

# Multimorbidity and chronic pain management with opioids and other therapies among adults in the United States: A cross-sectional study

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## Abstract

**Background:** Multimorbidity, defined as the concurrent presence of  $\geq 2$  chronic conditions, and chronic pain (i.e., pain lasting  $\geq 3$  months) often co-exist. Multimodal pain management that includes non-pharmacologic treatment and non-opioid therapy is recommended to prevent serious risks associated with opioids.

**Purpose:** Estimate the prevalence of types of pain treatment and analyze their associations with multimorbidity using a nationally representative survey in the United States (US).

**Methods:** Data was collected from the 2020 National Health Interview Survey among adults with chronic pain and chronic conditions (N= 12,028). Chronic pain management was grouped into four categories: opioid therapy; non-opioid multimodal pain treatment; pain treatment with monotherapy; and no pain treatment. Chi-square tests and multivariable multinomial logistic regressions were used to analyze the association of multimorbidity with types of pain treatment after controlling for age, sex, social determinants of health (SDoH), and lifestyle characteristics.

**Results:** Among NHIS respondents, 68% had multimorbidity. In adjusted multinomial logistic regressions with “pain management with monotherapy” as the reference group, those with multimorbidity were more likely to utilize opioids (AOR=1.63, 95% CI=1.23, 2.17). Those with severe pain were also more likely to use opioid therapy (AOR=19.36, 95% CI=13.35, 28.06) than those with little pain. Those with low income and education were less likely to have multimodal pain management without opioids.

**Conclusion:** Seven in 10 adults had multimorbidity. Those with multimorbidity reported severe pain and relied on opioids for pain control. Regardless of multimorbidity status, SDoH was associated with types of chronic pain management.

## Keywords

Multimorbidity, chronic pain, multimodal, opioid, pain management

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## Introduction

Chronic pain, defined as pain lasting  $\geq 3$  months, is associated with many chronic conditions<sup>1</sup> and is the source of significant morbidity in the United States.<sup>2</sup> Approximately 20% of adults experience chronic pain, and 7% experience high-impact chronic pain, which may lead to adverse

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outcomes such as decreased quality of life, poor mental health, and decreased physical function.<sup>3</sup> Chronic pain is also associated with a considerable economic burden estimated at \$560 billion annually in direct medical costs, lost productivity, and disability programs.<sup>4</sup>

Multimorbidity, characterized by the concurrent presence of two or more chronic conditions, is a global concern that affects both working-age and older individuals, with its prevalence increasing with age.<sup>5</sup> Like chronic pain, multimorbidity is associated with adverse health outcomes, often resulting in a decline in physiological function, decreased quality of life, and increased healthcare utilization.<sup>6</sup> Multimorbidity and chronic pain are two major global health issues that unfortunately often co-exist, especially with an aging population in the United States, as nearly one-third of elderly patients with multimorbidity take analgesics regularly or as needed.<sup>7</sup> Furthermore, a higher percentage of adults with multimorbidity report chronic pain compared to those without multimorbidity.<sup>8</sup> The incidence of chronic pain appears to be proportional to the number of long-term conditions (LTC). McQueenie et al. revealed that in individuals who reported chronic pain, 53.4% had 2-3 LTC, and 71.5% had  $\geq 4$  LTC, twice and four times more than those with no LTC, respectively.<sup>8</sup>

Despite the misuse of opioids amongst the general population resulting in severe clinical outcomes (eg respiratory depression and death),<sup>9</sup> opioids have been used broadly in treating chronic pain. In addition, their long-term benefits remain uncertain. Regulatory agencies and the public have called for a change in opioid prescribing practices due to the general unfavorable risk-to-benefit ratio of chronic opioid therapy. Because of the complex nature of chronic pain, monotherapy is rarely an adequate strategy for pain management; therefore, guidelines have emphasized a multimodal approach to pain management that considers biologic, psychological, and social characteristics.<sup>3</sup> Multimodal analgesia optimizes pain relief by treating pain along different pain processing pathways, often resulting in a synergistic effect. It includes pharmacologic (non-steroidal anti-inflammatory agents, acetaminophen, local anesthetics, opioids, adjuvant anesthetics), and nonpharmacologic interventions (interventional treatments, cognitive behavioral therapies, acupuncture, physical therapy, massage therapy, etc.).<sup>10</sup> For the management of chronic pain, The Center for Disease Control and Prevention (CDC) recommends that clinicians maximize the use of non-opioid therapies and consider initiating opioid therapy only if the expected benefits for pain and function are anticipated to outweigh the risks.<sup>3</sup> A multimodal approach to pain management is the ideal strategy to help reduce the dependence on a single medication and may reduce or eliminate the need for opioids. Studies have shown that multimodal pharmacologic approaches without the use of opioids may be just as effective as the use of opioid therapy for pain control among

individuals with chronic pain conditions. For example, Krebs et al studied the effects of opioid vs non-opioid medications on pain-related function in patients with chronic back pain or hip/knee osteoarthritis pain. They found that treatment with opioids was not superior to treatment with a combination of non-opioid medications over 12 months.<sup>11</sup>

In a study conducted by Rajbhandari-Thapa et al., multimorbidity was shown to account for more than 90% of opioid-related hospitalizations. However, the study did not distinguish between illicit or prescribed opioid therapy. Nevertheless, this indicates the need for alternatives to opioid prescriptions for pain control among individuals with multiple chronic conditions.<sup>12</sup> At present, studies assessing pain management strategies in individuals with multimorbidity are sparse; therefore, the main objective of this study was to estimate the prevalence of types of pain treatment and analyze their associations with multimorbidity using a US nationally representative survey.

## Methods

### Study design and data sources

We used a cross-sectional design and analyzed data on adults aged 18 or older with chronic pain and chronic conditions from the 2020 National Health Interview Study (NHIS) Survey. The participants who reported pain on some days, most days, and every day in the past 3 months were considered to have chronic pain. We excluded individuals who 1) received opioids for acute pain, ascertained through direct inquiry in the NHIS survey regarding opioid usage specifically for acute pain, 2) had a concurrent diagnosis of cancer or pregnancy, and 3) did not report pain. We also restricted the study sample to adults without missing data on health insurance status, opioid use, or sex.

### Measures

**Dependent variables.** The study participants were grouped into four chronic pain treatment categories: 1) opioid therapy, 2) non-opioid multimodal pain treatment, 3) non-opioid monotherapy, and 4) no pain treatment. Multimodal pain treatment was defined as adults using  $>1$  of the following strategies for pain management: over-the-counter analgesics, opioid therapy, mindfulness therapies (yoga, Tai Chi, Qi Gong, meditation, guided imagery, relaxation techniques, cognitive behavioral therapy), and physical therapies (exercise, massage, physical therapy, rehabilitative therapy, occupation therapy, chiropractic care).

1. *Opioid therapy:* adults who used opioid therapy in the past three months with or without multimodal pain treatment.

2. *Non-opioid multimodal pain treatment*: adults who used non-opioid multimodal pain treatments in the past three months.
3. *Non-opioid monotherapy*: adults who used only one of the following strategies in the past three months for pain management: over-the-counter analgesics, mindfulness therapies (yoga, Tai Chi, Qi Gong, meditation, guided imagery, relaxation techniques, cognitive behavioral therapy), physical therapies (exercise, massage, physical therapy, rehabilitative therapy, occupation therapy, chiropractic care)
4. *No pain treatment*: adults who did not use pharmacologic or nonpharmacologic treatments for the management of their pain.

**Key independent variable: Multimorbidity (Yes/No).** We defined multimorbidity as the co-occurrence of two or more chronic conditions in a single individual.<sup>13</sup> Multimorbidity was measured with an indicator variable (1 representing the presence of multimorbidity and 0 representing no multimorbidity). Adults with two or more conditions from a list of 14 commonly prevalent conditions (asthma, arthritis, chronic obstructive pulmonary disease, chronic kidney disease, diabetes, dementia, heart disease, hepatitis, hyperlipidemia, hypertension, chronic liver disease, stroke, anxiety, depression) were classified as having multimorbidity. These conditions were derived from the priority list of conditions for multimorbidity management.<sup>14</sup>

**Other explanatory variables.** For adjusted analyses, we controlled for biological factors, social determinants of health, clinical factors, and lifestyle factors. Biological factors included: sex (male/female); age in years (18-39, 40-49, 50-59, 59-64, 65-74, 75 and older); and race/ethnicity (Non-Hispanic White, Non-Hispanic Black, Hispanic/Latino, Other). Social determinants of health included: education (less than high school, high school, some college, college); health insurance status (yes, no); poverty relative to the federal poverty line (FPL) for NHIS (<100% FPL, 100-200% FPL, 200-400% FPL, >400% FPL); food security (yes, no); delayed medical care due to cost (yes, no); marital status (married/divorced/separated, widowed, and never married); region (Northeast, Midwest, South, and West); and metro status (Large metro, large fringe, medium-small, and non-metro). The clinical factor included pain intensity (little, a lot, and between little and lot and multimorbidity). Lastly, lifestyle factors included body mass index categories (underweight, normal weight, overweight, obese); smoking status (current smoker, former smoker, and never smoked); and alcohol use (heavy alcohol use, not heavy, no drink during the past 12 months, and abstained). We included missing data from independent variables.

## Statistical analyses

To account for the complex survey design of the NHIS, we used SAS survey procedures with clustering, strata, and weights.<sup>13</sup> We used Rao-Scott chi-square tests to analyze statistically significant group differences in chronic pain treatment by multimorbidity status. We used multivariable multinomial logistic regressions to determine the association between multimorbidity and different chronic pain treatments with the adjustment of individuals' biological, SDoH, and clinical factors. In these regressions, the reference category for the dependent variable was "non-opioid monotherapy."

## Results

15,832 participants met the inclusion criteria for the study out of a total number of 31,568 adults. Once exclusion criteria were applied, the analytical sample consisted of 12,028 adults, which represents about 89,670,893 adults. In our study, 53.8% were female, and 66.7% were non-Hispanic White. As seen in [Table 1](#), approximately 61 million adults reported having multimorbidity (unweighted N = 8,568, weighted % = 68.0). 54.8% had a college education, and 38.2% had income greater than or equal to 400% of the Federal Poverty Level (FPL). One in 5 adults (19.1%) reported experiencing a lot of pain, and 41.8% experienced moderate pain. The most common non-pharmacologic pain treatment was exercise (57.5%), followed by mind-body therapies (20.6%) and massage (15.5%). (For details, please see [Appendix 1](#)). When analyzing the weighted percentage of different pain treatments, 7.3% used opioid therapy, 57.1% used multimodal pain treatments without opioids, 29.2% used monotherapy for pain treatment, and 6.4% did not use any pain treatment ([Appendix 1](#)).

As described in [Table 2](#), We observed statistically significant differences in types of pain treatment by multimorbidity status. For example, more adults with multimorbidity were in the opioid therapy group (9.2% vs 3.2%) compared to those without multimorbidity. Individuals with multimorbidity were less likely to use non-opioid multimodal treatment (56.8% vs 58.9%) and treat their pain with monotherapy (28.5 vs 30.7%). Adults with multimorbidity were less likely to have no pain treatment (6.1% vs 7.2%). However, in unadjusted multinomial regression with "non-opioid monotherapy" as the reference group, there was no significant association of multimorbidity with non-opioid multimodal therapy or no pain treatment.

Regarding types of pain treatment ([Table 2](#)), the lowest percentages of opioid therapy were observed among individuals that were college educated (5.5%), food secure (6.6%), high income (4.3%, defined as  $\geq 400\%$  FPL), and

**Table 1.** Description of Adults (Age ≥ 18 years) by Multimorbidity Status With Chronic Conditions and without Cancer National Health Interview Survey, 2020.

	Multimorbidity		No Multimorbidity		Chisq	Prob
	N	Row Wt %	N	Row Wt%		
ALL	8,568	68.0	3,460	32.0		
<b>Sex</b>					37.395	< 0.001
Female	5,025	71.4	1,770	28.6		
Male	3,543	64.0	1,690	36.0		
<b>Race and Ethnicity</b>					21.253	< 0.001
White	6,267	69.7	2,425	30.3		
African American	1,027	67.1	377	32.9		
Latino	764	61.9	401	38.1		
Other race	510	64.8	257	35.2		
<b>Age (in Years)</b>					467.742	< 0.001
18-39	1,171	53.7	958	46.3		
40-49	934	59.0	628	41.0		
50-59	1,567	67.7	736	32.3		
60-64	1,128	76.1	357	23.9		
65-74	2,189	81.3	508	18.7		
75,+	1,579	85.3	273	14.7		
<b>Marital Status</b>					113.716	< 0.001
Married	4,124	66.2	1,979	33.8		
Divorced/Separated	1,700	75.0	519	25.0		
Widowed	1,293	83.2	247	16.8		
Never Married	1,299	61.5	669	38.5		
<b>Education</b>					72.56	< 0.001
Less than HS	592	76.1	140	23.9		
High School (HS)	1,866	75.4	532	24.6		
Some College	1,406	69.0	502	31.0		
College	4,688	63.8	2,282	36.2		
<b>Poverty Status (in FPL)</b>					80.731	< 0.001
< 100%	1,064	78.4	227	21.6		
100 - <200%	1,738	74.1	486	25.9		
200 - <400%	2,598	66.9	1,054	33.1		
>= 400%	3,168	62.7	1,693	37.3		
<b>Food Security</b>					49.504	< 0.001
Food Secure	7,501	66.4	3,223	33.6		
Food Insecure	888	80.9	178	19.1		
<b>Health Insurance</b>					15.698	< 0.001
Health Insurance	8,153	68.8	3,173	31.2		
No Health Insurance	415	59.5	287	40.5		
<b>Pain (last 3 months)</b>					215.959	< 0.001
Little	3,047	59.4	1,777	40.6		
Moderate	3,667	69.9	1,320	30.1		
A lot	1,854	81.4	363	18.6		
<b>Opioid use</b>					87.476	< 0.001
Opioid 3 months use	801	86.0	115	14.0		
No 3 months use	7,767	66.6	3,345	33.4		
<b>Inpatient (IP) Visit</b>					84.721	< 0.001
IP use past 12 months	1,117	83.3	198	16.7		
No IP use	7,447	66.2	3,262	33.8		

(continued)

**Table 1.** (continued)

	Multimorbidity		No Multimorbidity		Chisq	Prob
	N	Row Wt %	N	Row Wt%		
ALL	8,568	68.0	3,460	32.0		
<b>Healthcare Delay</b>					16.333	< 0.001
Delayed due to \$	790	75.2	236	24.8		
No delay	7,776	67.2	3,224	32.8		
<b>Pain (last 3 months)</b>					215.959	< 0.001
Little	3,047	59.4	1,777	40.6		
Moderate	3,667	69.9	1,320	30.1		
A lot	1,854	81.4	363	18.6		
<b>Body Mass Index</b>					111.319	< 0.001
Underweight	113	70.1	48	29.9		
Normal	1,891	60.0	1,030	40.0		
Overweight	2,673	65.5	1,239	34.5		
Obese	3,693	74.1	1,080	25.9		
<b>Smoking Status</b>					89.632	< 0.001
Current Smoker	1,316	72.7	436	27.3		
Former Smoker	2,750	75.5	815	24.5		
Never Smoked	4,453	63.1	2,199	36.9		
<b>Alcohol Consumption</b>					79.703	< 0.001
Heavy Alcohol	1,593	61.2	937	38.8		
No heavy alcohol	3,808	67.0	1,641	33.0		
Not drinking from past 12months	2,238	76.6	557	23.4		
Abstain	812	67.9	296	32.1		
<b>Region</b>					26.326	< 0.001
Northeast	1,495	70.6	549	29.4		
Midwest	2,068	67.1	809	32.9		
South	3,117	70.0	1,177	30.0		
West	1,888	63.3	925	36.7		
<b>Metro</b>					21.394	
Large Central Metro	2,276	65.5	992	34.5		
Large Fringe Metro	1,843	66.1	832	33.9		
Medium and Small	2,868	69.0	1,123	31.0		
Nonmetropolitan	1,581	73.1	513	26.9		
<b>Specific Pain Treatment</b>	<b>N</b>	<b>Column Wt. %</b>	<b>N</b>	<b>Column Wt. %</b>		
<b>OTC Pain Medications</b>					8.563	0.003
Yes OTC	6,698	78.7	2,656	75.5		
No OTC	1,870	21.3	804	24.5		
<b>Physical Therapy</b>					34.544	< 0.001
Physical Therapy	1,090	12.0	301	7.8		
No Physical Therapy	7,478	88.0	3,159	92.2		
<b>Chiropractor Use</b>					34.544	< 0.001
Chiropractor Use	1,090	12.0	301	7.8		
No Chiropractor Use	7,478	88.0	3,159	92.2		
<b>CBT</b>					27.298	< 0.001
CBT	233	2.7	41	1.0		
No CBT	8,335	97.3	3,419	99.0		
<b>Yoga, Tai Chi, Qi Gong</b>					16.176	< 0.001
Yes	728	8.0	395	10.6		
No	7,840	92.0	3,065	89.4		

(continued)

**Table 1.** (continued)

Exercise as Pain Tx					10.083	<0.01
Exercise	4,939	55.9	2,105	60.0		
No exercise	3,629	44.1	1,355	40.0		
Massage					2.823	0.093
Yes Massage	222	15.1	566	16.6		
No Massage	7,346	84.9	2,894	83.4		
Meditation					0.506	0.477
Yes Meditation	1,341	15.5	501	14.8		
No Meditation	7,227	84.5	2,959	85.2		
Other Treatment					20.42	< 0.001
Yes	1,454	16.0	443	12.0		
No other treatment	7,114	84.0	,017	88.0		

Based on 12,028 participants aged 18 or older, who reported pain during the past three months, had any of the following chronic conditions (asthma, arthritis, cancer, chronic kidney disease, chronic obstructive pulmonary disease, diabetes, dementia, heart diseases, high cholesterol, hypertension, liver conditions, stroke, anxiety, and depression) and no cancer, used opioids for chronic pain, and without missing data in the type of pain treatment and opioid use. Missing data for marital status, education, food security, inpatient visits, healthcare delay, body mass index, smoking status, and alcohol use are not presented. Rao-Scott Chi-squared test was used to determine significant group differences by multimorbidity status.

CBT: Cognitive Behavioral Therapy; FPL- Federal Poverty Level; Prob: Chi-square probability; Tx: Treatment; Wt: Weighted.

youngest age (3.1%). The highest percentages of opioid therapy were observed in adults with less than high school education (13.0%), low income (12.8%, defined as less than 100% FPL), and food insecure (13.0%). Similarly, the lowest percentages of non-opioid multimodal pain treatment were observed in low education (41.0%), food insecure (52.6%), and low-income groups (46.7%), and the highest percentages of non-opioid multimodal pain treatment were observed in college-educated (64.5%), food secure (57.6%), and high-income groups (64.7%). Adults with health insurance had higher rates of opioid use (7.7% vs 2.8%) and higher rates of non-opioid multimodal pain treatment (57.3% vs 54.6%) compared to those without health insurance. Severe pain was associated with higher rates of opioid use (20% vs 1.1%) compared to those with little pain. Those with severe pain had lower rates of non-opioid multimodal pain treatment (49.0% vs 56.8%) compared to those with little pain.

In adjusted analysis (Table 3), using “non-opioid monotherapy” as the reference group, those with multimorbidity had higher odds of opioid therapy (AOR = 1.63, 95% CI = 1.23, 2.17) and non-opioid multimodal treatment (AOR = 1.15, 95% CI = 1.01, 1.31) compared to adults without multimorbidity.

In general, those with severe pain had higher odds of opioid therapy (AOR=19.36, 95% CI=13.35, 28.06) than those with little pain. Adults with less than high school (AOR = 0.57, 95% CI = 0.44, 0.73) and high school (AOR = 0.55, 95% CI = 0.47, 0.65) had lower odds of non-opioid multimodal treatment compared to those with a college education. Regarding health insurance, adults without health insurance had lower odds of opioid therapy (AOR = 0.27, 95% CI = 0.15, 0.49) and non-

opioid multimodal treatment (AOR = 0.78, 95% CI = 0.62, 0.98) compared to those with health insurance.

## Discussion

In our study, which was restricted to those with chronic pain, 68% had multimorbidity, surpassing the 27% reported for the general population of 2018 NHIS respondents.<sup>15</sup> Study findings suggest that multimorbidity incidence for adults with chronic pain is higher than in the general population. Since it is well-studied that multimorbidity and chronic pain can independently lead to decreased quality of life, higher economic burden, and higher mortality,<sup>2,16</sup> improving health outcomes in situations where multimorbidity and chronic pain co-exist is paramount. Butchart et al noted that patients with chronic pain and other chronic health conditions were more likely to have poorer self-rated health, lower functional status, and lower overall ratings of quality of care.<sup>17</sup> Approaches found to improve health outcomes among individuals with multimorbidity in the primary care and community settings include organizational interventions (eg focus on risk factor management in commonly co-occurring conditions) and patient-centered interventions (eg focusing on functional improvement).<sup>18</sup>

In our study, those with multimorbidity were also more likely to rely on opioids as part of their pain management strategy despite adjusting for pain severity. Multimodal approaches that limit or eliminate the need for opioids in those with multiple chronic conditions are essential. Kaiser Permanente Colorado (KPCO) is an example of an integrated healthcare delivery system with a multidisciplinary pain management clinic composed of physicians specializing in pain management, psychologists, counselors,

**Table 2.** Description of Adults (Age ≥ 18 years) by Types of Pain Treatment National Health Interview Survey, 2020.

	Opioid TX.		Non-Opioid MM. TX.		Non-opioid Monotherapy		No pain TX.		Chisq	Prob
	N	Row Wt. %	N	Row Wt. %	N	Row Wt. %	N	Row Wt. %		
<b>ALL</b>	916	7.3	7,016	57.1	3,329	29.2	767	6.4		
<b>Multimorbidity</b>									78.252	< 0.001
Yes	801	9.2	4,911	56.2	2,330	28.5	526	6.1		
No	115	3.2	2,105	58.9	999	30.7	241	7.2		
<b>Sex</b>									65.198	< 0.001
Female	555	8.0	4,192	60.0	1,704	27.0	344	5.0		
Male	361	6.4	2,824	53.6	1,625	31.9	423	8.1		
<b>Race and Ethnicity</b>									61.303	< 0.001
White	666	7.4	5,167	58.9	2,367	28.2	492	5.5		
African American	127	7.9	697	47.8	442	33.9	138	10.4		
Latino	82	7.0	663	53.3	330	32.3	90	7.3		
Other race	41	5.4	489	63.3	190	25.0	47	6.4		
<b>Age (in Years)</b>									166.417	< 0.001
18-39	60	3.1	1,444	64.0	523	27.3	102	5.7		
40-49	92	5.4	1,001	60.4	399	28.8	70	5.3		
50-59	215	10.5	1,365	57.0	597	27.3	126	5.1		
60-64	158	10.3	831	53.7	399	28.7	97	7.3		
65-74	236	8.6	1,485	52.6	775	31.0	201	7.8		
75,+	155	8.3	890	46.6	636	35.9	171	9.1		
<b>Marital Status</b>									112.645	< 0.001
Married	398	6.7	3,722	58.6	1,668	29.4	315	5.3		
Divorced/Separated	215	10.3	1,258	54.9	598	28.6	148	6.3		
Widowed	156	11.4	734	43.2	504	34.9	146	10.6		
Never married	126	5.0	1,196	59.6	510	27.1	136	8.3		
<b>Education</b>									233.62	< 0.001
Less than HS	93	13.0	305	41.0	260	36.7	74	9.4		
High School	238	9.7	1,096	45.2	835	35.5	229	9.7		
Some College	183	8.1	1,047	54.1	554	31.6	124	6.2		
College	402	5.5	4,556	64.5	1,672	25.1	340	4.9		
<b>Poverty Status (in FPL)</b>									161.81	< 0.001
< 100%	175	12.8	627	46.7	368	31.8	121	8.7		
100 - <200%	244	9.6	1,127	50.6	688	31.9	165	7.9		
200 - <400%	291	7.5	2,069	55.4	1,042	30.3	250	6.7		
≥ 400%	206	4.3	3,193	64.7	1,231	26.2	231	4.8		
<b>Food Security</b>									39.196	< 0.001
Food Secure	729	6.6	6,322	57.6	3,003	29.5	670	6.4		
Food Insecure	166	13.0	565	52.6	259	27.8	76	6.7		
<b>Health Insurance</b>									23.619	< 0.001
Health Insurance	892	7.7	6,619	57.3	3,092	28.6	723	6.4		
No Health Insurance	24	2.8	397	54.6	237	36.3	44	6.2		
<b>Pain (last 3 months)</b>									521.187	< 0.001
Little	58	1.1	2,829	56.8	1,550	34.0	387	8.1		
Moderate	406	7.3	3,088	61.0	1,250	26.8	243	4.9		
A lot	452	20.0	1,099	49.0	529	24.8	137	6.2		
<b>Inpatient (IP) Visit</b>									69.031	< 0.001
IP use past 12 months	201	14.5	701	51.9	331	26.7	82	6.9		
No IP use	713	6.4	6,315	57.7	2,996	29.5	685	6.4		

(continued)

Table 2. (continued)

	Opioid TX.		Non-Opioid MM. TX.		Non-opioid Monotherapy		No pain TX.		Chisq	Prob
	N	Row Wt. %	N	Row Wt. %	N	Row Wt. %	N	Row Wt. %		
<b>ALL</b>	916	7.3	7,016	57.1	3,329	29.2	767	6.4		
<b>Healthcare Delay</b>									18.414	< 0.001
Delayed due to \$	100	8.3	644	63.4	239	24.3	43	4.1		
No delay	816	7.2	6,370	56.3	3,090	29.8	724	6.7		
<b>Body Mass Index</b>									65.052	< 0.001
Underweight	26	18.8	73	44.5	48	31.1	14	5.6		
Normal	180	5.7	1,776	61.1	761	25.9	204	7.3		
Overweight	250	6.2	2,337	57.8	1,081	29.8	244	6.2		
Obese	442	8.7	2,690	54.8	1,352	30.4	289	6.1		
<b>Smoking Status</b>									95.274	< 0.001
Current Smoker	231	12.1	858	49.4	538	31.9	125	6.6		
Former Smoker	302	9.0	2,062	57.0	993	28.2	208	5.8		
Never Smoked	377	5.1	4,065	59.2	1,782	29.0	428	6.7		
<b>Alcohol Consumption</b>									134.553	< 0.001
Heavy Alcohol	122	5.0	1,635	63.2	657	27.2	116	4.5		
No heavy alcohol	357	6.6	3,343	59.5	1,432	27.8	317	6.0		
Not drinking from past 12months	338	11.6	1,417	50.3	833	30.6	207	7.4		
Abstain	85	5.9	554	48.6	361	36.1	108	9.5		
<b>Region</b>									80.886	< 0.001
Northeast	112	5.1	1,256	60.7	539	27.5	137	6.7		
Midwest	240	7.7	1,690	57.8	803	29.5	144	5.0		
South	358	8.3	2,245	51.2	1,362	32.7	329	7.7		
West	206	6.7	1,825	63.9	625	24.1	157	5.3		
<b>Metro</b>									52.279	< 0.001
Large Central Metro	212	5.7	2,100	62.8	782	25.6	174	5.9		
Large Fringe Metro	184	6.5	1,595	58.0	727	29.0	169	6.5		
Medium and Small	318	8.0	2,235	54.3	1,176	31.4	262	6.2		
Nonmetropolitan	202	9.9	1,086	50.8	644	31.7	162	7.6		

Note: Based on 12,028 participants aged 18 or older, who reported pain during the past three months, had any of the following chronic conditions (asthma, arthritis, cancer, chronic kidney disease, chronic obstructive pulmonary disease, diabetes, dementia, heart diseases, high cholesterol, hypertension, liver conditions, stroke, anxiety, and depression) and no cancer, used opioids for chronic pain, and without missing data in the type of pain treatment and opioid use. Missing data for marital status, education, food security, inpatient visits, healthcare delay, body mass index, smoking status, and alcohol use are not presented.

FPL- Federal Poverty Level; MM: Multimodal; TX. Treatment; Wt: Weighted.

nurses, and social workers.<sup>19</sup> At the height of the COVID-19 pandemic, Gersch et al compared the effectiveness of pain control from an expert multidisciplinary telemonitoring service team vs. the usual care team (defined as a clinical pharmacy specialist and primary care physician) at KPCO for patients receiving  $\geq 30$ MME/day.<sup>20</sup> Though the multidisciplinary team's services were virtual, their telemonitoring services were associated with significant decreases in MME compared to the usual care group.<sup>20</sup>

When opioids are needed for pain management, patients should receive close monitoring and education regarding appropriate use, awareness of alternative therapies, and safe disposal of opioids. In addition, increasing naloxone (an opioid antagonist) prescribing

rates has been shown to prevent opioid-related overdose.<sup>21</sup> Those with multimorbidity may benefit from these interventions as they may have higher risks of opioid-related hospitalizations.<sup>12</sup>

Adults with multimorbidity also reported a higher incidence of severe pain than those without. Similar to the report from Ferguson et al, our study also showed that multimorbidity increased the prevalence and intensity of reported pain.<sup>22</sup> Co-morbid conditions, including depression and anxiety, could also lead to increased pain intensity, highlighting the importance of psychoeducational interventions in pain management.<sup>22</sup> Considering sociodemographic characteristics, individuals with a high school degree or less had lower odds of using non-opioid multimodal treatment



**Table 3.** Adjusted Odds Ratios (AOR) and 95% Confidence Intervals (CI) from Multinomial Logistic Regression on Type of Pain Treatment Reference Group for Type of Pain Treatment = Non-opioid Monotherapy National Health Interview Survey, 2020.

	Opioid TX.			Non-Opioid MM. TX			No Pain TX		
	AOR	95%CI	Sig	AOR	95%CI	Sig	AOR	95%CI	Sig
<b>Multimorbidity</b>									
Yes	1.63	[ 1.23, 2.17]	***	1.15	[ 1.01, 1.31]	*	0.84	[ 0.67, 1.06]	
No (Ref)									
<b>Sex</b>									
Female	1.29	[ 1.05, 1.59]	*	1.47	[ 1.30, 1.65]	***	0.64	[ 0.51, 0.80]	***
Male (Ref)									
<b>Race and Ethnicity</b>									
White (Ref)									
African American	0.75	[ 0.55, 1.02]		0.75	[ 0.62, 0.90]	**	1.37	[ 1.00, 1.87]	*
Latino	0.90	[ 0.61, 1.33]		0.80	[ 0.66, 0.97]	*	1.16	[ 0.82, 1.64]	
Other race	0.83	[ 0.49, 1.42]		1.12	[ 0.87, 1.44]		1.16	[ 0.75, 1.80]	
<b>Age (in Years)</b>									
18-39 (Ref)									
40-49	1.41	[ 0.92, 2.16]		0.89	[ 0.74, 1.08]		1.09	[ 0.72, 1.66]	
50-59	2.74	[ 1.84, 4.09]	***	0.91	[ 0.75, 1.10]		1.09	[ 0.74, 1.59]	
60-64	2.38	[ 1.58, 3.57]	***	0.84	[ 0.68, 1.04]		1.46	[ 0.97, 2.19]	
65-74	1.85	[ 1.24, 2.75]	**	0.74	[ 0.61, 0.89]	**	1.46	[ 0.98, 2.16]	
75,+	1.52	[ 0.95, 2.45]		0.61	[ 0.49, 0.77]	***	1.25	[ 0.84, 1.88]	
<b>Marital Status</b>									
Married (Ref)									
Divorced/Separated	1.08	[ 0.82, 1.41]		1.13	[ 0.96, 1.32]		1.14	[ 0.84, 1.54]	
Widowed	1.02	[ 0.73, 1.44]		0.85	[ 0.70, 1.04]		1.54	[ 1.10, 2.16]	*
Never married	1.03	[ 0.75, 1.43]		1.17	[ 0.98, 1.40]		1.66	[ 1.20, 2.31]	**
<b>Education</b>									
Less than HS	0.92	[ 0.61, 1.38]		0.57	[ 0.44, 0.73]	***	1.05	[ 0.70, 1.58]	
High School	0.76	[ 0.58, 1.00]		0.55	[ 0.47, 0.65]	***	1.25	[ 0.96, 1.64]	
Some College	0.93	[ 0.71, 1.23]		0.70	[ 0.59, 0.83]	***	0.95	[ 0.70, 1.30]	
College									
<b>Poverty Status (in FPL)</b>									
< 100%	1.29	[ 0.88, 1.91]		0.80	[ 0.63, 1.01]		1.27	[ 0.83, 1.95]	
100 - <200%	1.21	[ 0.88, 1.66]		0.88	[ 0.73, 1.05]		1.19	[ 0.87, 1.64]	
200 - <400%	1.28	[ 0.97, 1.69]		0.87	[ 0.76, 0.99]	*	1.16	[ 0.89, 1.51]	
>= 400% (Ref)									
<b>Food Security</b>									
Food Secure (Ref)									
Food insecurity	1.24	[ 0.90, 1.70]		1.14	[ 0.91, 1.43]		1.03	[ 0.71, 1.50]	
<b>Health Insurance</b>									
Yes (Ref)									
No Health Insurance	0.27	[ 0.15, 0.49]	***	0.78	[ 0.62, 0.98]	*	0.72	[ 0.44, 1.18]	
<b>Pain (last 3 months)</b>									
Little (Ref)									
Moderate	7.26	[ 5.15, 10.24]	***	1.43	[ 1.25, 1.64]	***	0.77	[ 0.60, 0.99]	*
A lot	19.36	[13.35,28.06]	***	1.33	[ 1.12, 1.58]	**	0.99	[ 0.74, 1.33]	
<b>In-Patient (IP) Visit</b>									
IP use past 12 months	1.67	[ 1.27, 2.19]	***	1.06	[ 0.89, 1.27]		1.16	[ 0.81, 1.66]	
No IP use (Ref)									

(continued)

Table 3. (continued)

	Opioid TX.			Non-Opioid MM. TX			No Pain TX		
	AOR	95%CI	Sig	AOR	95%CI	Sig	AOR	95%CI	Sig
<b>Healthcare Delay</b>									
Delayed due to Cost	1.24	[ 0.87, 1.79]		1.42	[ 1.13, 1.79]	**	0.89	[ 0.56, 1.42]	
No delay (Ref)									
<b>Body Mass Index</b>									
Underweight	2.13	[ 1.11, 4.09]	*	0.62	[ 0.39, 0.99]	*	0.72	[ 0.34, 1.52]	
Normal (Ref)									
Overweight	0.93	[ 0.70, 1.24]		0.91	[ 0.79, 1.06]		0.72	[ 0.55, 0.96]	*
Obese	1.01	[ 0.77, 1.32]		0.80	[ 0.69, 0.92]	**	0.73	[ 0.56, 0.96]	*
<b>Smoking Status</b>									
Current Smoker	1.40	[ 1.06, 1.86]	*	0.77	[ 0.65, 0.92]	**	0.86	[ 0.63, 1.18]	
Former Smoker	1.44	[ 1.13, 1.82]	**	1.05	[ 0.93, 1.19]		0.88	[ 0.69, 1.13]	
Never Smoked (Ref)									
<b>Alcohol Consumption</b>									
Heavy Alcohol	1.27	[ 0.82, 1.98]		1.50	[ 1.16, 1.93]	**	0.77	[ 0.52, 1.14]	
No heavy alcohol	1.52	[ 1.03, 2.23]	*	1.40	[ 1.12, 1.77]	**	0.98	[ 0.69, 1.39]	
Not drinking past 12months	1.70	[ 1.16, 2.50]	**	1.27	[ 1.00, 1.61]	*	0.99	[ 0.69, 1.42]	
Abstain (Ref)									
<b>Region</b>									
Northeast (Ref)									
Midwest	1.53	[ 1.08, 2.15]	*	0.90	[ 0.75, 1.08]		0.76	[ 0.53, 1.10]	
South	1.45	[ 1.05, 1.98]	*	0.79	[ 0.67, 0.93]	**	0.96	[ 0.69, 1.33]	
West	1.74	[ 1.26, 2.42]	***	1.17	[ 0.96, 1.43]		0.97	[ 0.67, 1.39]	
<b>Metro</b>									
Large Central Metro	0.96	[ 0.66, 1.40]		1.27	[ 1.03, 1.57]	*	0.86	[ 0.61, 1.20]	
Large Fringe Metro	0.94	[ 0.65, 1.37]		1.02	[ 0.83, 1.26]		0.93	[ 0.67, 1.29]	
Medium and Small	0.92	[ 0.66, 1.30]		0.92	[ 0.75, 1.13]		0.82	[ 0.60, 1.10]	
Nonmetropolitan (Ref)									

Note: Based on 12,028 participants aged 18 or older, who reported pain during the past three months, had any of the following chronic conditions (asthma, arthritis, cancer, chronic kidney disease, chronic obstructive pulmonary disease, diabetes, dementia, heart diseases, high cholesterol, hypertension, liver conditions, stroke, anxiety, and depression) and no cancer, used opioids for chronic pain, and without missing data in the type of pain treatment and opioid use. Missing indicators were included for marital status, education, food security, body mass index, smoking status, and alcohol use (data not presented). FPL- Federal Poverty Level; MM: Multimodal; Ref: Reference Group TX. Treatment; WT: Weighted;

\*\*\* $p < 0.001$ ; \*\*  $0.001 \leq p < .01$ ; \*  $0.01 \leq p < .05$ .

than those with a college degree. Several studies have suggested that opioid users achieve lower levels of education.<sup>23</sup> The 2021 National Health Statistics Report on prescription opioid use revealed adults with less than a high school diploma or General Education Development Test (GED) were more likely to use opioid prescriptions (26.2%), followed by those with some college or an associate's degree (23.5%), and adults with a bachelor's degree or higher (18.4%).<sup>24</sup> In this study, social determinants such as lack of health insurance were also associated with lower odds of using non-opioid multimodal treatment. The full range of therapeutic options for managing pain has historically been inaccessible to many patients because of insufficient access to treatment modalities such as behavioral therapy.<sup>3</sup> Specific barriers identified for accessing non-pharmacologic treatment options for chronic pain include geographical limitations,

health care system-related barriers (cost and reimbursement), and patient-related barriers (lack of knowledge/skepticism on the use of non-pharmacologic treatment).<sup>25</sup> Interventions such as telehealth and digitally delivered therapy for psychological interventions increased patient access and have yielded similar outcomes as traditional face-to-face psychological services for chronic pain control.<sup>26</sup> Chronic pain patient education has also been shown to improve self-management and self-efficacy in patients with chronic pain from any etiology.<sup>27</sup> Social determinants of health (SDoH) play a vital role in pain management, and patient-centered care focused on minimizing the disproportionate burden of pain in low-resource communities is crucial in optimizing pain care.

Regarding study strengths, we used a national representative data set with a large sample size to analyze a

comprehensive list of factors associated with pain treatment strategies in adults with and without multimorbidity. Specifically, we analyzed the impact of SDoH on different pain treatments. Our study showed that despite multimorbidity status, SDoH factors such as education and income status were associated with lower odds of using multimodal pain treatment without opioids. There is a positive correlation between socioeconomic marginalization and opioid-related overdose,<sup>28</sup> and emphasis on multimodal treatment strategies without opioids may be beneficial for preventing opioid-related overdose in socioeconomically disadvantaged adults. Patient-reported outcomes are also a strength of this study. Several previous studies reviewing pain management strategies for those with chronic pain have utilized claims data, which makes it difficult to account for commonly used over-the-counter medications or physical and psychoeducational interventions not covered by insurance. Our study accounted for the utilization of therapies not covered by insurance.

Our study has some notable limitations. First, this was a cross-sectional study design in which self-reported data is subject to recall bias. Secondly, NHIS 2020 data was collected during the COVID-19 pandemic. COVID-19 led to various treatment interruptions for chronic pain such as physical therapy and a change in prescribing patterns of opioid therapy.<sup>29</sup> Lee et al. noted that patients were more likely to receive higher doses of opioid therapy, and longer opioid prescriptions early in the pandemic. In addition, the proportion of patients receiving nonpharmacologic therapy was lower in the early pandemic period compared to 2019 highlighting the fact that despite decreased access to appointments during the early pandemic period, prescribers may have increased their levels of opioid prescribing in the absence of less risky non-pharmacologic alternatives.<sup>30</sup> Thirdly, due to COVID-19, there were significant changes to the NHIS interview procedures. Typically, NHIS data is collected as an in-person interview. During quarter 2 of the 2020 survey, NHIS temporarily became a telephone-only survey, which decreased household interview response rates (dropping from 60% in quarter 1 of 2020 to 42.7% in quarter 2).<sup>31</sup> NHIS also does not collect data on institutionalized patients, such as those in long-term facilities. These factors may have led to the under-reporting of multimorbidity and opioid utilization. To mitigate the low response rates seen with the telephone-only approach, NHIS has switched to a telephone-first approach. Household contacts will be contacted first via telephone, and personal visits reserved for those that did not respond. Lastly, we were unable to analyze the specific opioids utilized by study participants or the usage of prescribed medications, beyond opioids for pain management. This includes adjuvant analgesics such as anticonvulsants, serotonin and norepinephrine reuptake inhibitors (SNRIs), as this data is not available in NHIS.

In conclusion, nearly 7 in 10 adults with chronic pain had multimorbidity. Those with multimorbidity were more likely to report severe pain and use opioids for pain management. This study adds to the limited body of evidence analyzing pain treatment approaches in those with multimorbidity who may be at higher risk for opioid-related harms.

### Declaration of conflicting interests

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### IRB statement

The Office of Research Compliance / North Texas Regional Institutional Review Board has determined this project does not meet the definition of human subject research under the purview of the Institutional Review Board (IRB) according to federal regulations. Therefore, IRB review of this project is not required.

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## Appendix

**Appendix I.** Description of Characteristics of Adults (Age ≥ 18 years) with Chronic Conditions and without Cancer National Health Interview Survey, 2020.

	N	Wt. N	Wt. %
<b>ALL</b>	12,028	89,670,892	100.0
<b>Multimorbidity</b>			
Yes	8,568	60,963,125	68.0
No	3,460	28,707,768	32.0
<b>Sex</b>			
Female	6,795	48,273,685	53.8
Male	5,233	41,397,207	46.2
<b>Race and Ethnicity</b>			
White	8,692	59,845,490	66.7
African American	1,404	11,519,469	12.8
Latino/Hispanic	1,165	11,662,916	13.0
Other race	767	6,643,017	7.4
<b>Age (in Years)</b>			
18-39 Years	2,129	22,957,559	25.6
40-49 Years	1,562	13,378,828	14.9
50-59 Years	2,303	18,170,789	20.3
60-64 Years	1,485	10,058,360	11.2
65-74 Years	2,697	15,352,796	17.1
75 Years or Older	1,852	9,752,560	10.9
<b>Marital Status</b>			
Married	6,103	53,353,725	59.5
Divorced/Separated	2,219	11,643,593	13.0
Widowed	1,540	7,329,705	8.2
Never Married	1,968	15,809,933	17.6
<b>Education</b>			
Less than HS	732	5,786,613	6.5
High School (HS)	2,398	19,092,771	21.3
Some College	1,908	15,498,184	17.3
College	6,970	49,099,946	54.8
<b>Poverty Status (in FPL)</b>			
< 100%	1,291	10,320,956	11.5
100 - <200%	2,224	17,163,820	19.1
200 - <400%	3,652	27,891,009	31.1
≥ 400%	4,861	34,295,108	38.2
<b>Food Security</b>			
Food Secure	10,724	78,364,840	87.4
Food Insecurity	1,066	9,287,442	10.4
<b>Health Insurance</b>			
Health Insurance	11,326	82,111,330	91.6
No Health Insurance	702	7,559,563	8.4
<b>Pain (last 3 months)</b>			
Little	4,824	35,105,023	39.1
Moderate	4,987	37,449,908	41.8
A lot	2,217	17,115,961	19.1
<b>Opioid use (last 3 months)</b>			
Yes	916	6,531,162	7.3
No	11,112	83,139,730	92.7

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	N	Wt. N	Wt. %
<b>ALL</b>	12,028	89,670,892	100.0
<b>Inpatient (IP) Visit</b>			
IP use past 12 months	1,315	9,420,631	10.5
No IP use	10,709	80,225,056	89.5
<b>Healthcare Delay</b>			
Delayed due to Cost	1,026	8,954,484	10.0
No delay	11,000	80,700,855	90.0
<b>Body Mass Index</b>			
Underweight	161	1,166,817	1.3
Normal	2,921	21,416,090	23.9
Overweight	3,912	28,048,304	31.3
Obese	4,773	37,228,142	41.5
<b>Smoking Status</b>			
Current Smoker	1,752	14,103,945	15.7
Former Smoker	3,565	24,139,083	26.9
Never Smoked	6,652	50,932,640	56.8
<b>Alcohol Consumption</b>			
Heavy Alcohol	2,530	20,320,718	22.7
No heavy alcohol	5,449	39,200,602	43.7
Not drinking past 12months	2,795	19,345,115	21.6
Abstain	1,108	9,588,645	10.7
<b>Region</b>			
Northeast	2,044	14,839,934	16.5
Midwest	2,877	19,879,841	22.2
South	4,294	35,103,649	39.1
West	2,813	19,847,468	22.1
<b>Metro</b>			
Large Central Metro	3,268	25,586,550	28.5
Large Fringe Metro	2,675	21,225,711	23.7
Medium and Small	3,991	28,199,451	31.4
Nonmetropolitan	2,094	14,659,180	16.3
<b>Type of Pain Treatment</b>			
Opioid use	916	6,531,162	7.2
Non-opioid MM Tx.	7,016	51,155,925	57.1
Non-opioid monotherapy	3,329	26,226,612	29.2
No pain treatment	767	5,757,193	6.4

Notes: Based on 12,028 participants aged 18 or older reported pain during the past three months, with any of the following chronic conditions (asthma, arthritis, cancer, chronic kidney disease, chronic obstructive pulmonary disease, diabetes, dementia, heart diseases, high cholesterol, hypertension, liver conditions, stroke, anxiety, and depression) and without cancer, using opioids for chronic pain, without missing data in the types of pain treatment and opioid use. Missing data for the following variables (marital status, education, food security, inpatient visits, healthcare delay, body mass index, smoking status, and alcohol use) are not presented.

FPL: Federal Poverty Level; MM: Multimodal; Tx: Treatment; Wt. Weighted.