Traumatic injuries and persistent opioid use in the USA: findings from a nationally representative survey

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ABSTRACT

Background Although opioid abuse is a rising epidemic in the USA, there are no studies to date on the incidence of persistent opioid use following injuries. Therefore, the aims of this study are: (1) to examine the incidence of persistent opioid use among a nationally representative sample of injured and non-injured populations; (2) to evaluate whether an injury is an independent predictor of persistent opioid use.

Method Data from the Medical Expenditure Panel Survey were pooled (years 2009–2012). Adults were followed for about 2 years, during which they were surveyed about injury status and opioid use every 4–5 months. To determine whether injuries are associated with persistent opioid use, weighted multiple logistic regressions were constructed.

Results While 2.3 million injured individuals received any opioid during the follow-up, 371 170 (15.6%) individuals became persistent opioid users (defined as opioid use across multiple time points). In a multiple logistic regression analysis adjusting for sociodemographic characteristics and self-reported health, those who sustained injuries were 1.4 times (95% CI 1.1 to 1.9) more likely to report persistent opioid use than those without injuries.

Conclusions We found injuries to be significantly associated with persistent opioid use in a nationally representative sample. Further investment in injury prevention may facilitate reduction of persistent opioid use and, thus, improve population health and reduce health expenditures.

INTRODUCTION

Opioid abuse is a rising epidemic in the USA.[1] In 2013, there were over 16 000 opioid-related deaths, a 200% increase relative to 2000.[2] The increase in opioid-related deaths was concurrent with an increase in the number of users, the number of prescriptions filled and prescription costs.[3] In 2002, over 27 million people purchased one or more outpatient-prescribed opioids, while this figure increased to over 36 million in 2012.[4] Due to this rising burden, deaths associated with opioid overdose are now higher than those due to MVCs in 30 states.[5]

Over 39 million Americans are injured every year,[6] among whom pain remains a common concern.[7] Following changes in pain management recommendations in 2000, and possibly due to marketing from pharmaceutical companies, opioid utilisation increased over the past decade.[5 8] Consequently, more injured patients may be at risk of becoming persistent opioid users due to long-term use. Persistent opioid use has been associated with numerous adverse events such as overdose,[9] long hospital stays,[10] myocardial infarction, traffic crashes[11] and even death.[12]

The percentage of the US population who become persistent opioid users following injuries is currently unknown, but it is expected to have increased over the past decades. Some estimates put the prevalence of opioid dependence between 0.2% and 3.2%.[5] More comprehensive investigations of persistent opioid use may provide researchers and policy-makers with a basis to plan prevention strategies. This is instrumental for monitoring purposes and to guide future programmes aimed to reduce the burden of persistent opioid use.

No nationally representative studies have investigated the incidence of persistent opioid use following injuries. In this study, we aim to examine the incidence of persistent opioid use among both injured and non-injured populations. Additionally, we aim to evaluate whether sustaining an injury is an independent predictor of persistent opioid use after adjusting for potential confounders. We hypothesise that traumatic injuries are a significant predictor of persistent opioid use among US non-institutionalised populations.

METHODS

This prospective observational study used data from the Medical Expenditure Panel Survey (MEPS). The survey is conducted annually by the US Agency for Healthcare Research and Quality (AHRQ) and the National Center for Health Statistics.[13] The MEPS is a nationally representative sample and follows participants for about 2 years, during which participants are interviewed five times (4–5 months apart). For the present study, we used panels 14–17 that started between years 2009 and 2012. The survey comprises several data files covering areas such as expenditures, demographics, health status and medical conditions. We used three files: the population characteristics file, the prescription file and the medical conditions file. Detailed description of the survey methodology has been published previously.[14]

This study included participants 18 years of age or older and who were followed for the study period. Injured individuals were selected if they reported any injury in at least one of the first three rounds of follow-up (~first follow-up year), while the reference population included those without any reported injuries. Recidivists were those who reported an injury in more than one of the first

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three rounds. As this study was limited to de-identified and publicly available data, it was granted exemption by the institutional review board.

Injury status

In each of the five in-person interviews, medical conditions are collected as the reason for a particular episode of medical care (hospital stay, outpatient visit, emergency visit, home health episode, prescribed medication purchase or medical provider visit), the reason for one or more episodes of disability days or as a condition 'bothering' the person during the reference period. If a respondent reported a medical condition, he or she is then asked whether the condition was caused by an injury. Based on this response, an indicator variable was created to categorise injury status (yes vs no). In the injury group, only incidents that had occurred during follow-up were included to avoid bias due to including injured participants, who may have initiated opioids prior to the study. In addition, injured individuals, who reported opioid use prior to the injury incident, were excluded to ensure temporality between injuries and opioid use.

Opioid use

The prescription medication file was used to identify opioid users. The MEPS prescriptions file contains information on the medications a participant reported to have filled in a pharmacy during the study period. This study defined an opioid user as one who was prescribed opioids at least once in any round during the follow-up study. Based on the 'Multum Lexicon classification systems', codes that fit within two classifications of opioids were included. The first is narcotic analgesic which captured pure agonists like oxycodone. The second is narcotic analgesic combinations which captured combination drugs such as oxycodone/acetaminophen (eg, Percocet).[15]

Persistent opioid use

Use at a single time point was defined as opioid use in one round (4–5 months) of the five follow-up rounds. Persistent opioid use was defined as opioid use in more than one round (at least 8 months) following round 2 (ie, opioid use in rounds 3, 4, etc). To capture persistent opioid use, we created an indicator variable for those reporting opioid use in more than one round. This definition is consistent with several previous studies.[5 16]

Statistical analysis

STATA V.14 for Mac (STATA, College Station, Texas, USA) was used for all statistical analyses. Because the MEPS is a weighted sample and to account for the survey weights, strata and clustering of individuals, the *survey* command was used to provide nationally representative results of US non-institutionalised populations. Following AHRQ's recommendation, we divided survey weights by 2 to provide annual estimates of the injured and non-injured US populations.[17] Descriptive characteristics by injury status were obtained. Bivariate analyses were explored using χ^2 tests for categorical variables. A p value of <0.05 (two-sided) was considered statistically significant.

Several variables were examined in the univariate analyses including age, gender, race/ethnicity, family income, insurance status and baseline self-reported health (excellent, very good, good, fair and poor). In addition, depression status was examined, since mental health conditions are among potential risk factors for persistent opioid use and injuries.[18 19] Depression was explored using the Patient Health Questionnaire (PHQ-2) score. This instrument is used to screen for depressive symptoms and was found to have high sensitivity and specificity.[20] The PHQ-2 score ranges between 0 and 6, and a score of 3 or higher is considered a positive screen for depressive symptoms. Because the PHQ-2 was measured twice during follow-up, we created a categorical variable: negative depressive symptoms in both years, one positive screen for depression and positive screens for depressive symptoms in both years.

To determine whether injuries are associated with persistent opioid use, weighted simple and multiple logistic regressions were constructed adjusting for potential confounders. The following variables were significant in the univariate analysis and were included in the final model: gender (male as the reference), race/ethnicity (white as the reference, black and other), insurance status (private insurance as reference, public insurance and no insurance), baseline self-reported health and depressive symptoms. Because of its significant role in most health conditions, age (18–24 years as the reference, 25–44, 45–64 and ≥65) was included in the regression model despite its lack of significance in the univariate analysis. Interaction effects between injury status and age, gender and depression status were also investigated. The results were presented as ORs with associated 95% CIs.

RESULTS

Of the 36 824 participants included in the study, 4713 (12.7%) met the injury inclusion criteria (table 1). After taking sampling weights, clusters and strata into account, the injured population was representative of over 25 million injured individuals, of which 2.3 million (9.1%) used opioids at least once during follow-up. The data suggest that 371 170 individuals (15.6%) became persistent opioid users during the 2-year period (figure 1). Injured individuals also represented about 10.6% of the approximately 3.5 million individuals who reported persistent opioid use in the USA.

In the univariate analyses, injured individuals were more likely to be males, white and privately insured than those without injuries ($p<0.01$). While there were no differences in income and education, baseline self-reported health and depression status were significantly worse among injured individuals than those without injuries (table 1). In addition, injured individuals reported higher incidence of persistent opioid use than the injury-free population (2.8% vs 1.6%, $p<0.01$).

Regression analyses indicate that a traumatic injury is a significant predictor of persistent opioid use (table 2). Those who sustained an injury were 73% more likely to report persistent opioid use (OR=1.7, 95% CI 1.3 to 2.2). Increased odds of persistent opioid use remained significant even after adjusting for other covariates (OR=1.4, 95% CI 1.1 to 1.9). Interaction effects between injury status and age, gender or depression status were not significant.

Other health conditions were also significant predictors of persistent opioid use (table 2). Individuals who had two positive screens for depressive symptoms were three times more likely to report persistent opioid use than those without depressive symptoms, despite adjusting for other covariates (OR=3.0, 95% CI 2.2 to 4.2). Even higher odds of persistent opioid use were reported among patients with lower perceived health. Those who reported 'poor' baseline health were over 11 times more likely to report persistent opioid use than those reporting 'excellent' health adjusting for other variables (OR=11.8, 95% CI 7.2 to 18.4).

DISCUSSION

This nationally representative study found traumatic injuries to be a significant predictor of persistent opioid use. A significant

Table 1 Description of the MEPS study population by injury status

Variable	Injury-free (N=32 111)	Injured (N=4713)	Overall (N=36 824)	p Value*
Age (%)				
18–24	12.2	12.1	12.2	0.07
25–44	37.0	35.4	36.8	
45–64	33.1	35.6	33.5	
>64	17.6	16.9	17.5	
Gender (%)				
Female	53	49.6	52.5	<0.01
Income (%)†				
Poor (<100%)	20.7	21.5	20.9	0.32
Near poor (100% to <125%)	19.7	18.6	19.5	
Low (125% to <200%)	10.0	10.3	10.1	
Middle (200% to <400%)	21.9	22.8	22.0	
High (>400%)	27.7	26.7	27.6	
Highest degree (%)				
High school or less	15.4	14.7	15.3	0.19
Some college	30.0	29.8	30.0	
Bachelor	24.5	26.5	24.8	
Beyond	30.1	29.1	30.0	
Race/ethnicity (%)				
White	80.1	84.2	80.7	<0.01
Black	12.2	9.9	11.9	
Other	7.7	5.9	7.4	
Insurance (%)				
Private insurance	66.4	68.7	66.7	<0.01
Public	17.4	17.3	17.4	
Uninsured	16.3	14.0	15.9	
Region (%)				
Northeast	17.9	18.0	18.0	
Midwest	21.5	23.7	21.9	<0.01
South	38.0	33.7	37.4	
West	22.5	24.6	22.8	
Baseline health (%)				
Excellent	29.7	25.4	29.0	
Very good	31.6	30.1	31.4	
Good	25.0	27.1	25.3	<0.01
Fair	10.5	12.9	10.9	
Poor	3.2	4.5	3.4	
Depression screener positive (%)				
Neither years	86.8	82.6	86.2	<0.01
One year	10.0	12.6	10.4	
Both years	3.2	4.8	3.4	
Opioid (%)				
Persistent use (>8 months)	1.6	2.8	1.8	<0.01

*χ^2 test.
†Federal poverty level.
MEPS, Medical Expenditure Panel Survey.

outcome of the study is that among injured individuals who used opioids at least once, over 15% became persistent opioid users. This is higher than the estimated 11.4%, who become chronic users after initiating opioid treatment in Canada.[21] Our results also indicate that injured individuals, who became persistent opioid users, represent about 10.6% of the persistent opioid users in the USA. Public health programmes should target individuals with new injuries to reduce the burden of opioid dependence, abuse and associated medical costs.

The evidence presented here, that injuries are associated with increased likelihood of persistent opioid use, lends further credence to previous studies.[5 22] Our estimate of 2.8% is fairly similar to a study by Fishbain *et al*[23] who conducted a systematic review of 67 studies and found that opioid abuse rates varied between 0.2% and 3.2%. However, other studies found higher estimates of opioid use among patients with trauma.[18 22] Helmerhorst *et al*[18] examined persistent opioid use among patients with trauma, and found 28% reported using opioids 1–2 months after musculoskeletal injuries. A study by Cannon *et al*[22] found 20% patients were on prescription opioids at the time of the admission. Nevertheless, this study examined opioid incidence at the time of admission rather than long-term use and was limited to a single hospital. Hence, their estimate is not directly comparable with ours, and several confounders may have affected their findings. Another potential

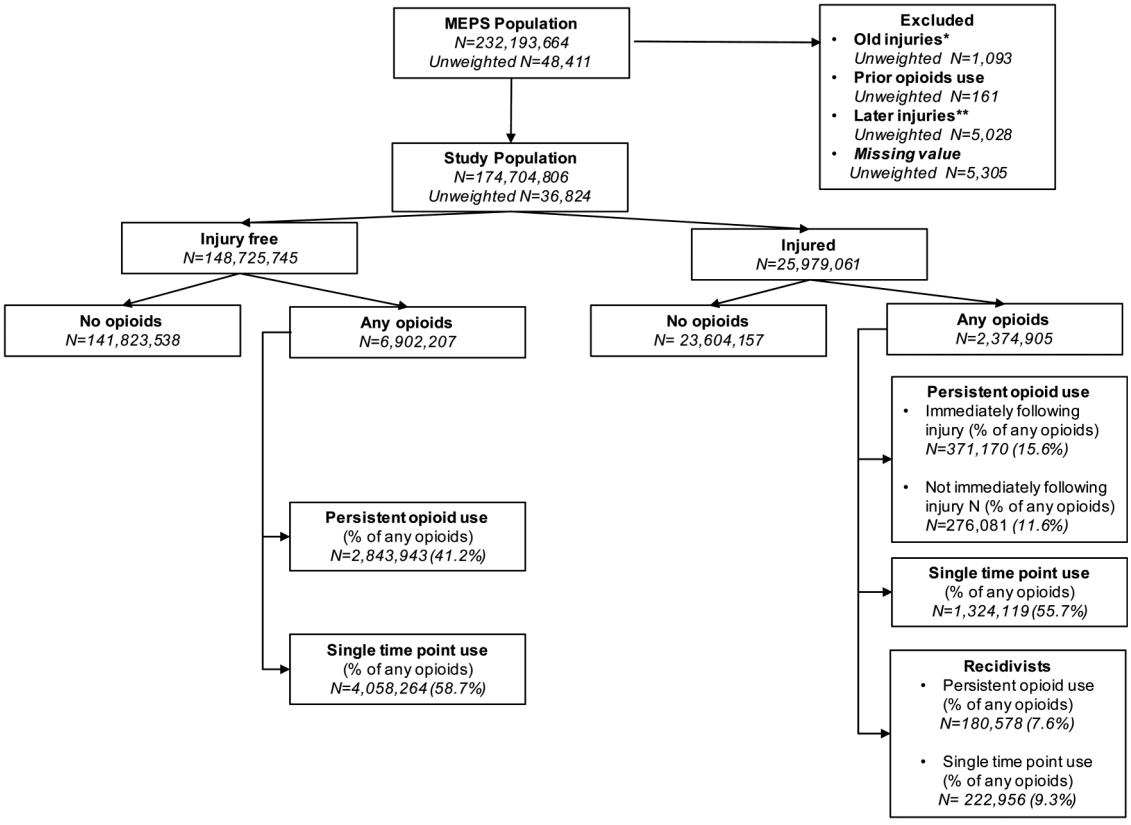

Figure 1 Weighted frequencies of Medical Expenditure Panel Survey (MEPS) participants by injury status and across opioid use categories. *Injuries sustained prior to the follow-up study. **Injuries sustained in either round 3 or 4.

explanation for the discrepancy between our findings and prior literature has to do with inclusion criteria. The present study examined persistent opioid use in a subset of the population which was not injured, was not on opioids, then became injured prior to opioid use. Therefore, it is not unlikely that rates of persistent opioid use may differ from other populations.

Compared with our result, a higher percentage of persistent opioid use was found among patients with trauma in other countries.[24 25] A study by Zwisler *et al*,[24] among Danish population, found that 7.0% of patients with trauma were persistent opioid users 6 months after injuries. Another study examined persistent opioid use among Australian workers and found 6.3% of those injured to be on opioid beyond the first year of injury.[25] It is possible that the discrepancy with our findings is due to differences in the study design or, more likely, to prescribing practices between the USA and other countries.

Among the study population, our estimate of persistent opioid use was lower than expected. Previous reports estimated that approximately 3.0% to 4.0% of the adult US population are persistent opioid users.[26] Population-based estimates from other countries are much lower than that of the USA. A study by Mellbye *et al*[27] examined persistent opioid use among the Norwegian population and found 0.6% to be persistent users. To the best of our knowledge, the only nationally representative US study was conducted by Sites *et al*[15] to examine trends in the use of prescription opioid analgesics in the USA. The authors found that 11.8% of the population were opioid users, but their study examined any opioids rather than persistent opioid use. In 2010, it was estimated that over 27 million were opioid users, and according to our finding, 3.5 million of those are persistent opioid users.[28] This is a major concern from a public health point of view and merits further investigation.

We found other health conditions to be associated with persistent opioid use, one of which is depression. Depressed individuals were three times more likely to be persistent opioid users than those without depression symptoms. This is very similar to the threefold to fourfold increase in the likelihood of persistent opioid use reported by prior findings.[5] Interestingly, a previous study using MEPS found depression to be associated with injuries and with injury recidivism.[19] There is a need for further studies to investigate whether addressing depressive symptom is associated with reduction of persistent opioid use.

Our study has important implications for public health. First, the estimated incidence of persistent opioid use provides a basis for initiatives aiming to reduce opioid dependence and measure the success of implemented programmes over time. For example, future studies of the incidence of persistent opioid use following the recent CDC opioid prescribing guidelines for chronic pain may provide valuable findings regarding its effectiveness.[29] A study by Franklin *et al*[30] in Washington State examined opioid use before and after implementation of a specific opioid dosing guideline and found a decline in the number of opioid-related deaths among injured workers. Second, we found injuries to be independently associated with persistent opioid use. Therefore, investing in preventing injuries may facilitate a sizeable decline of persistent opioid use. Third, our findings suggest depression is a strong predictor of persistent opioid use; thus, public health advocates could use these findings to call for initiatives in order to improve mental health and reduce persistent opioid use.

The study has several limitations. First, the data are self-reported and may not necessarily reflect true prescription or persistent opioid use. However, a previous study, using the MEPS dataset, validated self-reported prescriptions and found

Table 2 Logistic regression analysis of predictors of long-term opioid use in the USA (N=36 824)

Variables	Unadjusted model OR (95% CI)	Full model OR (95% CI)
Age categorised (years)		
18–24	–	Reference
25–44		2.9 (1.3 to 6.4)
45–64		5.3 (2.5 to 11.7)
65≥		5.1 (2.4 to 11.8)
Female	–	1.5 (1.2 to 1.9)
Race		
White	–	Reference
Black		72 (0.57 to 0.91)
Other		74 (0.48 to 1.1)
Insurance status		
Private	–	Reference
Public		1.0 (0.85 to 1.4)
Uninsured		56 (0.42 to 0.74)
Region		
Northeast	–	Reference
Midwest		1.3 (0.95 to 1.9)
South		1.5 (1.1 to 2.1)
West		1.2 (0.90 to 1.7)
Baseline health		
Excellent	–	Reference
Very good		1.8 (1.3 to 2.6)
Good		3.2 (2.2 to 4.7)
Fair		7.1 (4.8 to 10.6)
Poor		11.8 (7.2 to 0.18.4)
Depression screener positive		
Neither years		Reference
One year		2.5 (1.9 to 3.3)
Both years		3.0 (2.2 to 4.2)
Injury	1.7 (1.3 to 2.2)	1.4 (1.1 to 1.9)

that respondents accurately reported their medications.[31] Second, even if patients filled those prescriptions, actual adherence cannot be ascertained. The possibility remains that patients stopped using medications and were not persistent opioid users. Third, important variables such as alcohol abuse are not collected by the MEPS and, therefore, we were not able to assess their association with persistent opioid use. Fourth, injury mechanism is not collected in the MEPS, which limits the ability to design more specific injury prevention programmes. Finally, our study followed individuals for about 2 years. Therefore, it is unknown whether opioid use will continue in the upcoming years. Future longer prospective studies should take this into account to provide more comprehensive evidence.

Our findings may underestimate the true prevalence of persistent opioid use for a number of reasons. First, we excluded hospitalised patients with more severe injuries as well as patients who died due to drug overdose or misuse, which may have occurred following persistent opioid use. Second, those who used opioids prior to injuries, including for other conditions, were also excluded and thus not represented in our sample. Third, individuals who were prescribed opioids during the study and then transitioned to be persistent users through illegal means may not appear in our data. Additionally, substance abuse may also lead to persistent opioid use as suggested by previous studies.[32] Prescription opioids represent a major contributor to illegal recreational drugs in the USA, second after marijuana.[33] As a result, the burden may have been underestimated since the sample was limited to those followed for a 2-year period. Finally, it is possible that for some participants injury may have occurred toward the end of the 2-year study period. Those who became persistent opioid users will not be captured due to our limited follow-up.

In conclusion, we have shown that injures are significantly associated with persistent opioid use in a nationally representative sample. Public health interventions may use these findings as a basis for nationwide initiatives to reduce the burden of persistent opioid use among both injured and non-injured populations. Further investment in injury prevention may facilitate reduction of opioid abuse and, thus, improve population health and reduce health expenditures.

What is already known on the subject?

- Persistent opioid use is associated with overdose death and other negative health consequences.
- Previous observational studies provided little evidence on the association between injuries and persistent opioid use, because they only examined short-term opioid use after injuries or their generalisability was not established because of limitations in study populations.

What this study adds?

- This research presents the first nationally representative estimates of persistent opioid use among both injured and non-injured US populations.
- Among injured individuals who used opioids at least once, over 15% became persistent opioid users.
- Injured individuals who became persistent opioid users represent about 10.6% of persistent opioid users in the USA.

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Contributors SA conceived, developed and refined the study design. SA and RC came up with the research idea, analysed the data and prepared the manuscript. SA wrote a major part of the manuscript and RC contributed to the method and discussion sections. Both authors critically reviewed the manuscript and approved the final draft.

Competing interests None declared.

Provenance and peer review Not commissioned; internally peer reviewed.

Ethical approval Because it only used de-identified and publically available information, this study was granted an exemption status by the Institutional Review Board at Johns Hopkins University.

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Keeping cyclists from getting 'Doored'

Some otherwise desirable bicycle lanes place cyclists in a position where they are squeezed between car lanes and parked cars. Thus, when drivers open their door without looking, the door may hit a passing cyclist. One solution worth adopting while waiting for better urban designs is the 'Dutch Reach'. This entails teaching drivers to reach over with their right arm to open their door. This causes drivers to look back and see oncoming bicyclists. (In the case of right-side drivers, the left hand should be used.)

OFFENDER restraints can be fatal

In the UK, an internal risk assessment in young offender institutions shows that certain restraint procedures used against non-compliant children carry a 40%–60% chance of causing injuries. Many impair breathing or circulation. Comment: I wonder if these injuries would be classified as intentional or unintentional. Although one inquest judged the event to be accidental, the restraint technique used was withdrawn 2 months later.