

REVIEW ARTICLE

Chronic pain as a trigger for street opioid use: A systematic review

Supplementary file

Table S1. Quality assessment of all included studies

Author	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Granata <i>et al.</i> ¹	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	N/A
Dassieu <i>et al.</i> ²	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Dickson-Gomez <i>et al.</i> ³	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geile <i>et al.</i> ⁴	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	N/A
Guan <i>et al.</i> ⁵	Yes	Yes	Yes	N/A	Yes	Yes	Yes	Yes	N/A	N/A
D'Orazio and Fischel ⁶	Unclear	Yes	Yes	No	Yes	Unclear	Yes	Yes	No	N/A
Kim <i>et al.</i> ⁷	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	N/A
Guliyev <i>et al.</i> ⁸	Yes	Yes	Yes	Unclear	Yes	Yes	Unclear	Yes	N/A	N/A
McAdam <i>et al.</i> ⁹	Yes	No	Yes	Unclear	Yes	Yes	No	Yes	N/A	N/A
Bardwell <i>et al.</i> ¹⁰	Yes	Yes	Yes	Yes	Yes	No	Unclear	Yes	Yes	Yes
Liappas <i>et al.</i> ¹¹	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	N/A
Rosenblum <i>et al.</i> ¹²	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	N/A
Silverstein <i>et al.</i> ¹³	Yes	Yes	Yes	Yes	Yes	No	Unclear	Yes	Yes	Yes
Woodall <i>et al.</i> ¹⁴	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	N/A
Roxburgh <i>et al.</i> ¹⁵	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	N/A
Roxburgh <i>et al.</i> ¹⁶	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	N/A	N/A

Abbreviations: N/A: Not available

Table S2. Characteristics of all included studies

Authors	Year	Type of study	Timeline	City, country	Population	Pain location and severity	Past treatment of pain	Fentanyl route of administration
Granata <i>et al.</i> ¹	2014	Case report	August 2010 – August 2011	N/A	<i>n</i> =2; one 23-year-old man, one 20-year-old man	Moderate to severe pain; intensity reaching 8/10 on a numerical scale	Paracetamol, codeine, oral morphine, oral tramadol, ketoprofen, long-acting oxycodone, short-acting oxycodone	Transdermal, nasal
Dassieu <i>et al.</i> ²	2021	Qualitative study	July 2017 to May 2018	Montreal, Canada	<i>n</i> =25; <i>n</i> =10 women, <i>n</i> =15 men; age range=27 – 61	Back, knee, legs/feet, womb, hand, shoulder	Methadone or suboxone treatment	Injection
Dickson-Gomez <i>et al.</i> ³	2022	Qualitative study	N/A	Connecticut, Kentucky and Wisconsin	<i>n</i> =60 (Connecticut), <i>n</i> =32 (Kentucky), <i>n</i> =56 (Wisconsin)	Back, ribs, neck, face, emotional pain, leg, finger, kidney	Percocet, morphine, oxycontin 80, Lorcet, Vicodin, oxycodone, Lortabs, Valium, Suboxone/buprenorphine, Tylenol 3	Injection, oral, nasal
Geile <i>et al.</i> ⁴	2019	Observational retrospective case series	2010 – 2018	N/A	<i>n</i> =35	Back, severe chronic pain, Crohn's disease, impaired mobility, chronic obstructive pulmonary disease, unspecified heart disease	Morphine, tilidine, tapentadol, amitriptyline, doxepin	Transdermal
Guan <i>et al.</i> ⁵	2011	Case report	N/A	N/A	<i>n</i> =1; 62-year-old, white male	Chronic lower back pain	Oral narcotic analgesics	Transdermal, oral, transdermal, oral
D'Orazio and Fischel ⁶	2012	Case report	N/A	Philadelphia, Pennsylvania, United States	<i>n</i> =1; 34-year-old female	Back pain	Oxycodone/acetaminophen	Transdermal, oral abuse of fentanyl patches
Kim <i>et al.</i> ⁷	2025	Cross-sectional study	N/A	Vancouver, Canada	<i>n</i> =200; <i>n</i> =130 with chronic pain; age 18 – 40 (<i>n</i> =47; 36.2%), age 41 – 77 (<i>n</i> =83; 63.8%); male (<i>n</i> =81; 62.3%), female/non-binary (<i>n</i> =46; 65.7%)	65% reported back pain, 52% leg pain, 32% chest/abdomen, 28% extremities; mean pain intensity: 7.6/10	<i>n</i> =25 (19.2%) reported prescription opioids were not strong enough; <i>n</i> =14 (10.8%) lost access to previous prescription	<i>n</i> =23 (17.7%) injected street opioids in the past 6 months

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Table S2. (Continued)

Authors	Year	Type of study	Timeline	City, country	Population	Pain location and severity	Past treatment of pain	Fentanyl route of administration
Guliyev <i>et al.</i> ⁸	2022	Case report	N/A	Istanbul, Turkey	n=1; 63-year-old male	Feet, face, arthralgia, myalgia, withdrawal pain	N/A	Transdermal
McAdam <i>et al.</i> ⁹	2020	Case report	2019	Vancouver, Canada	n=1; 47-year-old male	Abdominal pain and nausea (acute appendicitis)	Initially: Morphine 50 mg; post-op: 2 x 50 mg, 1 x 10 mg intravenous (IV); upon re-admission: Ceftriaxone 1 g IV daily, metronidazole 500 mg IV bidaily, hydromorphone 10 – 20 mg IV hourly	Injection
Bardwell <i>et al.</i> ¹⁰	2021	Qualitative study	December 2019 – March 2020	Vancouver, Canada	n=24; n=12 cis women, n=12 cis men; mean age=51 (range 35 – 63); n=14 Indigenous, n=9 White, n=1 Black	Fibromyalgia	Prescribed methadone, morphine, hydromorphone, codeine/acetaminophen, oxycodone/acetaminophen, buprenorphine/naloxone	N/A
Liappas <i>et al.</i> ¹¹	2004	Case report	N/A	Greece	n=1; 36-year-old woman	Arthritic and severe ear pain; left auricle	Propoxyphene	Transdermal, oral
Rosenblum <i>et al.</i> ¹²	2003	Observational, cross-sectional study	January 2005 – December 2005	33 states, United States	n=5663; mean age=35; 36.6% women	Withdrawal pain	N/A	Intravenous
Silverstein <i>et al.</i> ¹³	2019	Qualitative study	May 2017 – June 2019	Dayton, Ohio metropolitan area, United States	Age range=19 – 70; mean age=38.9; 54% male	N/A	N/A	Intravenous
Woodall <i>et al.</i> ¹⁴	2008	Case report	January 2002 – December 2004	Ontario, Canada	n=7; n=3 male, n=4 female; age range=20 – 51	N/A	N/A	Oral abuse of transdermal fentanyl patches
Roxburgh <i>et al.</i> ¹⁵	2013	Observational, cross-sectional study	Prescription data: 2002 – 2011; fentanyl related death data: January 1, 2000 – November 30 2012	Australia	24% of fentanyl prescriptions (2002 – 2012) were for Australians aged ≥80; 13% each for ages 50 – 59, 60 – 69, and 70 – 79; ≤3% for those ≤20 years	N/A	N/A	Intravenous, transdermal

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Authors	Year	Type of study	Timeline	City, country	Population	Pain location and severity	Past treatment of pain	Fentanyl route of administration
Roxburgh <i>et al.</i> ¹⁶	2019	Observational, retrospective cohort study	2000 – 2015	Australia	n=10,795; n=7,431 male; n=3,902 aged 14 – 34, n=3,105 aged 35 – 44, n=2,285 aged 45 – 54	Chronic pain	N/A	Intravenous
Authors	Year	Fentanyl dosage	Source of fentanyl	Reason for using	Use of other substances	Interventions	Prices of fentanyl	
Granata <i>et al.</i> ¹	2014	Fentanyl nasal spray: 100 – 400 µg; patch: 75 µg/h	Prescribed	Insufficient pain relief and dosage for breakthrough cancer pain	N/A	Gradually reducing the amount of rapid-onset opioid	N/A	
Dassieu <i>et al.</i> ²	2021	N/A	Illicit (street), diverted prescription	Stigma, doctors' refusal to prescribe opioids, and poor past experience	Cocaine, cannabis, diverted Dilaudid	New health policies to recognize chronic non-cancer pain as a real issue for people who misuse drugs	N/A	
Dickson-Gomez <i>et al.</i> ³	2022	N/A	Illicit (street), diverted prescription, pill mills, friend's prescription, imported from Florida, unethical prescribing, stolen from family medicine cabinet	Tolerance to per os, recreational high, doctor cutting per os doses, doctor refusing to prescribe, changing prescribing laws, desire to fit in, emotional trauma	Lorcet, Vicodin, suboxone, oxycontin, methadone	More education about the safety and efficacy of medications for opioid use disorder	Significantly cheaper than heroin	
Geile <i>et al.</i> ⁴	2019	1 patch (50 µg/h), 3 patches (100 µg/h), 1 patch (75 µg/h), fentanyl 1 0.0066 µg/mL, norfentanyl (0.0121 µg/mL, 0.298 µg/mL, 0.0023 µg/mL)	Wife's prescription	Access to other per os is limited, recreational high	N/A	Additional toxicological investigations	N/A	
Guan <i>et al.</i> ⁵	2011	25 µg/h	Prescribed	Inadequate pain control with the prescription regimen	N/A	Additional education, treatment adjustment, referral to a therapist and pain specialist	N/A	
D'Orazio and Fischel ⁶	2012	Half of a 100 µg/h patch	Diverted friend's fentanyl patch	Ineffective prescription of oxycodone e/acetaminophen	N/A	Use of naloxone to treat patients who ingest fentanyl transdermal patches	N/A	

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Table S2. (Continued)

Authors	Year	Fentanyl dosage	Source of fentanyl	Reason for using	Use of other substances	Interventions	Prices of fentanyl
Kim <i>et al.</i> ⁷	2025	N/A	Illicit	Self-medication, lost access to per os, low dosages, or lack of access to per os.	<i>n</i> =65 (benzodiazepines), <i>n</i> =76 (stimulants), <i>n</i> =47 (alcohol), <i>n</i> =54 (cannabis)	N/A	N/A
Guliyev <i>et al.</i> ⁸	2022	100 µg/h every 5 days (2 weeks), 50 µg/h every 3 days (following weeks), 50 µg/h every 2 days (last 1.5 months); hospitalized with three patches applied simultaneously	Illicit, pharmacies/hospitals through the family	To quit opium gum	Alcohol, opium gum	Medically supervised detoxification with symptom management and maintenance therapy	N/A
McAdam <i>et al.</i> ⁹	2020	10 mg – 20 mg per day	Illicit	Uncontrolled pain/withdrawal	Crystal methamphetamine	Several forms of opioid agonist therapy including sublingual buprenorphine/naloxone, methadone, slow-release oral morphine and hydromorphone	N/A
Bardwell <i>et al.</i> ¹⁰	2021	N/A	Diverted prescription, safe supply, illicit	Limited availability and higher cost of per os, apprehension of counterfeit per os pills, the doctor cut-off or reduced per os prescription, self-medicate pain, recreational high	Morphine, oxycodone, hydromorphone, slow-release oral morphine, hydromorphone, oxycodone	Regulation and scale-up of safer supply interventions	Super cheap
Liappas <i>et al.</i> ¹¹	2004	Patches: 25 µg/h, increased to 75 – 250 µg daily	Diverted through multiple prescriptions	Arthritic and severe ear pain	N/A	Additional follow-up for pain	N/A
Rosenblum <i>et al.</i> ¹²	2003	N/A	Dealer (86%), friends/relatives (54%), doctor's prescription (28%), emergency room (13%), theft (7%)	Inadequately treated chronic pain	Oxycodone (79%), hydrocodone (67%), methadone (40%), morphine (29%), heroin (13%), hydromorphone	Methadone maintenance treatment	N/A

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Table S2. (Continued)

Authors	Year	Fentanyl dosage	Source of fentanyl	Reason for using	Use of other substances	Interventions	Prices of fentanyl
Silverstein <i>et al.</i> ¹³	2019	N/A	Internet (3%), forged prescriptions (3%), other (2%) Friends/relatives, illicit drug market	Self-medication, euphoric effects, and lack of health insurance	Heroin, buprenorphine	Additional monitoring for self-medication	N/A
Woodall <i>et al.</i> ¹⁴	2008	Patch: 25 – 100 µg/h	Prescription, diverted prescription from husband and friend	N/A	Amitriptyline, nortriptyline, doxepin, codeine, alprazolam, fentanyl, MDMA, methadone	N/A	N/A
Roxburgh <i>et al.</i> ¹⁵	2013	N/A	N/A	N/A	Benzodiazepines (45%), morphine (18%) and oxycodone (16%)	N/A	N/A
Roxburgh <i>et al.</i> ¹⁶	2019	N/A	Diverted pharmaceutical fentanyl	N/A	Alcohol, benzodiazepines	N/A	N/A

Abbreviations: N/A: Not available. IV: Intravenous

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