Published in final edited form as:

Am J Prev Med. 2017 November ; 53(5): e175–e183. doi:10.1016/j.amepre.2017.06.032.

Adolescent Sports Participation, E-Cigarette Use and Cigarette Smoking

Phil Veliz, PhD^a, Sean Esteban McCabe, PhD^{a,b}, Vita V. McCabe, MD^c, and Carol J. Boyd, PhD^{a,d,e}

^aInstitute for Research on Women and Gender, University of Michigan, Ann Arbor, Michigan

^bSubstance Abuse Research Center, University of Michigan, Ann Arbor, Michigan

^cSection of Thoracic Surgery, St. Joseph Mercy Ann Arbor, Ann Arbor, Michigan

^dSchool of Nursing, University of Michigan, Ann Arbor, Michigan

^eAddiction Research Center, Department of Psychiatry, University of Michigan, Ann Arbor, Michigan

INTRODUCTION

E-cigarette use, or electronic vaporizer use, is currently the most popular form of nicotine consumption among adolescents in the U.S.^{1–3} In 2015, roughly 16% of U.S. 12th graders indicated e-cigarette use during the past 30 days, while 11.4% indicated traditional cigarette smoking.³ Despite marketing campaigns claiming that e-cigarettes provide a safer platform to deliver nicotine, very little is known regarding both the short- and long-term health implications of e-cigarette use within the U.S. population.⁴

Several recent longitudinal studies of adolescents and young adults have found that individuals who used e-cigarettes at baseline assessments had higher odds of engaging in traditional cigarette smoking roughly 12 months later.^{5–6} These findings are concerning given that e-cigarettes may have the potential to appeal to individuals who would otherwise never engage in any type of smoking behaviors. For instance, a recent nationally representative sample of adolescents in the U.S. found that among e-cigarette users, more than half indicated inhaling just flavoring in their most recent use, while less than a quarter

Corresponding Author: Phil Veliz, PhD, 204 South State Street, Institute for Research on Women and Gender, University of Michigan, Ann Arbor, Michigan 48109, ptveliz@umich.edu, 734-764-4186.

Financial Disclosure: The authors have no financial relationships relevant to this article to disclose.

Conflict of Interest: The authors have no potential conflicts of interest relevant to this article to disclose.

Contributors Statement:

Phil Veliz: Dr. Veliz conceptualized and designed the study, drafted the initial manuscript, conducted the analyses, and approved the final manuscript as submitted.

Sean Esteban McCabe: Dr. McCabe helped draft the initial manuscript, interpret results, and approved the final manuscript as submitted.

Vita V. McCabe: Dr. McCabe interpreted data, critically reviewed the manuscript with a focus on the significance of the study for clinical practice, and approved the final manuscript as submitted.

Carol J. Boyd: Dr. Boyd helped conceptualize the study, critically reviewed the manuscript, and approved the final manuscript as submitted.

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

of e-cigarette users indicated inhaling nicotine.⁷ Although inhaling nicotine-free e-liquid could be considered a safer alternative when engaging in e-cigarette use, a recent regional study found that 34.1% of adolescent e-cigarette users did not know their e-liquid nicotine concentration.⁸ Despite these studies showing a large percentage of adolescents using nicotine-free flavoring, a large segment of these e-cigarette users are unaware of the nicotine content. Problematically, e-cigarettes could inadvertently expose adolescents to nicotine and may increase subsequent initiation rates of traditional cigarette smoking among nonsmokers.⁹

While the health risks associated with traditional cigarette smoking are well documented among adolescents,¹⁰ the association between adolescent health and e-cigarette use remains unclear. For instance, levels of physical activity and traditional cigarette smoking are inversely related in adolescent and adult populations.¹¹ Moreover, adolescents who participate in sports have been found to be at a lower risk of traditional cigarette smoking when compared to their nonparticipating peers.^{12–13} These findings demonstrate that adolescents who regularly engage in physical activity, like adolescents who participate in competitive sports,¹⁴ typically abstain from traditional cigarette smoking.

The inverse association between involvement in sport and cigarette smoking among adolescents may be due to an effort to simply maximize aerobic endurance in order to maintain a high level of performance.^{15–17} Additionally, adolescents may also abstain from cigarette smoking in order to cultivate important relationships among both adults and peers who are connected to these activities (e.g., cigarette smoking is not acceptable behavior for athletes).^{18–20} Despite the overall positive impact sport participation may have on lowering cigarette smoking among adolescents,^{12–13} some research has found that adolescent athletes who participate in certain sports may be at a greater or lower risk for cigarette smoking.¹⁶ In particular, a recent national study found that adolescents who participate in high-contact sports (e.g., football) were at the greatest risk for cigarette smoking, while adolescents who participate in non-contact sports (e.g., cross-country) were at the lowest risk for cigarette smoking.¹⁶

While the bifurcated effect found between participation in high- and non-contact sports on cigarette smoking could be due to either variation in aerobic demands placed on these athletes^{15–17} or the normative culture within these sports,^{16,21} the results clearly suggest a distinct pattern based on the level of contact or risk embedded within the sport.^{16,22} Unfortunately, it has yet to be determined if the same pattern among adolescent athletes exists with e-cigarette use. Given the marketing of a healthier, or safer form of smoking promoted by e-cigarette campaigns,^{9,23–25} it may be possible that certain low risk groups (i.e., athletes or athletes who participate in non-contact sports) may use this product because it is perceived to be much safer than traditional cigarette smoking. To date, no study has assessed the association between involvement in competitive sports and e-cigarette use among adolescents in the U.S. In order to fill this gap in our current knowledge of potential correlates of e-cigarette use, this study will explore the association between involvement in competitive sport participation, e-cigarette use and traditional cigarette smoking among a nationally representative sample of 12th grade students (modal age of 18).

METHODS

The present study uses cross-sectional data from the 2014 and 2015 Monitoring the Future (analyses were conducted in 2016).³ Based on a three-stage sampling procedure, MTF has surveyed nationally representative samples of approximately 15,000 U.S. high school seniors each year since 1975, with a response rate of 82% in 2014 and 83% in 2015. The project design and sampling methods are described in detail elsewhere.³ This study was approved by the institutional review board at the University of Michigan.

Sample

Measures for past-30 day e-cigarette use were added to several forms in 2014. Accordingly, data for the current analysis included 12th graders who were randomly assigned to complete form 5 given that questions on both e-cigarette use and competitive sport participation were only provided on this particular form. The analytic sample included 4,450 (weighted $n=4,453$) 12th grade respondents, 49.0% boys (51.0% girls). The racial/ethnic distribution was 13.2% Black, 17.1% Hispanic, 51.2% White, and 18.4% other race. Refer to Table 1 for additional sample characteristics.

Measures

Traditional cigarette smoking and e-cigarette use was based on several questions that asked respondents to report on past 30-day traditional cigarette smoking (“How frequently have you smoked cigarettes”) and past 30-day e-cigarette use (“on how many occasions have you used electronic cigarettes”). Response options ranged from “Not at all” to “Two packs or more per day” and “0 days” to “20–30 days”. For the purposes of this study, these questions were treated as dichotomous variables. Moreover, these measures were combined to create several categories that identified the following types of past 30 day traditional cigarette smoking and e-cigarette use: traditional cigarette smoking only, e-cigarette use only, and dual traditional cigarette smoking and e-cigarette use. Finally, it should also be noted that two additional outcomes were constructed using a measure of lifetime traditional cigarette smoking and the measure for past 30 day e-cigarette use: past 30 day e-cigarette use only without a history of lifetime traditional cigarette smoking and past 30 day e-cigarette use only with a previous history of lifetime traditional cigarette smoking.

Participation in competitive sports was the key set of independent variables used in the analyses. Participation in competitive sports was measured by asking respondents “In which competitive sports (if any) did you participate in during the LAST 12 MONTHS? Include school, community, and other organized sports. (Mark all that apply).” The competitive sports that respondents were able to select included baseball/softball, basketball, cheerleading, crew, cross-country, equestrian, field hockey, football, golf, gymnastics, ice hockey, lacrosse, soccer, swimming and diving, tennis, track and field, volleyball, water polo, weightlifting, wrestling, and ‘other’ sports. This variable was recoded into both a two category variable and a four category variable for the analyses (refer to Table 2). In order to adequately assess differences based on different types of sports, the analyses included the ten most popular sports for boys and ten most popular sports for girls.²⁶ Accordingly, thirteen different competitive sports that adolescents commonly participate in were included

in the analyses along with an additional variable that collapsed the other sports that were measured. See Table 2 for these sample characteristics

Control variables were also included in the analyses to account for potentially confounding factors that are known to be associated with cigarette smoking, e-cigarette use and other substance use within the MTF sample.³ Please refer to Table 1 for more details on these control variables.³

Analysis

Descriptive statistics were provided to examine the association between competitive sport participation and the measures for past 30-day traditional cigarette smoking and e-cigarette use. Multiple logistic regression was used to examine the odds of past 30-day traditional cigarette smoking and e-cigarette use among the different measures for competitive sport participation when controlling for potentially confounding factors.

For the analyses, STATA 14.0 was the software used to estimate the models outlined above (Version 14.0; StataCorp LP, College Station, Texas). All logistic regression models provide adjusted odds ratios (AOR) and 95% confidence intervals (95% CI) while controlling for the potentially confounding factors outlined above. All analyses used the weights provided by the MTF to account for the probability of selection into the sample. Given missing data within the MTF sample, multiple imputation was used to impute missing observations (see Table 1 and 2 for more details).²⁷ Finally, it should be noted that the models (i.e., Table 4) examining the differences across the 14 sports only consider values statistically significant at a .01 alpha level due to multiple comparisons being made within each outcome of interest.

RESULTS

Table 2 shows that e-cigarette use (18.0%) was more prevalent during the past 30 days than traditional cigarette smoking (12.1%). Past 30 day use of e-cigarettes only (10.8%) was the most common pattern followed by dual use of traditional cigarettes and e-cigarettes (7.2%) and traditional cigarette smoking only (4.7%). Moreover, roughly 5% of respondents indicated past 30 day e-cigarette use only without a history of lifetime traditional cigarette smoking while roughly 6% of respondents indicated past 30 day e-cigarette use only with a previous history of lifetime traditional cigarette smoking. With respect to competitive sport participation, the majority of respondents indicated participating in competitive sport during the past year (64.7%), with 30.8% of respondents participating in one competitive sport, 17.7% participating in two sports, and 15.9% participating in three or more sports. Table 2 also provides the percent of respondents indicating participation in thirteen of the most popular competitive sports for boys and girls.

Table 3 provides the results of the logistic regression examining the adjusted odds of past 30 day traditional cigarette smoking and e-cigarette use among adolescents involved in at least one competitive sport. The analyses show that respondents who participated in at least one competitive sport had lower odds of past 30 day traditional cigarette smoking and lower odds of dual use of traditional cigarettes and e-cigarettes when compared to respondents who did not participate in sports during the past year. No differences were found between

participants and non-participants with respect to past 30 day e-cigarette use, past 30 day cigarette smoking only, past 30 day e-cigarette use only, past 30 day e-cigarette use only with no history of traditional cigarette smoking (results not shown), and past 30 day e-cigarette use only with a previous history of traditional cigarette smoking (results not shown). It should also be highlighted that when the number of different competitive sports that adolescents participated in during the past year was used in the logistic regression models, only adolescents who participated in three or more sports had significantly lower odds of past 30 day cigarette smoking and past 30 day dual cigarette smoking and e-cigarette use when compared to their peers who did not participate in sports during the past year. No statistically significant differences were found between the number of different sports and the other outcomes for past 30 day traditional cigarette smoking and e-cigarette use.

Table 4 provides the results of the logistic regression examining the adjusted odds of past 30 day traditional cigarette smoking and e-cigarette use among adolescents involved in different types of sports. Adolescents who participated in **wrestling** had higher odds of past 30 day traditional cigarette smoking, past 30 day e-cigarette use, and past 30 day dual traditional cigarette smoking and e-cigarette use when compared to their peers who did not participate in this sport during the past year. Additionally, adolescents who participated in **baseball/softball** had higher odds of past 30 day e-cigarette use only and past 30 day e-cigarette use only with no history of traditional cigarette smoking when compared to adolescents who did not participate in this sport during the past year.

The analyses in Table 4 also shows one sport that reduced the odds of both past 30 day traditional cigarette smoking and e-cigarette use. Adolescents who participated in **soccer** had *lower* odds of past 30 day traditional cigarette smoking and past 30 day dual use when compared to adolescents who did not participate in these sports during the past year.

DISCUSSION

This study was the first to assess the association between competitive sport participation and different patterns of past 30-day traditional cigarette smoking and e-cigarette use. Overall, adolescents who participated in competitive sport, particularly those involved in three or more sports during the past year, were less likely to engage in past 30 day traditional cigarette smoking and past 30 day dual traditional cigarette smoking and e-cigarette use when compared to their nonparticipating peers. However, no association was found between competitive sport participation and past 30 day e-cigarette use. While the findings support previous research that adolescent athletes are at a lower risk of cigarette smoking,^{12–13} the same protective influence of participation in sport was not found with respect to e-cigarette use. The lack of a negative association between e-cigarette use and involvement in competitive sports among 12th graders raises concerns regarding the use of e-cigarettes as a possible gateway to traditional cigarette smoking and other tobacco use among healthy segments of the adolescent population. Traditional cigarette smoking is linked to lower levels of physical activity among adolescents and young adults,¹¹ and the use of e-cigarettes may erode barriers that may have protected healthier adolescents from using traditional cigarette smoking.

With respect to the analyses examining traditional cigarette smoking and e-cigarette use across different sports, participation in soccer was found to significantly lower the odds of traditional cigarette smoking when compared to the other types of sports. However, participation in wrestling was associated with a greater risk of traditional cigarette smoking, e-cigarette use, and dual use when compared to their peers involved in other types of sports. These findings are consistent with another study that found that adolescents who participated in non-contact sports (i.e., physical contact is officially prohibited) were less likely to engage in traditional cigarette smoking while adolescents who participated in high-contact sports (i.e., hitting is officially sanctioned) were more likely to smoke cigarettes.¹⁶ One possible explanation would suggest that non-contact sports may reduce the risk to engage in tobacco use due to these sports requiring more aerobic endurance than what is typically found in high contact sports that require higher levels of anaerobic effort.^{15–17} Another possible explanation is that sensation-seeking “riskier” adolescents, who are more prone to engage in cigarette smoking, may self-select into high-contact sports while risk-averse adolescents, who are less likely to smoke traditional cigarettes, may choose safer sports that have minimal contact and a lower possibility of severe injury.^{16,28} Finally, the influence of the cultural views and socioeconomic status of the athletes within certain sport may likely play a significant role with respect to viewing cigarette smoking or e-cigarette use as acceptable or trendy.^{21, 29–30}

The analyses also revealed that participation in baseball/softball was associated with a greater risk of certain patterns of e-cigarette use. In particular, participants in baseball/softball had higher odds of recent e-cigarette use with no history of traditional cigarette smoking. While it is difficult to determine in the current study as to why adolescents involved in these sports are moving toward e-cigarette use, these sports do tend to require more anaerobic effort. In other words, participants in baseball/softball may perceive that their performance will not be drastically impaired by using e-cigarettes and view them as a safer alternative to traditional cigarette smoking. Unfortunately, these adolescents who would otherwise never engage in traditional cigarette smoking may be at risk to engage in this behavior in the future due to their current exposure to e-cigarettes.

Limitations

The analyses for the current study rely on cross-sectional data and cannot determine causal patterns with respect to sport participation and different patterns of traditional cigarette and e-cigarette use. Future studies must assess how involvement in certain types of sport influences patterns of traditional cigarette and e-cigarette use as adolescents move into young adulthood. Second, the measures for tobacco use were constrained to traditional cigarette smoking and e-cigarette use. Measures of smokeless tobacco were not included on the MTF form used in the current study. Studies have shown that smokeless tobacco use is greater among adolescent athletes and could be linked to normative practices within certain sports that view smokeless tobacco use as an acceptable behavior.^{31–34} Given the findings from these studies, future studies need to assess if athletes moved from smokeless tobacco use to e-cigarette use or traditional cigarette smoking, or vice versa. Finally, the results from this study only focus on older adolescents (i.e., 12th graders). Younger athletes in elementary and middle school may reveal different patterns with respect to traditional cigarette and e-

cigarette use that future studies should take into consideration. Despite these limitations, the MTF study is the only large-scale nationally representative survey to have questions on e-cigarette use and measures of different types of sports that adolescents commonly participate in within their school or community.

CONCLUSIONS

The results of this study provide several important findings that aid in better understanding the association between e-cigarette use, traditional cigarette smoking and competitive sport participation. First, it appears that participation in multiple sports is a modest protective factor from traditional cigarette smoking and dual use of traditional cigarettes and e-cigarettes. Second, involvement in certain sports like soccer may be more likely to reduce the risk of traditional cigarette smoking, while other sports like wrestling may increase the likelihood of engaging in both traditional cigarette smoking and e-cigarette use. Finally, adolescents involved in baseball/softball had the highest rates of e-cigarette use without a history of traditional cigarette smoking. This is potentially problematic given that this behavior may eventually lower healthy levels of physical activity or may serve as a gateway to other forms of nicotine use that are known to cause serious health problems such as traditional cigarette smoking and smokeless tobacco. Greater effort should be directed at examining the association between participation in certain types of competitive sports and e-cigarette using longitudinal data to gain a better understanding of the short- and long-term effects of e-cigarette use on various health related outcomes.

Acknowledgments

Funding Source: The development of this article was supported by research grants L40DA042452, R01CA203809, R01DA031160 and R01DA036541 from the National Cancer Institute and National Institute on Drug Abuse, National Institutes of Health. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Cancer Institute, National Institute on Drug Abuse or the National Institutes of Health.

References

1. Arrazola RA, Singh T, Corey CG, et al. Tobacco use among middle and high school students-United States, 2011–2014. *MMWR Morb Mortal Wkly Rep.* 2015; 64(14):381–385. <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6345a2.htm>. [PubMed: 25879896]
2. Miech, RA., Johnston, LD., O'Malley, PM., Bachman, JG., Schulenberg, JE. Monitoring the future national survey results on drug use, 1975–2014: Volume I, Secondary school students. Ann Arbor: Institute for Social Research, The University of Michigan; 2015. http://www.monitoringthefuture.org/pubs/monographs/mtf-vol1_2014.pdf
3. Miech, RA., Johnston, LD., O'Malley, PM., Bachman, JG., Schulenberg, JE. Monitoring the future national survey results on drug use, 1975–2015: Volume I, Secondary school students. Ann Arbor: Institute for Social Research, The University of Michigan; 2016. http://www.monitoringthefuture.org/pubs/monographs/mtf-vol1_2015.pdf
4. Rigotti NA. E-cigarette use and subsequent tobacco use by adolescents new evidence about a potential risk of e-cigarettes. *JAMA.* 2015; 314(7):673–674. <http://dx.doi.org/10.1001/jama.2015.8382>. [PubMed: 26284717]
5. Leventhal AM, Strong DR, Kirkpatrick MG, et al. Association of electronic cigarette use with initiation of combustible tobacco product smoking in early adolescence. *JAMA.* 2015; 314(7):700–707. <http://dx.doi.org/10.1001/jama.2015.8950>. [PubMed: 26284721]

6. Primack BA, Soneji S, Stoolmiller M, Fine MJ, Sargent JD. Progression to traditional cigarette smoking after electronic cigarette use among US adolescents and young adults. *JAMA Pediatr.* 2015; 169(11):1018–1023. <http://dx.doi.org/10.1001/jamapediatrics.2015.1742>. [PubMed: 26348249]
7. Miech, RA., Patrick, ME., O'Malley, P., Johnston, LD. What are kids vaping? Results from a national survey of US adolescents. *Tob Control.* in press <http://dx.doi.org/10.1136/tobaccocontrol-2016-053014>
8. Morean ME, Kong G, Cavallo DA, Camenga DR, Krishnan-Sarin. Nicotine concentration of e-cigarettes used by adolescents. *Drug Alcohol Depen.* 2016; 167:224–227. <http://dx.doi.org/10.1016/j.drugalcdep.2016.06.031>.
9. Barrington-Trimis JL, Samet JM, McConnell R. Flavorings in electronic cigarettes: an unrecognized respiratory health hazard? *JAMA.* 2014; 312(23):2493–2494. <http://dx.doi.org/10.1001/jama.2014.14830>. [PubMed: 25383564]
10. The health consequences of smoking—50 years of progress: a report of the Surgeon General. Atlanta: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2014. <http://www.surgeongeneral.gov/library/reports/50-years-of-progress/full-report.pdf>
11. Kaczynski AT, Manske SR, Mannell RC, Keerat G. Smoking and physical activity: a systematic review. *Am J Health Behav.* 2008; 32(1):93–110. <http://dx.doi.org/10.5555/ajhb.2008.32.1.93>. [PubMed: 18021037]
12. Diehl K, Thiel A, Zipfel S, Mayer J, Litaker DG, Schneider. How healthy is the behavior of young athletes? A systematic literature review and meta-analyses. *J Sports Sci Med.* 2012; 11(2):201–220. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3737871/>. [PubMed: 24149192]
13. Lisha N, Sussman S. Relationship of high school and college sports participation with alcohol, tobacco, and illicit drug use: A review. *Addictive Behaviors.* 2010; 35:399–407. [PubMed: 20100638]
14. Sabo D, Veliz P. Participation in organized competitive sports and physical activity among US adolescents: Assessment of a public health resource. *Health Behav Policy Rev.* 2014; 1(6):503–512. <https://doi.org/10.14485/HBPR.1.6.8>.
15. Denham B. Alcohol and marijuana use among American high school seniors: Empirical associations with competitive sports participation. *Sociol Sport J.* 2011; 28(3):362–379. <http://dx.doi.org/10.1123/ssj.28.3.362>.
16. Veliz P, Boyd C, McCabe SE. Competitive sport involvement and substance use among adolescents: a nationwide study. *Subst Use Misuse.* 2015; 50(2):156–165. <http://dx.doi.org/10.3109/10826084.2014.962049>. [PubMed: 25290659]
17. Wichstrom T, Wichstrom L. Does sports participation during adolescence prevent later alcohol, tobacco and cannabis use? *Addiction.* 2009; 104(1):138–149. <http://dx.doi.org/10.1111/j.1360-0443.2008.02422.x>. [PubMed: 19133899]
18. Crosnoe R. Academic and health-related trajectories in adolescence: The intersection of gender and athletics. *J Health Soc Behav.* 2002; 43(3):317–336. <https://www.ncbi.nlm.nih.gov/pubmed/12467256>. [PubMed: 12467256]
19. McNeal RB. Extracurricular activities and high school dropouts. *Sociol Educ.* 1995; 68(1):62–81. <http://dx.doi.org/10.2307/2112764>.
20. Marsh HW. Extracurricular activities: Beneficial extension of the traditional curriculum or subversion of academic goals? *J Educ Psychol.* 1992; 84(4):553–562. <http://dx.doi.org/10.1037/0022-0663.84.4.553>.
21. Hughes R, Coakley J. Positive deviance among athletes: The implications of overconformity to the sport ethic. *Sociol Sport J.* 1991; 8(4):307–325. <http://dx.doi.org/10.1123/ssj.8.4.307>.
22. Veliz P, Schulenberg J, Patrick ME, Kloska D, McCabe SE. Competitive sports participation in high school and subsequent substance use in young adulthood: assessing differences based on level of contact. *Int Rev Sociol Sport.* 2017; 52(2):240–259. <http://journals.sagepub.com/doi/abs/10.1177/1012690215586998>. [PubMed: 28344426]

23. Abrams DB. Promise and peril of e-cigarettes: can disruptive technology make cigarettes obsolete? JAMA. 2014; 311(2):135–136. <http://dx.doi.org/10.1001/jama.2013.285347>. [PubMed: 24399548]
24. Maziak W. Potential and pitfalls of e-cigarettes. JAMA. 2014; 311(18):1922. <http://dx.doi.org/10.1001/jama.2014.2995>.
25. Zhu SH, Sun JY, Bonnevie E, et al. Four hundred and sixty brands of e-cigarettes and counting: implications for product regulation. Tob Control. 2014; 23(suppl 3):iii3–iii9. <http://dx.doi.org/10.1136/tobaccocontrol-2014-051670>. [PubMed: 24935895]
26. High school athletics participation survey 2015–2016. Indianapolis, IN: National Federation of State High School Associations; http://www.nfhs.org/ParticipationStatistics/PDF/2015-16_Sports_Participation_Survey.pdf
27. Raghunathan TE, Lepkowski JM, Van Hoewyk J, Solenberger P. A multivariate technique for multiply imputing missing values using a sequence of regression models. Surv Methodol. 2001; 27(1):85–95. <http://www.statcan.gc.ca/pub/12-001-x/2001001/article/5857-eng.pdf>.
28. Schepis TS, Desai RA, Smith AE, et al. Impulsive sensation seeking, parental history of alcohol problems, and current alcohol and tobacco use in adolescents. J Addict Med. 2008; 2(4):185–93. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2678841/>. [PubMed: 19956365]
29. Bourdieu P. Sport and social-class. Soc Sci Info. 1978; 17(6):819–840. <http://dx.doi.org/10.1177/053901847801700603>.
30. Primack BA, Fertman CI, Rice KR, Adachi-Mejia AM, Fine MJ. Waterpipe and cigarette smoking among college athletes in the United States. J Adolesc Health. 2010; 46(1):45–51. [PubMed: 20123257]
31. Castrucci BC, Gerlach KK, Kaufman NJ, Orleans CT. Tobacco use and cessation behavior among adolescents participating in organized sports. Am J Health Behav. 2004; 28(1):63–71. <https://doi.org/10.5993/AJHB.28.1.7>. [PubMed: 14977160]
32. Davis TC, Arnold C, Nandy I, et al. Tobacco use among male high school athletes. Journal Adolesc Health. 1997; 21(2):97–101. [https://doi.org/doi:10.1016/S1054-139X\(97\)00032-3](https://doi.org/doi:10.1016/S1054-139X(97)00032-3).
33. Melnick MJ, Miller KE, Sabo D, Farrell MP, Barnes GM. Tobacco use among high school athletes and nonathletes: results of the 1997 youth risk behavior survey. Adolescence. 2001; 36(144):727–747. <https://www.ncbi.nlm.nih.gov/pubmed/11928879?dopt=Abstract>. [PubMed: 11928879]
34. Taliaferro LA, Rienzo BA, Donovan KA. Relationships between youth sport participation and selected health risk behaviors from 1999 to 2007. J Sch Health. 2010; 80(8):399–410. <http://dx.doi.org/10.1111/j.1746-1561.2010.00520.x>. [PubMed: 20618623]

Table 1

Sample characteristics (n = 4,450)

Control Variables	MI (10 imputations)		Listwise Deletion		% missing
	%	SE	%	SE	
Boys (ref.)	49.0%	0.009	47.1%	0.010	5.4%
Girls	51.0%	0.009	52.9%	0.010	
White (ref.)	51.2%	0.009	58.5%	0.010	0.0%
Black	13.2%	0.006	10.8%	0.007	
Hispanic	17.1%	0.007	16.0%	0.007	
Other Race	18.4%	0.007	14.7%	0.007	2.4%
Exercise less than every day (ref.)	62.9%	0.009	62.2%	0.010	
Exercise every day	37.1%	0.009	37.8%	0.010	
Did not cut class (ref.)	71.1%	0.009	72.2%	0.009	9.0%
Cut class	28.9%	0.009	27.8%	0.009	
Has an average grade of B- or higher (ref.)	84.1%	0.007	85.1%	0.007	5.6%
Has an average grade of C+ or lower	15.9%	0.007	14.9%	0.007	
Goes out at most 2 nights a week (ref.)	61.8%	0.009	61.2%	0.013	6.9%
Goes out 3 or more times a week	38.2%	0.009	38.8%	0.010	
Does not have a job (ref.)	40.8%	0.009	39.7%	0.010	6.7%
Works 1 to 20 hours a week	38.1%	0.009	40.5%	0.010	
Works 21 or more hours a week	21.1%	0.008	19.9%	0.008	4.3%
Both parents have less than a BA (ref.)	49.8%	0.009	47.9%	0.010	
At least one parent has a BA	50.2%	0.009	52.1%	0.010	0.0%
Respondent lives in a Non MSA (ref.)	19.9%	0.007	21.4%	0.008	
Respondent lives in a MSA	49.6%	0.009	48.7%	0.010	0.0%
Respondent lives in a Large MSA	30.5%	0.008	29.9%	0.010	
Respondent lives in the Northeast (ref.)	18.3%	0.006	16.8%	0.007	0.0%
Respondent lives in the Midwest	20.3%	0.007	21.9%	0.008	
Respondent lives in the South	39.1%	0.009	37.6%	0.010	0.0%
Respondent lives in the West	22.2%	0.008	23.7%	0.009	
No past 30 day alcohol use (ref.)	64.5%	0.009	63.8%	0.010	7.7%

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

	MI (10 imputations)			Listwise Deletion			% missing
	%	SE		%	SE		
past 30 day alcohol use	35.5%	0.009		36.2%	0.010		
No past 30 day marijuana use (ref.)	78.0%	0.007		79.0%	0.008		5.4%
Past 30 day marijuana use		22.0%		0.007	21.0%		0.008

% = percent; SE = standard error; MI = multiple imputation; ref. = reference group in logistic regression models.

Table 2

Descriptive statistics for the major independent and dependent variables (n = 4,450)

Independent Variables of Interest (Past Year)	MI (10 imputations)		Listwise Deletion		% missing
	%	SE	%	SE	
Participates in Competitive Sports					
Does not participate in sport (ref.)	35.3%	0.009	34.9%	0.010	12.8%
Participates in at least one sport	64.7%	0.009	65.1%	0.010	
Number of Different Sports					
Participates in one sport	30.8%	0.009	30.6%	0.010	12.8%
Participates in two sports	17.7%	0.007	17.9%	0.008	
Participates in three + sports	15.9%	0.007	16.5%	0.008	
Different Types of Sports					
Baseball/Softball	11.7%	0.006	11.8%	0.007	12.8%
Basketball	17.4%	0.007	17.0%	0.008	
Cheerleading	4.8%	0.004	5.0%	0.005	
Cross Country	4.7%	0.004	4.6%	0.004	
Football	12.9%	0.006	12.5%	0.007	
Golf	4.9%	0.004	5.0%	0.005	
Lacrosse	2.6%	0.003	2.5%	0.003	
Soccer	11.9%	0.006	11.5%	0.006	
Swimming and Diving	5.7%	0.004	6.0%	0.005	
Tennis	5.5%	0.004	5.5%	0.004	
Track and Field	11.4%	0.006	12.1%	0.007	12.8%
Volleyball	8.0%	0.005	8.6%	0.006	
Wrestling	3.8%	0.003	3.3%	0.004	
Other Sport	23.1%	0.008	23.6%	0.008	
Dependent Variables (Past 30 Days)					
Cigarette Smoking	12.1%	0.006	11.2%	0.007	3.6%
E-Cigarette Use	18.0%	0.007	17.8%	0.008	11.1%
Dual Cigarette and E-Cigarette Use	7.2%	0.005	6.8%	0.005	13.0%
Cigarette Smoking Only	4.7%	0.004	4.4%	0.004	13.0%

	MI (10 imputations)		Listwise Deletion		% missing
	%	SE	%	SE	
E-Cigarette Use Only	10.8%	0.006	11.0%	0.007	13.0%
E-Cigarette Use Only (without a history of lifetime cigarette smoking)	4.9%	0.004	4.7%	0.004	13.0%
E-Cigarette Use Only (previous history of lifetime cigarette smoking)	6.2%	0.005	6.2%	0.005	13.0%

% = percent; SE = standard error; MI = multiple imputation; ref. = reference group in logistic regression models.

Table 3

Multiple logistic regression models assessing the association between sport participation and past 30 day cigarette/e-cigarette use.

n = 4453 weighted/n = 4450 unweighted		Model 1	Model 2	Model 3	Model 4	Model 5
Past year participation in sports		Cigarette smoking	E-Cigarette use	Dual use	Cigarette smoking only	E-Cigarette use only
Does not participate in sport		% AOR (95% CI)	% AOR (95% CI)	% AOR (95% CI)	% AOR (95% CI)	% AOR (95% CI)
Participates in at least one sport		14.7% Reference	18.2% Reference	8.7% Reference	5.7% Reference	9.4% Reference
		10.6% 0.73 (.538,.973)	17.8% 0.97 (.754,1.24)	6.2% 0.66 (.438,.982)	4.2% 0.98 (.643,1.50)	11.5% 1.29 (.934,1.78)
Past year participation in sports						
Does not participate in sport		% AOR (95% CI)	E-Cigarette use	Dual use	Cigarette smoking only	E-Cigarette use only
Participates in one sport		14.7% Reference	% AOR (95% CI)	% AOR (95% CI)	% AOR (95% CI)	% AOR (95% CI)
Participates in two sports		11.3% 0.88 (.619,1.24)	17.2% 1.00 (.769,1.30)	6.5% 0.80 (.538,1.18)	4.9% 1.13 (.669,1.91)	11.0% 1.24 (.884,1.75)
Participates in three or more sports		9.9% 0.62 (.389,1.01)	17.2% 0.92 (.651,1.29)	5.9% 0.57 (.322,1.03)	3.8% 0.85 (.462,1.56)	11.5% 1.29 (.856,1.96)
		9.9% 0.55 (.332,.909)	19.4% 0.94 (.674,1.32)	6.4% 0.53 (.303,.918)	3.6% 0.79 (.372,1.69)	13.4% 1.47 (.954,2.26)

Note: Boldface indicates statistical significance ($p < 0.05$); % = percent (prevalence); AOR = adjusted odds ratio; 95% CI = 95% confidence interval; Reference = reference group.

All models control for sex, race, exercise frequency, cutting class, average grade in school, time away from home at night, work status, parental education, urbanicity (e.g., does respondent live in a MSA), region (e.g., does respondent live in the Northeast), past 30-day alcohol use, and past 30-day marijuana use. Please refer to Table 1 for more details on these control variables.

Results for E-cigarette use only/with no history of cigarette smoking and E-cigarette use only/with history of cigarette smoking can be provided upon request.

Table 4

Multiple logistic regression models assessing the association between different types of sport participation and past 30 day cigarette/e-cigarette use.

	Model 1			Model 2			Model 3			Model 4			Model 5		
	Cigarette smoking			E-Cigarette use			Dual use			Cigarette smoking only			E-Cigarette use only		
n = 4453 weighted/n = 4450 unweighted	%	AOR	(95% CI)	%	AOR	(95% CI)	%	AOR	(95% CI)	%	AOR	(95% CI)	%	AOR	(95% CI)
Past year participation in sports															
Baseball/Softball	10.8%	0.78	(.483,1.26)	22.7%	1.36	(.974,1.90)	7.2%	0.88	(.500,1.56)	4.0%	0.88	(.443,1.73)	16.6%	1.74**	(1.20,2.51)
Basketball	9.2%	0.75	(.496,1.15)	17.1%	0.90	(.627,1.28)	5.3%	0.70	(.428,1.13)	3.9%	0.93	(.508,1.71)	11.9%	1.03	(.673,1.56)
Cheerleading	7.1%	0.72	(.367,1.42)	12.5%	0.84	(.482,1.47)	4.5%	0.85	(.282,2.53)	2.6%	0.53	(.177,1.61)	8.6%	0.89	(.472,1.69)
Cross Country	8.6%	0.84	(.404,1.74)	14.9%	0.80	(.448,1.41)	5.0%	0.78	(.333,1.84)	3.0%	0.82	(.316,2.13)	9.4%	0.78	(.430,1.40)
Football	13.5%	0.81	(.526,1.25)	22.8%	0.84	(.571,1.22)	8.4%	0.79	(.475,1.31)	5.1%	1.05	(.528,2.08)	14.6%	0.96	(.649,1.43)
Golf	6.6%	0.36	(.157,.825)	19.0%	0.81	(.505,1.29)	4.2%	0.41	(.163,1.01)	1.5%	0.29	(.084,1.01)	15.1%	1.23	(.716,2.12)
Lacrosse	20.0%	1.53	(.706,3.30)	34.6%	1.77	(1.06,2.96)	11.9%	1.31	(.559,3.08)	7.8%	1.75	(.532,5.78)	21.0%	1.54	(.867,2.75)
Soccer	6.2%	0.46**	(.274,.776)	14.6%	0.70	(.491,1.003)	3.1%	0.37**	(.181,.753)	2.9%	0.71	(.397,1.28)	11.5%	1.04	(.700,1.55)
Swimming and Diving	9.4%	0.78	(.422,1.44)	19.1%	0.99	(.621,1.57)	7.4%	1.13	(.578,2.20)	1.8%	0.41	(.138,1.24)	11.3%	0.85	(.526,1.39)
Tennis	9.5%	0.98	(.484,1.96)	17.6%	0.99	(.636,1.55)	5.4%	0.85	(.418,1.74)	3.1%	1.00	(.306,3.24)	10.2%	0.86	(.480,1.52)
Track and Field	7.8%	0.81	(.507,1.31)	14.7%	0.99	(.671,1.46)	4.1%	0.69	(.354,1.34)	3.9%	1.19	(.609,2.32)	10.9%	1.21	(.789,1.86)
Volleyball	10.7%	1.20	(.704,2.05)	15.0%	0.87	(.567,1.34)	5.8%	1.90	(.578,2.06)	5.3%	1.36	(.729,2.55)	9.4%	0.78	(.464,1.30)
Wrestling	24.4%	2.91***	(1.75,4.85)	33.7%	2.14***	(1.29,3.53)	15.8%	2.44***	(1.34,4.47)	7.9%	2.02	(.862,4.73)	18.6%	1.53	(.872,2.68)
Other Sport	11.8%	1.07	(.776,1.48)	19.7%	1.14	(.871,1.49)	7.6%	1.15	(.789,1.62)	4.2%	1.00	(.645,1.54)	12.3%	1.12	(.840,1.49)

p<.01**, p<.001***; % = percent (prevalence); AOR = adjusted odds ratio; 95% CI = 95% confidence interval

Note that the reference group for a specific sport (e.g., baseball) are all respondents who indicated not participating in that particular sport (e.g., baseball) during the past year.

All models control for sex, race, exercise frequency, cutting class, average grade in school, time away from home at night, work status, parental education, urbanicity (e.g., does respondent live in a MSA), region (e.g., does respondent live in the Northeast), past 30-day alcohol use, and past 30-day marijuana use. Please refer to Table 1 for more details on these control variables.

Results for E-cigarette use only/with no history of cigarette smoking and E-cigarette use only/with history of cigarette smoking can be provided upon request. Note that only baseball/softball reached statistical significance for E-cigarette use only/with no history of cigarette smoking (AOR = 2.26 95% CI = 1.37,3.71).