional	Population-based		SI (current)	Unspecified pain	Older adults		↑ SI in pain
Magni et al., 1998 (USA)	Cross-sectional	Population-based		-DW (lifetime) -SI (lifetime) -SA (lifetime)	Abdominal pain	Adults		↑ DW, SI and SA in abdominal pain
Manoranjitham et al., 2010 (South India)	Cross-sectional	Population-based		SD	Unspecified chronic pain	Adults		↑ Risk of SD in pain
Meeks et al., 2008 (USA)	Cross-sectional	Clinical population		SI (current)	Unspecified chronic pain	Older adults	People with major depression, depressive disorder not otherwise specified, or dysthymia	↑ SI in chronic pain
Miller et al., 2008 (USA)	Case-control	Population-based		SD	-Spine disorder -Osteoarthritis	Older adults	People who were simultaneous beneficiaries of Medicare and the New Jersey Pharmaceutical Assistance Program for the Aged and Disabled	(-) SD in spine disorder and osteoarthritis
Mitchell et al., 2017 (Australia)	Cohort	Clinical population	10 years	DSH (lifetime)	-Unspecified -Arthritis/arthroses	Mixed ages (adolescents and adults)	Patients hospitalised for self-harm and non-self-harm injuries	↑ DSH in pain (-) Arthritis/arthroses

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Table 1 (continued)

Study (country)	Design	Setting	Hazard period/duration	Suicidal outcome	Physical pain type	Population age	Special population	Main results
Muruthi et al., 2022 (USA)	Cross-sectional	Population-based		DW (current)	-Arthritis -Unspecified pain (mild and moderate bodily pain)	Mixed ages (adults and elders)	Women with depression	↑ DW in bodily pain (-) Arthritis
Noamesi et al., 2023 (USA)	Cross-sectional	Population-based		-SI (lifetime) -DSH (lifetime)	Migraine	Adults	Inpatient sample	↑ SI and DSH in migraine
Okamura et al., 2014 (Japan)	Cross-sectional	Population-based		SI (current)	Unspecified pain	Mixed ages (adults and older adults)	Homeless people	↑ SI in pain
Ortiz et al., 2010 (Canada)	Cross-sectional	Clinical population		SA (lifetime)	Migraine	Adults	People with psychiatric disorders: BD type I (n = 235), BD II (n = 100), BD not otherwise specified (NOS) (n = 6), and schizoaffective disorder (n = 29)	↑ SA in BD patients with migraine
Owen-Smith et al., 2019 (USA)	Case-control	Clinical population		SD	Unspecified pain	Mixed ages (adolescents, adults, and older adults)		(-) SD in nonmalignant chronic pain
Park et al., 2019a (Korea)	Cross-sectional	Population-based		SI (current)	Arthritis	Mixed ages (adults and older adults)		↑ SI in arthritis
Park et al., 2019b (Korea)	Cross-sectional	Population-based		-SI (lifetime) -SP (lifetime) -SA (lifetime)	-Single somatic pain -Multiple somatic pain	Adults		↑ SI, SP, and SA in single somatic pain ↑ SI, SP, and SA in multiple somatic pain
Park et al., 2020 (Korea)	Cross-sectional	Population-based		SI (current)	Osteoarthritis	Mixed ages (adolescents and adults)		↑ SI in osteoarthritis (men had higher OR than women)
Prior et al., 2020	Cohort (retrospective)	Clinical population	16 years	DSH (current)	-Ankylosing Spondylitis	Prior et al., 2020	Cohort (retrospective)	Clinical population
Ratcliffe et al., 2008 (Canada)	Cross-sectional	Population-based		-SI (current) -SA (current)	-Different types of pain (any pain) -Migraine -Arthritis -Back pain -Fibromyalgia	Mixed ages (adolescents, adults, and older adults)		↑ SI, SA in one or more pain conditions ↑ SI, SA in migraine when OR were adjusted for sex, age, marital status, education, any mood disorder, any anxiety disorder, any substance dependence disorder, comorbidity (3 or more mental disorders), and other chronic pain disorders (arthritis, back problems, and migraine) (-) SI, SA in arthritis, back pain, back pain, fibromyalgia when OR was adjusted for sex, age, marital status, education, any mood disorder, any anxiety disorder, any substance dependence disorder, comorbidity (3 or more mental disorders), and other chronic pain disorders (arthritis, back problems, and migraine)
Raue et al., 2007 (USA)	Cohort	Clinical population	1 year	-DW (current) -SI (current)	Unspecified pain	Older adults	Patients newly initiating homecare for skilled nursing services	↑ DW and SI with pain

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Table 1 (continued)

Study (country)	Design	Setting	Hazard period/duration	Suicidal outcome	Physical pain type	Population age	Special population	Main results
Reigstad et al., 2006 (Norway)	Cross-sectional	Clinical population		-DSH (lifetime) -SA (lifetime) SD	Unspecified pain	Adolescents		(-) DSH, SA in pain
Rowe et al., 2006 (USA)	Case-control	Clinical population		SA (lifetime)	Unspecified pain	Older adults	Home Health Care Utilizers	↑ SD in pain
Sansone et al., 2014 (USA)	Cross-sectional	Clinical population		SA (lifetime)	Unspecified pain	Adults		↑ SA in pain
Saygin et al., 2015 (Turkey)	Cross-sectional	Clinical population		-SI (current) -SP (current) -DW (current)	-Ankylosing spondylitis -Behcet's syndrome major organ -Behcet's syndrome mucocutaneous	Adults	Outpatients	↑ SI, SP, DW Behcet's syndrome major organ (-) Ankylosing spondylitis, Behcet's syndrome
Scott et al., 2010 (New Zealand)	Cohort (retrospective)	Population-based	5 years	-SA (lifetime) -SI (lifetime)	-Arthritis -Different types of pain (back and neck pain) -Headache -Unspecified	Mixed ages (adults and older adults)		↑ SI in all pain groups ↑ SA in headache and unspecified pain (-) SA in arthritis and different types of pain (back and neck pain)
Singhal et al., 2014** (UK)	Cohort (retrospective)	Clinical population	13 years	DSH (lifetime)	-Inflammatory polyarthropathies -Migraine -Psoriasis	Mixed ages (adolescents, adults, and older adults)		↑ DSH in inflammatory polyarthropathies, migraine, psoriasis
Sleurs et al., 2020 (USA)	Cross-sectional	Population-based		-SA (lifetime) -SA (current)	Fibromyalgia	Mixed ages (adults and older adults)		↑ SA (lifetime, current) in fibromyalgia
Sommer et al., 2019 (Canada)	Cross-sectional	Population-based		-SI (current) -SP (current) -SA (current)	-Arthritis -Migraine -Back pain	Mixed ages (adolescents, adults, and older adults)	People with generalized anxiety disorder	↑ SI, SP in migraine ↑ SA in arthritis (-) SI, SP, SA in back pain
Srivastava et al., 2004 (India)	Case-control	Clinical population		SA (lifetime)	-Abdominal and pelvic pain -Arthritis	Mixed ages (adolescents and adults)		↑ SA in abdominal and pelvic pain (-) SA in arthritis
Tang et al., 2020 (China)	Cross-sectional	Population-based		-SI (current) -SP (current) -SA (current)	Unspecified pain	Mixed ages (adolescents and adults)	Medical students	↑ SI, SP in general pain (-) SA in general pain
Theodoulou et al., 2005 (UK)	Cross-sectional	Clinical population	2 years	DSH (current)	Unspecified pain	Adults		(-) DSH in pain
Thompson et al., 2006 (USA)	Cross-sectional	Clinical population		SI (current)	Unspecified pain (moderate and severe)	Adults	Veterans receiving treatment for opiate dependence Tertiary care outpatient sample	↑ SI in severe chronic pain (-) SI in moderate pain ↑ SI in pain
Tripp et al., 2016 (Canada)	Cross-sectional	Clinical population		SI (current)	Interstitial cystitis or bladder pain syndrome Headache	Mixed ages (adults and older adults) Adolescents		↑ DSH in headache
Tsai et al., 2011 (Taiwan)	Cross-sectional	Population-based		DSH (lifetime)	Headache	Adolescents		↑ DSH in headache
Tsoh et al., 2005 (China)	Case-control	Clinical population		-SD -SA (current)	Arthritis	Older adults		↑ SD, SA in arthritis
van Tilburg et al., 2011 (USA)	Cohort	Population-based	1 year	-SI (current) -SA (current)	-Stomachache -Headache -Muscle/joint pain	Adolescents		↑ SI in stomachache, headache, and muscle/joint pain ↑ SA in stomachache, headache, and muscle/joint pain
Vilhjalmsjon et al., 1998 (Iceland)	Cross-sectional	Population-based		SI (current)	Unspecified pain	Adults		↑ SI and chronic pain
Voaklander et al., 2008 (Canada)	Case-control	Population-based		SD	Osteoarthritis	Older adults		↑ SD in osteoarthritis
Wang et al., 2009 (Taiwan)	Cross-sectional	Population-based		SI (current)	-Nonmigraine headache -Migraine with aura -Migraine without aura -Probable migraine	Adolescents		↑ SI in all migraine groups (-) Nonmigraine headache

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Table 1 (continued)

Study (country)	Design	Setting	Hazard period/duration	Suicidal outcome	Physical pain type	Population age	Special population	Main results
Wu et al., 2017 (USA)	Cohort (retrospective)	Clinical population	8 years	-SI (current)	-Psoriasis -Psoriatic arthritis	Mixed ages (adults and older adults)		(-) SI and SA in psoriasis, psoriatic arthritis, ankylosing spondylitis
Zhu et al., 2021 (China)	Cross-sectional	Clinical population		SI (current)	-Ankylosing spondylitis Unspecified pain (mild, moderate, and severe)	Older adults	Inpatients	↑ SI and pain intensity
Zhu et al., 2022 (China)	Cross-sectional	Clinical population		SI (current)	-Gastric ulcer -Arthritis	Older adults		↑ SI and gastric ulcer, arthritis

Note. †: increase/association; (-): no difference/no association; Adolescents: <18 years old; Adults: 19-65 years old; Older adults: >65 years old; SP: suicidal plan; SI: suicidal ideation; SA: suicide attempt; SD: suicide death; DSH: deliberate self-harm; NSSI: non-suicidal self-injury; (current): <24 months; (lifetime): >24 months; BPD: borderline personality disorder; GAD: general anxiety disorder; MDD: major depression disorder; OCD: obsessive-compulsive disorder; PTSD: post-traumatic stress disorder; SUD: substance use disorder; GDS: geriatric depression scale.

* Control group composed of those with physical pain "hardly ever - less than once a week", compared to those who reported physical pain "at least once a week".

** Studies not included in the final analysis because they provided hazard ratios or risk ratios instead of odds ratios.

likely to have had lifetime SI (OR = 3.21) compared to pain-free control groups, as were adults (OR = 1.94), adolescents (OR = 1.78), and mixed ages (OR = 1.56).

3.4. Suicidal planning

Eleven studies focused on current or lifetime SP (Table 2). Individuals with physical pain were more likely to have reported both current SP (OR = 1.89) and lifetime SP (OR = 1.89). High heterogeneity was detected among studies on current SP ($p(\chi^2) = 0.029$, $I^2 = 47\%$) and lifetime SI ($p(\chi^2) = 0.003$, $I^2 = 64\%$). In terms of age differences, mixed ages group with pain had higher odds of reporting SP (current SP: OR = 2.34; lifetime SP: OR = 2.54) compared to pain-free controls, as were adults (current SP: OR = 1.74; lifetime SP: OR = 2.25) and adolescents (lifetime SP: OR = 1.72).

3.5. Deliberate self-harm

Thirteen studies reported the occurrence of current or lifetime DSH (Table 2). Individuals with physical pain were more likely to have experienced current DSH (OR = 1.92) and lifetime DSH (OR = 1.61). However, high heterogeneity was detected in both current DSH ($p(\chi^2) < 0.0001$, $I^2 = 94\%$) and lifetime DSH ($p(\chi^2) < 0.0001$, $I^2 = 98\%$) studies. Moreover, adolescents with pain were more likely to have had DSH (current DSH: OR = 3.62; lifetime DSH: OR = 3.23) compared to pain-free controls, as were adults (current DSH: OR = 1.64; lifetime DSH: OR = 2.08), mixed ages (lifetime DSH: OR = 1.67), and older adults (lifetime DSH: OR = 0.87).

3.6. Suicide attempt

Thirty-four studies examined current or lifetime SA (Table 2). Individuals with physical pain were more likely to have had both current SA (OR = 1.58) and lifetime SA (OR = 1.94). High heterogeneity was detected in studies on current SA ($p(\chi^2) < 0.0001$, $I^2 = 71\%$) and lifetime SA ($p(\chi^2) < 0.0001$, $I^2 = 88\%$). When age groups were considered separately, older adults with pain were more likely to have attempted suicide (current SA: OR = 22.60; lifetime SA: OR = 2.42) compared to pain-free controls, so were adults (current SA: OR = 2.31; lifetime SA: OR = 2.39), mixed ages (current SA: OR = 2.20; lifetime SA: OR = 1.68), and adolescents (current SA: OR = 1.14; lifetime SA: OR = 1.85).

3.7. Suicide death

Thirteen studies reported the occurrence of SD (Table 2). Individuals with physical pain were more likely to have died by suicide (OR = 1.12). However, high heterogeneity was detected among SD studies ($p(\chi^2) <$

0.0001 , $I^2 = 90\%$). In terms of age group, adults with pain were more likely to have died by suicide (OR = 17.47) compared to pain-free controls, so were older adults (OR = 2.04), mixed ages (OR = 1.27), and adolescents (OR = 0.92).

3.8. Sensitivity analyses

3.8.1. Gender differences

Results revealed that females with any physical pain were more likely to have had current SI (OR = 2.19) and lifetime SI (OR = 6.40) compared to those without physical pain, but not current DW ($p = 0.317$; OR = 0.69) and lifetime SA ($p = 0.749$; OR = 1.28). Similarly, males with any physical pain were more likely to have had current SI (OR = 2.33) and lifetime SI (OR = 3.08) compared to those without physical pain, but not lifetime SA ($p = 0.988$; OR = 1.02) (Table 3).

3.8.2. Physical pain severity

Individuals with limited to mild physical pain were less likely to have had current DW (OR = 0.30) and more likely to have had current SI (OR = 1.28), lifetime SA (OR = 1.20), and SI (OR = 1.49), but they were not more likely to have died by suicide ($p = 0.200$; OR = 1.09) compared to those without any physical pain. When only individuals with moderate to severe physical pain were considered, results revealed that those participants were less likely to have experienced current DW (OR = 0.29) and more likely to have experienced current SA (OR = 2.10), SI (OR = 1.67), lifetime SA (OR = 1.52), and SD (OR = 1.83), but not lifetime SI ($p = 0.110$; OR = 2.12) (Table 4).

3.8.3. Specific physical pain

Studies examining migraine-related pain (migraine with aura, migraine without aura, status migrainosus, and probable migraine) reported that those suffering from migraine were more likely to have experienced current DW (OR = 1.79), SI (OR = 2.77), SP (OR = 2.83), SA (OR = 2.63), and lifetime DSH (OR = 2.37), SA (OR = 2.42), SI (OR = 2.30), but not lifetime SP ($p = 0.701$; OR = 1.08), while those suffering from non-migrainous headache were more likely to have experienced current DSH (OR = 3.34), SI (OR = 1.93) and lifetime DSH (OR = 4.19), DW (OR = 2.64), SA (OR = 1.45), SI (OR = 1.61), SP (OR = 1.54), but not current SA ($p = 0.214$; OR = 1.20) and SD ($p = 0.328$; OR = 0.86). When only arthritis-related pain (osteoarthritis, rheumatoid arthritis, psoriatic arthritis, polyarthritis, spondyloarthritis, inflammatory polyarthropathies, and ankylosing spondylitis) were considered, results showed that people with any form of arthritis were more likely to have had current DSH (OR = 1.44), DW (OR = 1.21), SA (OR = 2.18), SI (OR = 1.58), and lifetime SA (OR = 1.44), SI (OR = 1.32), SP (OR = 1.53), but not lifetime DSH ($p = 0.111$; OR = 0.44) and current SP ($p = 0.927$; OR = 0.96). Moreover, people with abdominal pain were more likely to

Table 2

The odds ratio of trials comparing suicide-related outcomes rates in individuals with and without physical pain grouped by population age.

Analysis	Records: K	Odds ratio [95 % confidence interval]	Overall effect: Z (P)	Heterogeneity: I ² (P)
Current death wish	17	1.50 [1.26–1.79]	4.54 (<0.001)	74 % (<0.001)
<i>Adults</i>	7	1.79 [0.80–4.02]	1.41 (0.159)	0 % (0.748)
<i>Older adults</i>	8	1.64 [1.34–2.00]	4.82 (<0.001)	80 % (<0.001)
<i>Mixed ages</i>	2	1.01 [0.68–1.51]	0.06 (0.954)	42 % (0.187)
Lifetime death wish	5	2.10 [1.28–3.42]	2.96 (0.003)	58 % (0.051)
<i>Adults</i>	5	2.10 [1.28–3.42]	2.96 (0.003)	58 % (0.051)
Current suicidal ideation	66	1.93 [1.68–2.22]	9.27 (<0.001)	98 % (<0.001)
<i>Adolescents</i>	14	2.27 [1.69–3.00]	5.57 (<0.001)	87 % (<0.001)
<i>Adults</i>	18	1.86 [1.44–2.40]	4.73 (<0.001)	80 % (<0.001)
<i>Older adults</i>	14	1.75 [1.33–2.31]	3.99 (<0.001)	95 % (<0.001)
<i>Mixed ages</i>	20	1.92 [1.42–2.58]	4.28 (<0.001)	99 % (<0.001)
Lifetime suicidal ideation	26	1.85 [1.64–2.08]	10.23 (<0.001)	97 % (<0.001)
<i>Adolescents</i>	6	1.78 [1.49–2.12]	6.36 (<0.001)	55 % (0.048)
<i>Adults</i>	12	1.94 [1.52–2.47]	5.39 (<0.001)	94 % (<0.001)
<i>Older adults</i>	1	3.21 [2.13–4.83]	5.58 (<0.001)	0 % (1.0)
<i>Mixed ages</i>	7	1.56 [1.23–1.98]	3.65 (<0.001)	95 % (<0.001)
Current suicidal planning	13	1.89 [1.28–2.78]	3.20 (0.001)	47 % (0.029)
<i>Adults</i>	7	1.74 [1.11–2.75]	2.39 (0.017)	0 % (0.834)
<i>Mixed ages</i>	6	2.34 [1.11–4.93]	2.23 (0.026)	74 % (0.002)
Lifetime suicidal planning	10	1.88 [1.58–2.23]	7.27 (<0.001)	64 % (0.003)
<i>Adolescents</i>	5	1.72 [1.41–2.10]	5.36 (<0.001)	0 % (0.672)
<i>Adults</i>	4	2.25 [1.32–3.83]	2.98 (<0.001)	83 % (<0.001)
<i>Mixed ages</i>	1	2.54 [1.66–3.88]	4.28 (<0.001)	0 % (1.0)
Current deliberate self-harm	8	1.92 [1.43–2.58]	4.30 (<0.001)	94 % (<0.001)
<i>Adolescents</i>	2	3.62 [1.86–7.05]	3.80 (<0.001)	89 % (0.003)
<i>Adults</i>	6	1.64 [1.18–2.28]	2.91 (0.004)	91 % (<0.001)
Lifetime deliberate self-harm	8	1.92 [1.83–2.01]	28.23 (<0.001)	94 % (<0.001)
<i>Adolescents</i>	4	3.23 [2.18–4.79]	5.84 (<0.001)	67 % (0.028)
<i>Adults</i>	2	2.08 [1.43–3.04]	3.80 (<0.001)	62 % (0.105)
<i>Older adults</i>	1	0.87 [0.60–1.28]	-0.69 (0.489)	0 % (1.0)
<i>Mixed ages</i>	1	1.92 [1.84–2.02]	27.77 (<0.001)	0 % (1.0)
Current suicide attempt	19	1.58 [1.39–1.80]	6.87 (<0.001)	71 % (<0.001)

Table 2 (continued)

Analysis	Records: K	Odds ratio [95 % confidence interval]	Overall effect: Z (P)	Heterogeneity: I ² (P)
<i>Adolescents</i>	3	1.14 [0.95–1.36]	1.41 (0.160)	0 % (0.899)
<i>Adults</i>	2	2.31 [1.22–4.37]	2.57 (0.010)	0 % (0.499)
<i>Older adults</i>	1	22.60 [3.22–158.45]	3.14 (0.002)	0 % (1.0)
<i>Mixed ages</i>	13	2.20 [1.80–2.68]	7.79 (<0.001)	45 % (0.039)
Lifetime suicide attempt	47	1.94 [1.69–2.23]	9.37 (<0.001)	88 % (<0.001)
<i>Adolescents</i>	9	1.85 [1.36–2.50]	3.97 (<0.001)	71 % (<0.001)
<i>Adults</i>	23	2.39 [1.82–3.13]	6.31 (<0.001)	75 % (<0.001)
<i>Older adults</i>	2	2.42 [1.51–3.87]	3.69 (<0.001)	0 % (0.946)
<i>Mixed ages</i>	13	1.68 [1.36–2.07]	4.86 (<0.001)	91 % (<0.001)
Suicide death	15	1.12 [0.96–1.31]	1.45 (0.147)	90 % (<0.001)
<i>Adolescents</i>	2	0.92 [0.76–1.12]	-0.81 (0.421)	0 % (0.542)
<i>Adults</i>	1	17.47 [2.26–135.02]	2.74 (0.006)	0 % (1.0)
<i>Older adults</i>	7	2.04 [1.37–3.04]	3.51 (<0.001)	77 % (<0.001)
<i>Mixed ages</i>	5	1.27 [0.87–1.84]	1.24 (0.214)	94 % (<0.001)

Table 3

Odds ratio of trials comparing suicide-related outcomes rates in females and males.

Analysis	Records: K	Odds ratio [95 % confidence interval]	Overall effect: Z (P)	Heterogeneity: I ² (P)
Females	13	2.02 [1.71–2.38]	8.29 (<0.001)	31 % (0.135)
<i>Current death wish</i>	1	0.69 [0.34–1.43]	-1.00 (0.317)	0 % (1.0)
<i>Current suicidal ideation</i>	4	2.12 [1.78–2.52]	8.53 (<0.001)	36 % (0.196)
<i>Lifetime suicidal ideation</i>	4	6.40 [1.52–27.04]	2.53 (0.012)	0 % (0.953)
<i>Lifetime suicide attempt</i>	4	1.28 [0.29–5.73]	0.32 (0.749)	0 % (0.926)
Males	10	2.34 [1.71–3.22]	5.25 (<0.001)	8 % (0.365)
<i>Current suicidal ideation</i>	4	2.33 [1.66–3.26]	4.93 (<0.001)	65 % (0.037)
<i>Lifetime suicidal ideation</i>	4	3.08 [1.03–9.21]	2.01 (0.044)	0 % (0.926)
<i>Lifetime suicide attempt</i>	2	1.02 [0.10–10.16]	0.02 (0.988)	0 % (0.711)

have experienced lifetime DSH (OR = 2.47), DW (OR = 2.83), SA (OR = 3.54), SI (OR = 2.47), and current SI (OR = 2.13). Furthermore, those who suffered from psoriasis or psoriatic arthritis were more likely to have experienced SA (OR = 1.47), SI (OR = 1.580), and SD (OR = 1.19), but not current SI ($p = 0.211$; OR = 1.30). Finally, participants with fibromyalgia were more likely to have had current DSH (OR = 2.84) and both current SA (OR = 2.46) and lifetime SA (OR = 3.30), but not current DW ($p = 0.051$; OR = 8.31) and SI ($p = 0.521$; OR = 1.21)

Table 4

The odds ratio of trials comparing suicide-related outcomes rates in individuals with different physical pain severity.

Analysis	Records: K	Odds ratio [95 % confidence interval]	Overall effect: Z (P)	Heterogeneity: I ² (P)
Limited-to-mild pain	12	1.24 [1.18–1.30]	8.58 (<0.001)	50 % (0.025)
Current death wish	1	0.30 [0.11–0.84]	-2.29 (0.022)	0 % (1.0)
Current suicidal ideation	2	1.28 [1.21–1.36]	8.27 (<0.001)	0 % (0.416)
Lifetime suicidal ideation	2	1.49 [0.92–2.39]	1.64 (0.102)	65 % (0.090)
Lifetime suicide attempt	3	1.20 [1.06–1.35]	2.91 (0.004)	30 % (0.241)
Suicide death	4	1.09 [0.93–1.27]	1.07 (0.285)	15 % (0.316)
Moderate-to-severe pain	20	1.73 [1.57–1.90]	11.22 (<0.001)	91 % (<0.001)
Current death wish	1	0.29 [0.11–0.78]	-2.46 (0.014)	0 % (1.0)
Current suicidal ideation	5	1.67 [1.48–1.87]	8.53 (<0.001)	0 % (0.587)
Lifetime suicidal ideation	2	2.12 [0.49–9.16]	1.00 (0.315)	96 % (<0.001)
Current suicide attempt	2	2.10 [1.73–2.56]	7.37 (<0.001)	0 % (0.386)
Lifetime suicide attempt	4	1.52 [1.04–2.22]	2.17 (0.030)	87 % (<0.001)
Suicide death	6	1.83 [1.04–3.21]	2.10 (0.036)	94 % (<0.001)

(Table 5).

3.9. Quality assessment and funnel plot

The NIH Quality Assessment Tools scores are reported in Supplementary Tables 5 and 6. The studies' scores were calculated by summing the total points for each category evaluated. For a study to be considered of fair quality, the overall score had to be greater than 50 %, while to be considered of high quality, it had to be greater than 70 % on either the cross-sectional/cohort or case-control tools. A study with a score of less than 50 % was considered to be of poor quality. The risk of bias assessment revealed that 4 articles (4.4 %) reported poor quality, 33 (36.26 %) fair quality, and 54 (59.34 %) good quality.

The funnel plot is presented in Supplementary Fig. 12. Visual examination of the funnel plot showed slight asymmetry, with a marginally higher concentration on the right side. In order to objectively assess publication bias, an Egger's regression test was conducted. The intercept was -1.126 (95 % CI: -2.651 to 0.400), with a p-value of 0.147 for the two-tailed test, indicating insufficient evidence to conclude significant asymmetry in the funnel plot. The relatively modest intercept and its confidence interval crossing zero indicate that, although some asymmetry may be present, it was not statistically significant.

4. Discussion

This meta-analysis aimed to evaluate the extent to which suicide-related outcomes differentiate between individuals with and without physical pain. In the last decade, there has been a notable increase in scientific interest in the association between physical pain and suicidality. Indeed, the number of studies included in this updated meta-analysis has almost tripled since the last meta-analysis conducted in

Table 5

Odds ratio of trials comparing suicide-related outcomes rates in individuals with specific physical pain.

Analysis	Records: K	Odds ratio [95 % confidence interval]	Overall effect: Z (P)	Heterogeneity: I ² (P)
Migraine-related pain	42	2.37 [2.35–2.38]	293.75 (<0.001)	95 % (<0.001)
Current death wish	1	1.79 [1.05–3.05]	2.14 (0.032)	0 % (1.0)
Current suicidal ideation	11	2.77 [2.16–3.55]	8.01 (<0.001)	75 % (<0.001)
Lifetime suicidal ideation	7	2.30 [1.93–2.74]	9.35 (<0.001)	83 % (<0.001)
Current suicidal planning	2	2.83 [1.60–5.01]	3.56 (<0.001)	0 % (0.852)
Lifetime suicidal planning	1	1.08 [0.73–1.60]	0.38 (0.701)	0 % (1.0)
Lifetime deliberate self-harm	1	2.37 [2.35–2.38]	293.37 (<0.001)	0 % (1.0)
Current suicide attempt	4	2.63 [1.99–3.48]	6.83 (<0.001)	9 % (0.347)
Lifetime suicide attempt	15	2.42 [1.72–3.39]	5.10 (<0.001)	75 % (<0.001)
Non-migrainous headache	27	1.52 [1.40–1.65]	9.86 (<0.001)	75 % (<0.001)
Lifetime death wish	1	2.64 [1.18–5.92]	2.35 (0.019)	0 % (1.0)
Current suicidal ideation	4	1.93 [1.29–2.88]	3.22 (0.001)	86 % (<0.001)
Lifetime suicidal ideation	5	1.61 [1.42–1.81]	7.66 (<0.001)	42 % (0.143)
Lifetime suicidal planning	4	1.54 [1.28–1.86]	4.58 (<0.001)	0 % (0.916)
Current deliberate self-harm	1	3.34 [1.46–7.63]	2.86 (0.004)	0 % (1.0)
Lifetime deliberate self-harm	2	4.19 [1.85–9.48]	3.44 (0.001)	83 % (0.015)
Current suicide attempt	1	1.20 [0.90–1.60]	1.24 (0.214)	0 % (1.0)
Lifetime suicide attempt	8	1.45 [1.13–1.86]	2.93 (0.003)	53 % (0.036)
Suicide death	1	0.86 [0.63–1.17]	-0.98 (0.328)	0 % (1.0)
Arthritis-related pain	46	1.47 [1.36–1.60]	9.49 (<0.001)	96 % (<0.001)
Current death wish	4	1.21 [0.85–1.71]	1.06 (0.288)	57 % (0.075)
Current suicidal ideation	11	1.58 [1.19–2.09]	3.17 (0.002)	87 % (<0.001)
Lifetime suicidal ideation	4	1.56 [1.07–2.29]	2.29 (0.022)	93 % (<0.001)
Current suicidal planning	2	0.96 [0.43–2.15]	-0.09 (0.927)	0 % (0.964)
Lifetime suicidal planning	3	1.53 [0.96–2.46]	1.78 (0.075)	72 % (0.028)
Current deliberate self-harm	3	1.44 [1.25–1.66]	4.97 (<0.001)	42 % (0.180)
Lifetime deliberate self-harm	2	0.44 [0.16–1.21]	-1.59 (0.111)	94 % (<0.001)
Current suicide attempt	4	2.18 [1.13–4.22]	2.32 (0.020)	70 % (0.017)
Lifetime suicide attempt	8	1.59 [1.38–1.83]	6.39 (<0.001)	28 % (0.203)
Suicide death	5	1.38 [1.10–1.73]	2.83 (0.005)	45 % (0.123)
Abdominal pain	10	2.68 [2.27–3.15]	11.76 (<0.001)	0 % (0.486)
Lifetime death wish	2	2.83 [2.00–4.01]	5.87 (<0.001)	19 % (0.265)

(continued on next page)

Table 5 (continued)

Analysis	Records: K	Odds ratio [95 % confidence interval]	Overall effect: Z (P)	Heterogeneity: I^2 (P)
Current suicidal ideation	2	2.13 [1.25–3.63]	2.77 (0.006)	0 % (0.346)
Lifetime suicidal ideation	2	2.47 [1.73–3.54]	4.94 (<0.001)	12 % (0.286)
Lifetime deliberate self-harm	1	2.47 [1.83–3.34]	5.90 (<0.001)	0 % (0.486)
Lifetime suicide attempt	3	3.54 [2.40–5.23]	6.34 (<0.001)	0 % (0.380)
Psoriasis-related pain	11	1.25 [1.11–1.40]	3.77 (<0.001)	94 % (<0.001)
Current suicidal ideation	2	1.30 [0.86–1.96]	1.25 (0.211)	0 % (0.408)
Lifetime suicidal ideation	2	1.58 [0.76–3.31]	1.21 (0.225)	99 % (<0.001)
Lifetime suicide attempt	4	1.47 [1.10–1.97]	2.59 (0.010)	95 % (<0.001)
Suicide death	3	1.19 [1.04–1.36]	2.57 (0.010)	2 % (0.360)
Fibromyalgia	7	2.87 [2.49–3.32]	14.27 (<0.001)	67 % (0.006)
Current death wish	1	8.31 [0.99–69.68]	1.95 (0.051)	0 % (1.0)
Current suicidal ideation	1	1.21 [0.68–2.17]	0.64 (0.521)	0 % (1.0)
Current deliberate self-harm	1	2.84 [2.28–3.54]	9.26 (<0.001)	0 % (1.0)
Current suicide attempt	3	2.46 [1.30–4.64]	2.77 (0.006)	63 % (0.066)
Lifetime suicide attempt	1	3.30 [2.66–4.09]	10.83 (<0.001)	0 % (1.0)

2015 (Calati et al., 2015). Furthermore, the present study has included most of the studies considered by two previous reviews published on this topic (Hinze et al., 2019; Santos et al., 2020), excluding only those that did not meet all the inclusion criteria.

Results revealed that individuals with physical pain, compared to those without pain, were more likely to experience all the investigated suicide-related outcomes, especially lifetime DW, current SI, current DSH, and lifetime SA. These findings are consistent with those of previously published studies (Calati et al., 2015; Fishbain et al., 2014). It is noteworthy that physical pain increased by 92 % the likelihood of engaging in DSH in the previous 24 months, as well as by 94 % the likelihood of a lifetime SA. However, those with physical pain were only 12 % more likely to die by suicide compared to those without pain. A plausible explanation could be that this result indicates physical pain as a pivotal suicide risk factor for engaging in DSH or SA. However, a debilitating physical condition might at least partially limit access to highly lethal means or methods. Additionally, individuals with a serious physical condition may receive frequent visits from relatives or friends, which increases the chances of providing quick assistance right after a self-injurious behavior, explaining the disproportion between the critical increased risk of SA or DSH and only the moderate increased risk of SD. Also, the relatively small association with SD could be explained by the lack of available studies compared to other suicide-related outcomes. In terms of age, adolescents with physical pain reported higher odds of experiencing current SI and both current and lifetime DSH compared to those without pain. The same results have been confirmed in both adult and older adult groups despite a weaker association. Moreover, adults were at least twice as likely to experience both current and lifetime SA, and lifetime SP compared to those without any physical pain and were more likely to report current DW or die by suicide compared to adolescents and older adults. Nevertheless, the robust association between pain and SD in adults may be attributed to the fact that only one study encompassing this age group was included in the

analysis. More specifically, Manoranjitham et al. (2010) found that suffering from chronic pain increased the likelihood of dying by suicide by more than 1600 % compared to adults who did not have chronic pain. However, the findings of this study require cautious interpretation for two primary reasons: firstly, it is the sole study that has investigated suicide death in adults included in our meta-analysis; and secondly, as it was conducted in a rural area in the southern region of India, a substantial effect observed in comparison to studies conducted with participants from western countries may be attributable to socioeconomic factors and the prevalence of non-communicable diseases, which have reached epidemic levels in these rural areas of India (Roy et al., 2023). Indeed, the healthcare infrastructure in rural parts of India is often described as inadequate, with a shortage of healthcare centers and professionals and a struggle to deliver effective care (Gogoi et al., 2021; Nagar et al., 2024). Older adults with physical pain reported higher odds of experiencing lifetime SI and both current and lifetime SA compared to those without physical pain and other age groups with physical pain. Regarding suicide-related behavioral outcomes, a significant discrepancy was observed among older adults. Indeed, Kim S. and colleagues (Kim et al., 2022) observed that physical pain was associated with a 12.6 % reduction in the risk of hospitalization due to DSH, which reached 74.6 % when considering only those with arthritis. Conversely, the findings of Tsoh et al. (2005) indicated that the likelihood of attempting suicide among older adults aged 65 and over with arthritis was 2160 % higher than in those without arthritis. However, older adults were the less investigated age group, lacking data about lifetime DW, current and lifetime SP, and current DSH. Subsequently, when studies that had considered two or more age groups together were analyzed, the suicide-related outcomes most strongly associated with physical pain were both current and lifetime SP and current SA. Overall, adults and elders with physical pain had a higher probability of experiencing the whole spectrum of suicide-related outcomes compared to adolescents, except for current (but not lifetime) SI and both current and lifetime DSH.

In sensitivity analyses, results indicated that males and females in pain were more likely to experience SI during their lifetime or within the previous 24 months than those without pain. The increased risk of having lifetime SI was 577 % for females and 208 % for males. This result lends further support to the hypothesis that the higher prevalence of SI among females, as observed in the general population (Nowotny et al., 2015), is also evident in individuals with physical pain. Moreover, sensitivity analyses on pain severity yielded contrasting results. Interestingly, individuals with limited-to-mild physical discomfort were less likely to experience current DW or to have died by suicide than those without physical pain but more likely to have experienced SI or SA. In contrast, when only those with moderate or severe physical pain were included in the analysis, the odds of dying by suicide were greater than in those without any physical pain. Still, they were also less likely to have had current DW. These findings suggest that physical pain severity seems to be linked to suicide-related behavioral outcomes, such as SA or SD, but not necessarily to outcomes associated with an increase of active (SI) or passive (DW) ideation. Therefore, as severe pain appears to cause individuals to jump over steps in the suicidal process continuum, thus preventive methods should be adjusted accordingly, as SI alone may be insufficient to identify those at risk. This result also aligns with findings on trigeminal neuralgia, also known as "suicide disease" (Adams et al., 2011), a condition that makes everyday living unbearable, causing both physical and mental anguish and ultimately increasing the risk of suicide (Zakrzewska, 2006). Moreover, the results of the analyses for specific physical pain showed that people with migraine were more likely to report DW, SI, SP, and DSH compared to those without it. These findings align with previous reviews concerning the association between migraine and SI (Friedman et al., 2017) and SA (Karimi et al., 2020; Nović et al., 2016). Similarly, those with non-migrainous headaches were more likely to have experienced current DW, SI, SP, DSH, and SA compared to those without it. Furthermore, individuals with rheumatic

disorders, such as arthritis or fibromyalgia, were more likely to experience most of the suicide-related outcomes when compared to those without such conditions. This result confirms previous findings by Li and colleagues (Li et al., 2018), indicating an association between rheumatic diseases and SI and SA. Finally, results showed that abdominal pain increased the risk for DW, SI, and DSH, as suggested by Spiegel et al. (Spiegel et al., 2007); while having psoriasis increased the risk for SI, DSH, SA, and SD, ultimately confirming the association between this condition and suicidality (Chi et al., 2017; Gooderham et al., 2016; Pompili et al., 2021; Singh et al., 2017).

These findings are of particular significance in the context of new-generation models of suicidal behavior based on the ideation-to-action framework (Klonsky et al., 2018). In particular, the Interpersonal-Psychological Theory of Suicidal Behavior (Joiner, 2005) posits that the co-occurrence of psychological states (thwarted belongingness and perceived burdensomeness) and the capability for suicide, including tolerance of physical pain, act as determinants of the critical transition from suicidal desire to lethal SA. Similarly, physical pain sensitivity plays an equally relevant role in the Integrated Motivational-Volitional Model (O'Connor, 2011; O'Connor and Kirtley, 2018) as a moderating factor in the relationship between SI and suicidal behavior. Moreover, the Three Step Theory (Klonsky et al., 2015) suggests that pain, whether physical or psychological, plays a tripartite role since (i) it contributes to the formation of suicidal desire when experienced in conjunction with hopelessness; (ii) when it exceeds connectedness, suicidal desire becomes severe; and finally, (iii) physical pain tolerance and sensitivity represents one of the factors that increase the capability for suicide, considerably increasing the risk of suicidal behavior.

The present study was moderately inclusive, resulting in high heterogeneity between studies due to differing characteristics. These discrepancies include research designs (cohort, case-control, or cross-sectional), methodological aspects about the assessment of pain and suicide-related outcomes, the duration of pain (e.g., acute or chronic), specific study populations (e.g., psychiatric populations, veterans, or tertiary care outpatient sample), and the diverse countries in which the studies were conducted. Notably, sensitivity analyses on subgroups (gender, physical pain severity, and specific physical pain) in most cases resulted in a notable reduction in heterogeneity while preserving statistical significance.

Moreover, a sensitivity analysis concerning the chronicity or acuity of physical pain was not conducted, given that only a few of the included studies explicitly defined the duration of the pain. While some evaluated the frequency of pain every week, they did not specify the length of time over which the pain had persisted. Consequently, concerning the duration of physical pain, a considerable number of studies have been categorized as "unspecified", a minority have been classified as "acute pain", while most studies on "chronic pain" were those which focused on chronic disorders by definition, such as arthritis, fibromyalgia, psoriasis, or migraines.

This study has important limitations that warrant note. First, in light of the complex biopsychosocial nature of suicide, the inclusion of special populations such as homeless, veterans, or psychiatric patients may result in findings that are partially influenced by other psychological states or relevant life events, particularly within these study populations. Second, high heterogeneity was observed in the majority of the primary analyses. Indeed, despite our attempts to address this through subgroup analyses, some sensitivity analyses still exhibited high heterogeneity. Third, although we systematically evaluated pain-free control groups for each study, we deemed it appropriate to include the article by Hamada et al. (2021) in the analyses, in which the control group consisted of those who reported experiencing physical pain "hardly ever—less than once a week". Fourth, in studies investigating the presence of a specific condition (e.g., arthritis or fibromyalgia), the control group consisted of individuals who did not suffer from the condition under investigation. Thus, it was assumed that the control

group, comprising individuals without the specific condition, did not experience any physical pain. This raises the question of whether those without that specific condition (e.g., arthritis or fibromyalgia) were free from any other physical pain. Similarly, this line of reasoning can be applied to studies examining chronic pain and whether or not it can be assumed that individuals who did not experience chronic pain did not also experience acute physical pain and vice versa. Furthermore, it should be noted that the sparse effects in our results could be due to the inflation of ORs in retrospective studies, which represents a limitation of the monotone likelihood statistical approach (Tzeng, 2021). Lastly, the differentiation of suicide-related outcomes, along with categorizing each of these into current or lifetime, resulted in more precise information regarding specific outcomes across different age groups. However, this approach also reduced the overall data available for each outcome, with a notable lack of data concerning certain outcomes, especially lifetime DW, current SP, and current DSH.

In conclusion, we presented the most comprehensive meta-analysis of the increased risk of experiencing suicide-related outcomes among individuals of all ages with physical pain, including 88 trials in the analyses. Consequently, our study not only encompasses more studies than the previous meta-analysis on this topic (Calati et al., 2015) but also incorporates additional sensitivity analyses for specific subgroups. The results suggested that particular subgroups of individuals are at an elevated risk of experiencing specific suicide-related outcomes compared to others, ultimately guiding future works in this field.

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CRediT authorship contribution statement

Gabriele Torino: Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Martina Rignanese:** Methodology, Data curation. **Eleonora Salmè:** Methodology, Data curation. **Fabio Madeddu:** Writing – review & editing. **Philippe Courtet:** Writing – review & editing. **Jelena Forget:** Writing – review & editing. **David Attali:** Writing – review & editing. **Larissa Kalisch:** Writing – review & editing. **Carolina Baeza-Velasco:** Writing – review & editing. **Jorge Lopez-Castroman:** Writing – review & editing. **Michele Fornaro:** Writing – review & editing, Methodology. **Raffaella Calati:** Writing – review & editing, Validation, Supervision, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.psychres.2025.116371](https://doi.org/10.1016/j.psychres.2025.116371).

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