

# Nonmedical Prescription Opioid and Heroin Use Among Adolescents Who Engage in Sports and Exercise

Philip Veliz, PhD,<sup>a</sup> Carol J. Boyd, MSN, PhD,<sup>a,b,c</sup> Sean Esteban McCabe, PhD<sup>a</sup>

abstract

**OBJECTIVES:** Previous research has found that adolescent athletes may be at increased risk of nonmedical prescription opioid use (NPOU) due to injuries. Although adolescent athletes are at an increased risk of engaging in NPOU, it has yet to be determined if they are also at greater risk for heroin use. The major purpose of this study was to examine both the trends in prevalence rates and patterns of initiation in lifetime NPOU and lifetime heroin use among adolescents who engage in sports and exercise.

**METHODS:** Eighteen cross-sections of eighth and 10th graders were used from the Monitoring the Future study. The sample consisted of 191 682 respondents who answered questions on past-year participation in sports and exercise, lifetime NPOU, lifetime heroin use, age of NPOU onset, and age of heroin onset.

**RESULTS:** The trends in NPOU and lifetime heroin use among adolescents who engage in sports and exercise has declined between 1997 and 2014. Logistic regression analyses found that adolescents who engage in sports and exercise had lower odds of reporting lifetime NPOU and heroin use compared with adolescents who did not engage in these activities during the past year. Analyses among lifetime heroin users found that adolescents who engage in sports and exercise had lower odds of initiating NPOU before heroin when compared with their peers who did not engage in these activities in the past year.

**CONCLUSIONS:** Daily participation in sports and exercise may serve as a protective factor with respect to NPOU and heroin use.



<sup>a</sup>Institute for Research on Women & Gender, <sup>b</sup>Addiction Research Center, Department of Psychiatry, and <sup>c</sup>Health Behavior and Biological Sciences (HBBS), School of Nursing, University of Michigan, Ann Arbor, Michigan

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Address correspondence to Philip Veliz, PhD, 1136 Lane Hall, 204 S State St, Ann Arbor, MI 48109.  
E-mail: ptveliz@umich.edu

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**WHAT'S KNOWN ON THIS SUBJECT:** Research has found that athletes are at risk for nonmedical prescription opioid use (NPOU) due to injuries. Although athletes are at risk for engaging in NPOU, it has not been determined whether they are at risk for heroin use.

**WHAT THIS STUDY ADDS:** Although athletes have been found to be at risk for NPOU, the majority of adolescents who engage in sports are less likely to report NPOU and heroin use during a period when opioid use has increased in the US.

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The prescribing of opioid analgesics and nonmedical prescription opioid use (NPOU) has increased significantly among US children and adolescents over the past 2 decades.<sup>1-3</sup> Regional and national studies indicate that lifetime exposure to prescription opioids in medical or nonmedical contexts among US high school students ranges from 22% to 45%.<sup>4-6</sup> Despite the efficacy of opioid analgesics when used properly to treat acute pain-related conditions, there are growing public health concerns based on their high abuse potential and the elevated risk among adolescents to engage in heroin use due to increased exposure to prescription opioids in medical and nonmedical contexts.<sup>2,7-11</sup>

Although NPOU among adolescents has decreased in recent years,<sup>2,3</sup> there are concerns that adolescents and young adults are moving toward heroin because of its greater availability and affordability in relation to prescription opioids. Indeed, the association between NPOU and heroin use is robust among adolescents and young adults.<sup>9,12,13</sup> For instance, the past-year heroin incidence rate was 19 times higher among those who reported previous NPOU than among those who did not report NPOU.<sup>9</sup> Moreover, more than half of past-year heroin initiates reported NPOU before starting heroin, whereas ~1% of past-year NPOU initiates had used heroin before starting NPOU.<sup>9</sup> These results indicate that early onset of NPOU during adolescence warrants closer examination because it may be a key precursor to heroin use.

In particular, adolescents who participate in athletics may be at a greater risk to engage in NPOU because of their greater risk of injury<sup>14,15</sup> or because of a greater opportunity to receive diverted opioid medications from teammates.<sup>16</sup> Several studies have found that youth who are highly involved in competitive sports are

at a greater risk of being prescribed opioid medications, misusing opioid medications (eg, use to “get high”), and being approached to divert (eg, give away) these opioid medications.<sup>15,16</sup> A national study found that youth who participated in high-injury sports such as football and wrestling were at greater risk to misuse prescription pain medications.<sup>14</sup> The greater risk to misuse opioid medications may be related to the fact that football players and wrestlers have the highest severe injury rates among high school athletes<sup>17</sup> and may be more likely to have been prescribed opioid medications by a physician. In addition, youth who participate in high-injury sports may be surrounded by peers who are more likely to have leftover prescription opioids, making it easier to receive diverted prescription opioids to ease injuries without having to acknowledge to parents and coaches that they need medical attention (eg, hiding injuries from coaches to participate).

Although adolescent athletes may be at greater risk of engaging in NPOU, it has yet to be determined whether they are also at greater risk for heroin use. Anecdotal evidence from various media sources has suggested prescription opioids may be turning adolescent athletes into heroin addicts.<sup>18,19</sup> These narratives typically describe how a young athlete was injured through participation in sports, was prescribed opioids to manage pain, began misusing these medications, and eventually turned to heroin (because it was easily available or cheaper). Although these narratives are compelling, there have been no large-scale studies to assess whether NPOU is actually leading to an “epidemic” of heroin users among the population of adolescents who frequently engage in sports and exercise.

To date, the association between NPOU and heroin use among adolescents who engage in sports and exercise has not been examined. Moreover, the extent to which NPOU may act as a precursor to heroin use has not been studied in the population of adolescents who engage in sports and exercise. Given that >75% of the adolescent population in the United States participates in organized sports,<sup>20</sup> it is critical to assess whether this large population of adolescents are more likely to misuse opioid analgesics or use heroin. Accordingly, this exploratory study seeks to examine 3 specific questions by using nationally representative data among eighth and 10th graders from the Monitoring the Future (MTF) study between 1997 and 2014: Have rates of lifetime NPOU and heroin use increased among adolescents who engage in sports and exercise during a period when prescribing opioids accelerated among the adolescent population? Do adolescents who participate in sports and exercise have a higher risk of lifetime NPOU and heroin use compared with other adolescents who do not engage in these activities when key sociodemographic and lifetime substance use behaviors are controlled for? Are adolescents who engage in sports and exercise more likely to have a history of NPOU before (or concurrently with) initiating heroin use when compared with their nonactive peers?

## METHODS

The current study used 18 cross-sections of the MTF study between 1997 and 2014.<sup>2</sup> Based on a 3-stage sampling procedure, MTF has surveyed nationally representative samples of ~15 000 US high school seniors each year since 1975 and 30 000 eighth and 10th graders since 1991 via questionnaires administered in classrooms. The

response rate among eighth, 10th, and 12th graders between 1991 and 2014 has ranged from 79% to 91%. The project design and sampling methods are described in greater detail elsewhere.<sup>2</sup>

The current study used secondary data from eighth and 10th graders who were randomly assigned to complete Form 2 between 1997 and 2014. The 1997 school year was chosen as the first year to include in this study because of changes in the eighth and 10th grade forms after 1996 (ie, only 2 forms were provided between 1991 and 1996, whereas 4 forms were provided in 1997 and beyond). Additionally, Form 2 was chosen because it is the only form that has questions on both involvement in athletics and when respondents initiated heroin and NPOU. The sample of 12th graders provided by the MTF were excluded because none of the 5 forms for high school seniors has a combination of questions about sports or physical activity, NPOU, heroin use, and when NPOU or heroin use was initiated. Given the parameters for the sample outlined above, the sample includes 191 682 (weighted  $n = 191\ 660$ ) respondents (52% eighth graders, 48% 10th graders). The demographics for the sample are provided in Table 1.

## Measures

Lifetime opioid or opiate use was based on 3 questions that asked respondents to report on lifetime heroin use with a needle, lifetime heroin use without using a needle, and lifetime NPOU (ie, used “narcotics other than heroin, such as methadone, opium, morphine, codeine, Demerol, Vicodin, OxyContin, and Percocet . . . without a doctor telling you to take them”). Respondents could select from 7 response categories that ranged from “0 Occasions” to “40 or more occasions.” Two binary measures were constructed from these

**TABLE 1** Sample Characteristics

Dependent Variables	Original Sample, $n = 191\ 660$		MI Sample, $m = 10, n = 191\ 660$
	%	% Missing	%
Lifetime NPOU	7.6	2.9	7.6
Lifetime heroin use	1.5	2.5	1.6
History of initiating NPOU in relation to initiating heroin			
No lifetime NPOU or heroin use	95.6	11.0	95.3
Lifetime NPOU only	3.5		3.7
Lifetime heroin use only	0.25		0.27
Initiated NPOU and heroin use in the same grade	0.38		0.42
Initiated NPOU in $\geq 1$ grade before heroin use	0.17		0.19
Initiated heroin use in $\geq 1$ grade before initiating NPOU	0.10		0.11
Participation in sports and exercise (independent variables)			
No past-year participation in sports and exercise (reference)	7.89	0.70	7.9
Participates in sports and exercise once a week at most	38.8		38.8
Participates in sports and exercise almost every day	53.3		53.3
Control variables			
Male (reference)	48.8	3.5	48.9
Female	51.2		51.1
White (reference)	57.4	0.00	57.4
Nonwhite	42.6		42.6
Respondent is in 8th grade (reference)	52.0	0.52	52.1
Respondent is in 10th grade	48.0		47.9
Never has been suspended from school (reference)	75.4	3.5	75.1
Has been suspended $\geq 1$ time from school	24.6		24.9
Both parents have less than a college degree (reference)	49.0	3.1	49.1
$\geq 1$ Parent has a college degree or higher	51.0		50.9
Respondent lives in a non-MSA (reference)	22.2	0.0	22.2
Respondent lives in an MSA	47.0		47.0
Respondent lives in a large MSA	30.8		30.8
Respondent lives in the Northeast (reference)	18.8	0.0	18.8
Respondent lives in the Midwest	24.1		24.1
Respondent lives in the South	35.6		35.6
Respondent lives in the West	21.6		21.6
Cohort years (1997–1999) (reference)	17.4	0.0	17.4
Cohort years (2000–2002)	16.2		16.2
Cohort years (2003–2005)	17.6		17.6
Cohort years (2006–2008)	17.1		17.1
Cohort years (2009–2011)	16.5		16.5
Cohort years (2012–2014)	15.3		15.3
No lifetime cigarette use (reference)	65.3	2.6	65.5
Lifetime cigarette use	34.7		34.5
No lifetime alcohol use (reference)	47.7	6.1	47.4
Lifetime alcohol use	52.3		52.6
No lifetime illicit drug use (excluding opioids) (reference)	61.3	1.0	61.3
Lifetime illicit drug use (excluding opioids)	38.7		38.7
No lifetime heroin use (reference)	98.9	7.6	98.9
Initiated heroin use in 4th grade or 7th grade	0.49		0.53
Initiated heroin use in 8th, 9th, or 10th grade	0.59		0.61
No lifetime NPOU (reference)	95.6	10.1	95.3
Initiated NPOU in 4th through 7th grade	1.1		1.3
Initiated NPOU in 8th, 9th, or 10th grade	3.2		3.4

MI, multiple imputation; MSA, Metropolitan Statistical Area. Weighted sample is provided;  $n = 191\ 660$ .

questions that indicated whether respondents ever reported heroin use during their lifetime (ie, with a needle or without a needle) or whether respondents ever reported NPOU during their lifetime.

History of initiating NPOU in relation to initiating heroin was measured with 2 separate questions that asked the following: “When (if ever) did you FIRST do each of the following things? Don’t count anything you took because a doctor told you to. . . [a] Try heroin. . . [b] Try a narcotic other than heroin (codeine, Vicodin, OxyContin, Percocet, etc.)” Both questions had response categories that ranged from “Grade 4” to the respondent’s current grade level (“Grade 8” or “Grade 10”). An additional category was also provided for respondents to indicate “never.” Both of these questions were combined into a mutually exclusive variable of the following categories: No Lifetime NPOU or Heroin Use, Lifetime NPOU Only, Lifetime Heroin Use Only, Initiated NPOU and Heroin Use in the Same Grade, Initiated NPOU in at Least One Grade Before Initiating Heroin Use, and Initiated Heroin Use in at Least One Grade Before Initiating NPOU.

Participation in sports and exercise was measured with 1 question that asked respondents how often they “Actively participate in sports, athletics or exercising.” Responses included “Never,” “A few times a year,” “Once or twice a month,” “At least once a week,” and “Almost every day.” This question was collapsed into a mutually exclusive variable that included categories for respondents who reported not participating in sports and exercise in the past year (ie, “Never”), respondents who reported participating in sports and exercise once a week at most (ie, “A few times a year,” “Once or twice a month,” “At least once a week”), and respondents who reported participating in sports and exercise almost every day

(ie, “Almost every day”). It should be noted that ~55% of eighth graders and 52% of 10th graders in the study sample indicated participating in sports and exercise almost every day (ie, highly involved athletes). Whereas the current measure used to assess the extent of participation in sports could include adolescents who engage only in exercise, with no history of participation in sports, other measures of the extent of past-year involvement in school and community sports among eighth and 10th graders in the MTF have found that ~58% of eighth graders and 45% of 10th graders participated on  $\geq 2$  teams in the past year (ie, highly involved athletes).<sup>21</sup>

In addition to these key variables, several control variables were included to account for any potentially confounding factors that are known to be associated with NPOU and heroin use in the MTF sample.<sup>13,22</sup> These variables include sex, race, grade level of respondent, suspension from school, parental education, urbanicity, region in the United States, cohort year, lifetime cigarette use, lifetime alcohol use, lifetime illicit drug use other than opioids and heroin (ie, marijuana, LSD, psychedelics, crack, cocaine, nonmedical amphetamine use, nonmedical barbiturate use, nonmedical tranquilizer use, inhalants, or steroids), and grade of initiation of NPOU and heroin.

### Analysis

Multiple logistic regression was used to examine the odds of reporting lifetime NPOU and heroin use among respondents who indicated being involved in sports and exercise during the past year versus those who indicated no past year involvement in these activities. Additional descriptive and multivariate analyses were conducted to examine lifetime NPOU and heroin use between 1997 and 2014. Moreover, multiple logistic regression analyses of lifetime

heroin users were conducted to examine whether respondents who indicated participating in sports and exercise had greater odds of reporting initiation of NPOU before initiating heroin use, or concurrently with heroin use, when compared with respondents who indicated no past-year involvement in sports and exercise.

For the analyses, Stata 14.0 (version 14.0; StataCorp, College Station, TX) was used to estimate the models outlined above. All logistic regression models provided adjusted odds ratios (aORs) and 95% confidence intervals (CIs) while controlling for the potentially confounding factors outlined above. All analyses used the weights provided by the MTF (public use files) to account for the probability of selection into the sample. Finally, given missing data in the MTF sample, multiple imputation was used to impute missing observations.<sup>23</sup> In particular, sequential regression imputation was used to impute missing values; several separate imputations with the full MTF sample used chained multinomial, logistic, and ordered logit models in Stata’s mi impute chained procedure (10 imputations, 5 burn-in iterations each; the augment option was used in the presence of perfect prediction). The percentages of respondents missing data for all the measures used in the analyses are provided in Table 1.

### RESULTS

The descriptive results presented in Table 1 show that 7.6% of respondents reported lifetime NPOU and 1.6% reported lifetime heroin use. The majority of respondents reported past-year athletic participation, with 53.3% indicating involvement in sports and exercise almost every day, 38.8% indicating involvement in sports and exercise once a week at most, and 7.9% indicating no past-year involvement in sports and exercise.

**TABLE 2** Examining Participation in Sports and Exercise and Lifetime Prevalence of NPOU and Heroin Use (All Respondents)

Participation in Sports and Exercise	% Lifetime NPOU	Lifetime NPOU		% Lifetime Heroin Use	Lifetime Heroin Use	
		aOR	95% CI		aOR	95% CI
No past-year participation in sports and exercise (reference)	11.2			2.9		
Participates in sports and exercise once a week at most	8.4	0.86*	0.80–0.92	1.8	0.74*	0.65–0.86
Participates in sports and exercise almost every day	6.5	0.74*	0.68–0.79	1.3	0.66*	0.57–0.76
Control variables						
Male (reference)	7.5			1.6		
Female	7.7	1.11*	1.06–1.16	1.6	1.03	0.93–1.15
White (reference)	8.8			1.5		
Nonwhite	6.0	0.59*	0.56–0.62	1.7	1.47*	1.33–1.63
Respondent is in 8th grade (reference)	5.2			1.6		
Respondent is in 10th grade	10.2	1.44*	1.37–1.50	1.6	0.52*	0.47–0.58
Never has been suspended from school (reference)	5.5			0.9		
Has been suspended ≥1 time from school	14.0	1.44*	1.38–1.51	3.8	1.63*	1.47–1.80
Both parents have less than a college degree (reference)	8.6			1.9		
At least 1 parent has a college degree or higher	6.7	1.04	0.99–1.09	1.3	1.10**	1.00–1.22
Respondent lives in a non MSA (reference)	9.1			1.9		
Respondent lives in a MSA	7.9	0.95	0.90–1.00	1.5	0.91	0.81–1.03
Respondent lives in a large MSA	6.2	0.84*	0.79–0.89	1.5	1.06	0.93–1.20
Respondent lives in the Northeast (reference)	6.5			1.4		
Respondent lives in the Midwest	7.9	1.15*	1.08–1.24	1.6	0.87	0.75–1.00
Respondent lives in the South	8.0	1.17*	1.09–1.24	1.6	0.83***	0.73–0.95
Respondent lives in the West	7.7	1.31*	1.22–1.40	1.7	0.94	0.81–1.08
Cohort years (1997–1999) (reference)	10.1			2.3		
Cohort years (2000–2002)	8.1	0.84*	0.78–0.90	1.8	0.83**	0.72–0.96
Cohort years (2003–2005)	7.2	0.87*	0.81–0.93	1.6	0.69*	0.60–0.80
Cohort years (2006–2008)	7.7	1.06	0.99–1.14	1.4	0.60*	0.52–0.70
Cohort years (2009–2011)	7.7	1.09**	1.01–1.18	1.4	0.58*	0.50–0.68
Cohort years (2012–2014)	5.0	0.83*	0.76–0.90	1.0	0.58*	0.48–0.69
No lifetime cigarette use (reference)	2.4			0.3		
Lifetime cigarette use	17.5	2.14*	2.02–2.26	4.0	2.18*	1.88–2.51
No lifetime alcohol use (reference)	1.4			0.3		
Lifetime alcohol use	13.3	2.42*	2.22–2.63	2.8	1.26**	1.05–1.51
No lifetime illicit drug use, excluding opioids (reference)	1.1			0.1		
Lifetime illicit drug use, excluding opioids	17.9	7.61*	7.07–8.20	4.0	12.81*	10.05–16.32
No lifetime heroin use (reference)	6.9					
Initiated heroin use in 4th or 7th grade	66.8	10.21*	8.50–12.27		—	—
Initiated heroin use in 8th, 9th, or 10th grade	71.5	9.36*	7.96–11.00		—	—
No lifetime NPOU (reference)				0.7		
Initiated NPOU use in 4th–7th grade		—	—	32.0	20.75*	17.95–23.99
Initiated NPOU use in 8th, 9th, or 10th grade		—	—	14.9	10.99*	9.41–12.82

MSA, Metropolitan Statistical Area.

\*  $P < .05$ .

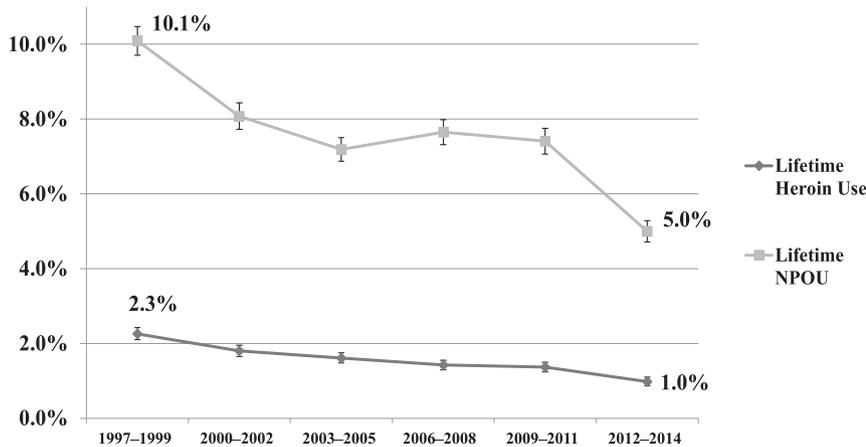
\*\*  $P < .01$ .

\*\*\*  $P < .001$ .

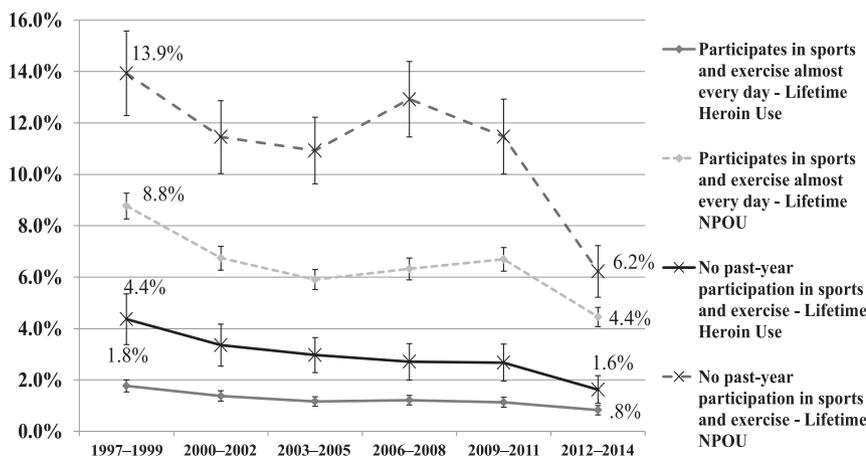
Table 2 provides the results of the logistic regression analyses examining involvement in sports and exercise and lifetime NPOU and heroin use. Respondents who reported participating in sports and exercise almost every day, and respondents who reported

participating in sports and exercise once a week at most, had lower odds of indicating lifetime NPOU and lifetime heroin use when compared with respondents who reported no participation in sports and exercise during the past year. It should also be noted that respondents who

reported participating in sports and exercise almost every day (lifetime NPOU, aOR = 0.73; 95% CI, 0.67–0.79; lifetime heroin use, aOR = 0.71; 95% CI, 0.59–0.85) and respondents who reported participating in sports and exercise once a week at most (lifetime NPOU, aOR = 0.86; 95% CI,



**FIGURE 1**  
Trends in lifetime heroin use and lifetime NPOU among eighth and 10th graders between 1997 and 2014. 95% CIs are provided.



**FIGURE 2**  
Trends in lifetime heroin use and lifetime NPOU among eighth and 10th graders between 1997 and 2014, by respondents who participate in sports and exercise almost every day and those who did not participate in these activities in the past year. 95% CIs are provided.

0.79–0.93; lifetime heroin use, aOR = 0.78; 95% CI, 0.65–0.93) had lower odds of indicating both past-year NPOU and past-year heroin use when compared with respondents who reported no involvement in these activities (results for past-year NPOU and heroin use are not provided in Table 2).

With respect to the overall trends in lifetime prevalence of NPOU and heroin use, Fig 1 shows declines in both lifetime NPOU (1997–1999, 10.1% vs 2012–2014, 5.0%) and lifetime heroin use (1997–1999, 2.3% vs 2012–2014, 1.0%). The aORs

presented in Table 1 indicate that these differences in prevalence rates between the earliest (1997–1999) and latest cohort (2012–2014) are significantly lower ( $P < .001$ ). It should also be noted that the decreasing prevalence rates in lifetime heroin use among eighth and 10th graders match what is reported by MTF; however, the MTF does not provide prevalence rates in lifetime NPOU among eighth and 10th graders in the yearly monographs, so comparisons cannot be made.<sup>2</sup>

Figure 2 shows similar declines in lifetime NPOU and lifetime heroin use among both respondents who

indicated participating in sports and exercise almost every day and those who indicated no past-year involvement in these activities. It should be noted that no significant interactions were found between cohort years and participation in sports and exercise, indicating similar declines in prevalence rates between 1997 and 2014.

Table 3 shows the results from the logistic regression models examining past-year participation in sports and exercise and history of initiating NPOU in relation to initiating heroin among respondents who reported lifetime heroin use. The results indicate that respondents who reported participating in sports and exercise almost every day had lower odds of initiating NPOU and heroin in the same grade and had lower odds of initiating NPOU in  $\geq 1$  grade before first heroin use when compared with respondents who reported no involvement in these activities. Moreover, respondents who reported participating in sports and exercise once a week at most had lower odds of initiating heroin use in at least  $\geq 1$  grade before first NPOU when compared with respondents who reported no involvement in these activities.

Finally, it should be noted that additional analyses (ie, negative binomial regression) were estimated to assess the mean frequency of lifetime and past-year NPOU and heroin use among adolescents who indicated being involved in sports and exercise during the past year versus those who indicated no past-year involvement in these activities. Similar results were found with respect to the logistic regression analyses examining both lifetime and past-year prevalence of NPOU and heroin use. Moreover, additional sensitivity analyses examining the 5 original categories provided for past-year involvement in sports and exercise (ie, no past

**TABLE 3** Logistic Regression Examining Participation in Sports and Exercise and History of NPOU in Relation to Initiating Heroin Use (Lifetime Heroin Use Only)

Participation in Sports and Exercise	Lifetime Heroin Use Only			Initiated NPOU and Heroin in the Same Grade			Initiated NPOU in $\geq 1$ Grade Before Initiating Heroin Use			Initiated Heroin Use in $\geq 1$ Grade Before Initiating NPOU		
	%	aOR	95% CI	%	aOR	95% CI	%	aOR	95% CI	%	aOR	95% CI
No past year participation in sports and exercise (reference)	18.7			33.7			17.6			9.5		
Participates in sports and exercise once a week at most	17.2	0.90	0.73–1.12	28.3	0.95	0.79–1.15	13.4	0.96	0.77–1.19	7.0	0.72*	0.53–0.98
Participates in sports and exercise almost every day	12.8	1.14	0.89–1.46	13.7	0.66**	0.52–0.83	5.8	0.60**	0.45–0.81	4.4	0.78	0.52–1.17
Control variables							0.0			0.0		
Male (reference)	15.6			24.2			12.1			7.2		
Female	17.3	1.02	0.85–1.23	27.1	1.08	0.92–1.27	12.6	1.00	0.81–1.23	6.6	0.87	0.66–1.14
White (reference)	16.2			26.0			12.7			6.3		
Nonwhite	16.1	0.90	0.75–1.09	24.1	0.93	0.78–1.10	11.4	0.92	0.74–1.13	7.1	1.14	0.86–1.52
Respondent is in 8th grade (reference)	16.5			23.2			10.9			5.6		
Respondent is in 10th grade	16.6	0.91	0.76–1.10	29.3	1.10	0.93–1.29	13.9	1.20	0.98–1.47	8.4	1.36*	1.04–1.78
Never has been suspended from school (reference)	15.7			20.1			8.3			4.2		
Has been suspended $\geq 1$ time from school	17.3	0.67**	0.55–0.81	30.8	1.13	0.96–1.33	16.3	1.53**	1.23–1.91	9.7	1.51***	1.13–2.03
Both parents have less than a college degree (reference)	17.0			26.3			13.0			7.4		
$\geq 1$ Parent has a college degree or higher	15.9	0.80*	0.67–0.97	25.0	1.16	0.99–1.37	11.3	1.00	0.82–1.23	6.4	1.08	0.82–1.42
Respondent lives in a non-MSA (reference)	15.1			28.9			12.1			7.0		
Respondent lives in an MSA	16.5	1.09	0.85–1.39	24.0	0.88	0.71–1.07	10.7	0.98	0.76–1.26	7.5	1.34	0.95–1.90
Respondent lives in a large MSA	16.3	1.35*	1.05–1.74	23.4	0.85	0.68–1.06	13.6	1.34*	1.02–1.76	5.5	0.87	0.60–1.28
Respondent lives in the Northeast (reference)	15.9			25.2			13.0			7.4		

**TABLE 3** Continued

Participation in Sports and Exercise	Lifetime Heroin Use Only			Initiated NPOU and Heroin in the Same Grade			Initiated NPOU in ≥1 Grade Before Initiating Heroin Use			Initiated Heroin Use in ≥1 Grade Before Initiating NPOU		
	%	aOR	95% CI	%	aOR	95% CI	%	aOR	95% CI	%	aOR	95% CI
Respondent lives in the Midwest	15.6	1.00	0.76–1.32	25.1	0.92	0.72–1.17	13.5	1.05	0.78–1.42	7.5	0.98	0.66–1.44
Respondent lives in the South	16.1	1.06	0.84–1.34	25.1	1.09	0.88–1.35	10.8	0.91	0.69–1.19	7.0	0.93	0.66–1.29
Respondent lives in the West	17.0	0.94	0.72–1.24	24.2	1.02	0.80–1.29	11.3	0.93	0.69–1.25	5.1	0.65**	0.42–1.00
Cohort years (1997–1999) (reference)	24.2			33.9			15.3			8.9		
Cohort years (2000–2002)	16.1	0.76*	0.59–0.98	20.1	0.60**	0.47–0.77	9.1	0.63**	0.45–0.88	6.4	1.04	0.71–1.54
Cohort years (2003–2005)	19.4	0.72*	0.56–0.94	29.9	0.95	0.75–1.19	14.9	1.12	0.84–1.49	7.8	0.91	0.62–1.35
Cohort years (2006–2008)	12.8	0.64***	0.47–0.87	24.0	1.07	0.82–1.39	12.1	1.19	0.86–1.65	7.1	0.99	0.65–1.51
Cohort years (2009–2011)	9.5	0.53**	0.37–0.74	19.6	0.94	0.70–1.27	9.0	1.01	0.71–1.44	5.2	0.77	0.46–1.29
Cohort years (2012–2014)	9.3	0.50**	0.34–0.73	16.9	0.89	0.64–1.24	9.4	1.24	0.83–1.86	3.6	0.58	0.32–1.05
No lifetime cigarette use (reference)	14.2			16.5			7.9			5.1		
Lifetime cigarette use	21.2	1.10	0.83–1.45	34.9	1.44***	1.15–1.80	16.8	1.35	0.95–1.91	9.3	0.94	0.64–1.39
No lifetime alcohol use (reference)	11.7			16.5			7.9			4.8		
Lifetime alcohol use	21.2	1.01	0.75–1.37	33.5	1.14	0.88–1.47	16.1	1.10	0.76–1.61	9.0	1.06	0.68–1.67
No lifetime illicit drug use, excluding opioids (reference)	5.7			7.9			3.5			1.8		
Lifetime illicit drug use, excluding opioids	21.8	2.16**	1.64–2.87	33.9	2.30**	1.81–2.92	16.3	2.59**	1.85–3.64	9.3	1.96***	1.18–3.27
Initiated heroin use between the 8th and 10th grade (reference)	12.3			19.2			11.7			2.4		
Initiated heroin use between the 4th and 7th grade	27.4	1.66**	1.36–2.02	42.0	1.73**	1.45–2.06	12.6	0.65**	0.51–0.82	19.8	6.96**	5.27–9.18

MSA, Metropolitan Statistical Area. Multiple imputations were estimated for each outcome (overall row percentages will not add to 100%).

\*  $P < .05$ .

\*\*  $P < .01$ .

\*\*\*  $P < .001$ .

year involvement, a few times a year, 1 or 2 times a month, at least once a week, and almost every day) were estimated and confirmed that greater levels of involvement in sports and exercise were associated with lower odds of NPOU, heroin use, and initiating NPOU before (or concurrently with) heroin use.

## DISCUSSION

This was the first national study to examine trends in lifetime NPOU and heroin use among US adolescents involved in sports and exercise. Moreover, it was the first study to examine whether adolescents involved in these activities were more likely to have a history of NPOU before (or concurrently with) initiating heroin use. The analyses found that trends in both lifetime NPOU and heroin use among adolescents involved in sports and exercise, along with adolescents who were not involved in these activities, has declined at a similar pace between 1997 and 2014. For instance, among adolescents who reported participating in sports and exercise almost every day, lifetime prevalence rates of NPOU and heroin use declined from 8.8% and 1.8% in 1997 to 4.4% to 0.8% in 2014, respectively. The logistic regression analyses also found that adolescents who indicated participating in sports and exercise had lower odds of reporting lifetime (and past-year) NPOU and heroin use when compared with adolescents who did not participate in these activities, when key sociodemographic and substance use behaviors were controlled for. Additional analyses among lifetime heroin users also found that adolescents who reported daily involvement in sports and exercise had lower odds of initiating NPOU before (or concurrently with) first heroin use when compared with their peers who did not participate in these activities.

The results of this study suggest that participation in sports and exercise may serve as a protective factor with respect to NPOU and heroin use. The physical activity and positive social connections embedded in sports may be positive developmental experiences that can deter youth from serious types of illicit substance use such as NPOU, heroin use, or cocaine use.<sup>24,25</sup> Although participation in sports and physical activity generally have been found to be negatively associated with illicit substance use (excluding alcohol) among adolescents,<sup>26–28</sup> other studies have suggested that certain types of sports that involve high levels of contact or risk of injury put adolescents at greater risk for NPOU.<sup>14</sup> Although athletes in high-injury sports should be monitored for opioid analgesic prescriptions and misuse, the overwhelming majority of athletes do not participate in these types of sports<sup>29</sup> and are not at a higher risk of using or misusing prescription opioids or heroin.

Although this study provides the first examination of the initiation patterns involving NPOU and heroin use among adolescents involved in sports and exercise, several limitations must be considered. First, this study relies on cross-sectional data and cannot examine the temporal ordering of sport participation, NPOU, and heroin use. For instance, it is plausible that those who initiate NPOU and heroin use were more likely to drop out of sports and exercise at least a year before taking the MTF survey. Although this limitation may be problematic, the cross-sectional design of the MTF allowed the researchers to examine a large sample of adolescent athletes involved in sports and exercise who were heroin users and made it possible to examine trends and patterns of NPOU and heroin

use among this subpopulation of adolescents. Another limitation was how sport participation was measured in the current study. The measure used to examine athletes in this study may have included respondents who engaged only in exercise, with no history of participating in sports. Despite this limitation of the measure used to examine participation in sports, it provides a good indicator of physical activity that is consistent with measures assessing highly involved athletes.<sup>21</sup>

## CONCLUSIONS

This study provides a valuable analysis of the transition of NPOU and heroin use among adolescents involved in sports and exercise during a period of increased prescription opioid use in the US population. Future study designs should examine sport type to determine whether athletes in high-contact sports are at a greater risk of transitioning from NPOU to heroin use because of their higher risk of injury and exposure to prescription opioids. Moreover, greater effort among large-scale surveys of drug use should incorporate more questions on sports injury and pain management because of the large number of US adolescents who participate in sports. Given that large sample sizes are needed to examine low-occurring types of substance use in the adolescent population, such studies have a unique opportunity to help expand our knowledge of the risks and benefits of adolescent sport participation.

## ABBREVIATIONS

aOR: adjusted odds ratio  
CI: confidence interval  
MTF: Monitoring the Future  
NPOU: nonmedical prescription opioid use

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