Original investigation

Examining the Association Between Physical Activity, Sedentary Behavior and Sport Participation With E-Cigarette Use and Smoking Status in a Large Sample of Canadian Youth

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Abstract

Introduction: Youth e-cigarette use is common worldwide, but the profile of e-cigarette users compared with tobacco users is unclear. This study examines how sport participation and activity levels among youth differ between e-cigarette users and smokers.

Methods: Using Canadian data from 38977 grade 9 to 12 students who participated in Year 3 (2014–15) of the COMPASS study, logistic regression models were used to examine the likelihood of sport participation and activity level based on e-cigarette use and smoking status. Pearson's chi-square tests were used to examine subgroup differences by gender.

Results: E-cigarette users are more likely to participate in intramural, competitive, and team sports compared to non-users. Current and former smokers are less likely to participate in those sports than non-smokers. Youth e-cigarette users are more likely than non-users to meet the physical activity guidelines. Current smokers are more likely than non-smokers to undertake physical activity at least 60 min daily but less likely than non-smokers to tone at least 3 times per week. Youth e-cigarette users are less likely than non-users to be sedentary less than 2 h daily. Gender differences among males and females show that male e-cigarettes users drive the general relationship.

Conclusion: Results suggest that e-cigarette users are more likely to engage in physical activity compared to non e-cigarette users. Youth e-cigarette users are more likely to be physically active while the opposite is true for smokers. Although e-cigarettes may be less harmful to health compared to cigarette smoking, the increased uptake among youth of differing profiles should be considered in prevention efforts.

Implications: These results highlight the importance of addressing e-cigarette use in youth who undertake health promoting behaviors. Prevention efforts should not focus only on youth who may undertake riskier health habits; e-cigarette prevention programs should go beyond the domain of tobacco control.

Introduction

Prevention of initiation into tobacco use by youth has been a priority for public health since the Surgeon General's report on the impact of tobacco use on health.¹ Overall, use of tobacco by youth steadily decreased in Canada and the United States over the past several decades.² Recently however, there is a concern about the renormalization of cigarette smoking due to the use of electronic cigarettes by youth.³⁻⁵ Electronic cigarettes (e-cigarettes) heat a liquid to produce a vapor that is then inhaled by the user. Although the use has proliferated over recent years, the long-term health impact of e-cigarettes is largely unknown.⁶ One of the reasons youth use e-cigarettes is the perception that they are less harmful than conventional cigarettes.^{7,8} High school students perceive e-cigarettes to have negligible health impacts compared to cigarettes.^{9,10} Furthermore, youth perceive e-cigarettes to be less addictive than other conventional tobacco products, including cigarettes, smokeless tobacco, and cigars.¹¹ Youth, smokers or not, may be intrigued by a new technological gadget and by the media portraying it as not harmful to health, and experiment with this new technology.^{10,12,13}

The use of e-cigarettes by youth is becoming more common worldwide. In the United States, from 2011 to 2012 there has been a two-fold increase in the experimentation of use of e-cigarettes by middle and high school students.¹⁴ In Canada, approximately 17% of youth nationally reported having ever tried an e-cigarette.^{15,16} In Ontario and Alberta, about 7.2% of grade 9 to 12 students were considered current e-cigarette users in 2013/2014¹⁷ and 9.75% in 2014/2015.¹⁸ However, although e-cigarettes might aid in smoking cessation among adults,¹⁹ e-cigarette use among youth has been associated with a higher susceptibility to cigarette smoking²⁰ and it is not clear that they are not a gateway to use of cigarettes²¹ or a means of renormalizing tobacco smoking.²²⁻²⁵ Overall, e-cigarette use by youth is a public health concern, and more research to better understand the profile of users and associations is warranted.

With that, if e-cigarettes are thought of as a safer alternative to smoking, it might entice some healthier-minded individuals who would not smoke cigarettes, but are willing to try e-cigarettes. Health promoting behavioral habits like adequate physical activity and a balanced and nutritious dietary intake are important contributors to youth health and development that translate to adult health and well-being. Though physical activity has many well-documented health benefits,¹ research also suggests that it can reduce the likelihood of participating in other risk behaviors that have a detrimental impact on health (eg, smoking).^{26,27} Sport participation has also been shown to act as a buffer for risk behaviors that would impact performance. For instance, research suggests that athletes are less likely to smoke cigarettes, use marijuana, or other illegal drugs compared to their non-athlete counterparts.²⁸⁻³¹ Yet, there is a gap in the evidence pertaining to the relationship between sport participation and activity level and the use of e-cigarettes. Taken together, the research to date has not explored how e-cigarette use is associated with physical activity, sedentary behavior, and sport participation. The purpose of this study is to evaluate the relationship between e-cigarette use and activity level (defined by the Canadian Physical Activity Guidelines and the Canadian Sedentary Behaviour Guidelines³²) and sport participation in a large sample of Canadian youth using data from the COMPASS Study. Although it is not possible to identify causal links between e-cigarette use and activity level and sport participation, exploring these relationships using data from the COMPASS Study will provide important descriptive information which does not currently exist.

The goal of the current study is to examine the likelihood of sport participation and various measures of activity based on e-cigarette use and smoking status, adjusted for the influence of variables known or suggested to moderate the relationship between smoking cigarettes and activity level. Furthermore, understanding how e-cigarette use is associated with physical activity, sedentary behavior, and sport participation will allow for better design of programs and/or policies aimed at e-cigarette control.

Methods

Data

This study uses data from the COMPASS study which is an established school-based system designed to effectively guide and improve youth prevention research and practice.³³ The COMPASS study is an ongoing cohort study (2012–2021) collecting hierarchical and linked longitudinal behavioral and program/policy data from a sample of 50 000+ grade 9 to 12 students and the 89 secondary schools they attended in Ontario [$n = 79$] and Alberta [$n = 10$].³³ While the first wave of data for COMPASS were collected during the 2012/13 school year, measures of e-cigarette use were not added until the Year 2 data collection (2013/14). Building off earlier research examining e-cigarette use and substance use³⁴ this paper looks at data from 87 secondary schools participating in Year 3 of COMPASS (2014/15). A full description of the study methods are available in print³³ or online (www.compass.uwaterloo.ca).

Student-Level Recruitment and Participants

All participating COMPASS schools provided permission to use active-information passive-consent parental permission protocols. In the active-information passive-consent protocol, the parent(s) or guardian(s) of eligible students were mailed an information letter about the COMPASS study and were asked to contact the COMPASS recruitment coordinator using either the toll-free phone number or email address provided in the information letter should they not want their child to participate. All eligible students whose parent(s) or guardian(s) did not contact the COMPASS team to withdraw their child were deemed eligible to participate, though students could decline to participate at any time. In Year 3, data were collected from 42 355 grade 9 to 12 students (78.7% participation rate) in 87 schools. Youth who were at field trips, absent, or had classroom spares on the day and time of the survey resulted in missing data (20.5%) and parental refusal accounted for the remaining missing data (0.8%).

Data Collection Tools

The student-level questionnaire for COMPASS (Cq) collects individual student data pertaining to multiple behavioral domains (eg, marijuana use, eating behavior, tobacco use, physical activity, etc.), correlates of the behaviors, and demographic characteristics. In each school, the Cq was used to collect within-school samples during class time. The Cq items were based on national standards or current national public health guidelines, as described elsewhere.³³

Measures

Sport participation was measured by asking respondents: (1) Do you participate in before-school, noon hour, or after school physical activities organized by your school? (eg, intramurals, non-competitive clubs) [answer: Yes, No, None offered at my school, Not Stated];

(2) Do you participate in competitive school sports teams that compete against other schools? (eg, junior varsity or varsity sports) [answer: Yes, No, None offered at my school, Not Stated]; (3) Do you participate in league or team sports outside of school? [answer: Yes, No, There are none available where I live, Not Stated]. Sport participation was modeled as a dichotomous variable, with “yes” (yes = 1) representing students who participate in the type of sport and “no” otherwise (0 = no).

Using previously validated physical activity measures,^{35,36} the Cq asked students to report: “Mark how many minutes of HARD physical activity you did on each of the last 7 days. This includes physical activity during physical education class, lunch, after school, evenings, and spare time.” Hard physical activities are those that increase your heart rate and make you breath and sweat including but not limited to: jogging, team sports, fast dancing, and jump-rope. The second question asked students to report their moderate physical activity; “Mark how many minutes of MODERATE physical activity you did on each of the last 7 days. This includes physical activity during physical education class, lunch, after school, evenings, and spare time. Do not include time spent doing hard physical activities.” Moderate physical activities are lower intensity activities such as walking, biking to school, and recreational swimming. On how many days in the last 7 days did you do exercises to strengthen or tone your muscles? (eg, push-ups, sit-ups, or weight-training). Since physical activity can fluctuate week-to-week in a given school year, we focus on respondents for whom the past 7 days were a typical week in terms of the physical activity that they usually do. This is assessed using the question from the COMPASS questionnaire: “Were the last 7 days a typical week in terms of the amount of physical activity that you usually do?”. Responses were then coded based on the physical activity recommendations made by the Canadian Society for Exercise Physiology³⁷ which are: (1) An accumulation of at least 60 min per day of moderate to vigorous physical activity involving a variety of aerobic activities; (2) Vigorous physical activities and muscle and bone strengthening activities should each be incorporated at least 3 days per week; (3) Several hours of a variety of structured and unstructured light physical activities; (4) No more than 2 hours per day of recreational screen time; (5) Limited sitting for extended periods. This study uses the derived measures for total combined hard and moderate physical activity (1) and resistance training (2). Respondents were categorized into dichotomous measures with 1 representing student who met the specified activity recommendation(s) (Yes = 1), and no otherwise (No = 0). Sedentary behavior was coded by combining the “number in minutes” that respondents reported for the following behaviors: watching TV, playing video games, doing homework, talking on the phone, surfing internet, testing/messaging, and sleeping. Respondents were coded into two categories based (1) sedentary less than 2 h per day and (2) sedentary 2 h or more daily.

Current use of e-cigarettes, is modeled using the following question: In the last 30 days, did you use any of the following? (Mark all that apply). Options are: pipe tobacco, cigarillos or little cigars, cigars, roll-your-own cigarettes, loose tobacco mixed with marijuana, e-cigarettes, smokeless tobacco, nicotine patches, nicotine gum, nicotine lozenges, or nicotine inhalers, hookah to smoke tobacco, hookah to smoke herbal sheesha/shisha, blunt wraps, have not used any of these things in the last 30 days. Consistent with previous research, respondents who reported using e-cigarettes in the past 30 days were considered current e-cigarette users.¹⁷

Cigarette smoking was assessed by asking respondents, “Have you ever smoked 100 or more whole cigarettes in your life?” and “On how many of the last 30 days did you smoke one or more cigarettes?”. Consistent with previously validated measures of current smoking³⁸ students who reported ever smoking 100 cigarettes and any smoking in the previous 30 days were classified as current smokers, those who ever smoked 100 cigarettes but did not smoke in the past 30 days were classified as former smokers. Students who responded never smoking 100 cigarettes or more were classified as non-smokers.

To control for observable correlates, we included age (14 or younger, 15, 16, 17, 18, or older), gender (female, male), ethnicity (White, Black, Asian, Aboriginal, Latin American/Hispanic, Other/Mixed) and amount of weekly spending money in dollars (zero, 1–20, 21–100, more than 100) in the models as well. These correlates have been found to affect physical activity and e-cigarette use and therefore should help reduce omitted variable bias.

Sample Construction

To create the final study sample, we kept all participants for whom we had full information available on the variables of interest. Data from 3378 respondents were excluded due to missing data for age ($n = 216$), gender ($n = 262$), ethnicity ($n = 197$), inconsistency in response to use of alternate tobacco products ($n = 475$) [Inconsistency in response to the use of alternate tobacco products is a result of youth responding: I have not used any of these things in the last 30 days to the question: In the last 30 days, did you use any of the following? (Mark all that apply), but in fact select a substance that they used], inconsistent response with the past 30 days of use of alternate and cigarettes ($n = 134$), missing data on intramural participation ($n = 492$), competitive sport participation ($n = 125$), league sport participation ($n = 205$), sedentary behavior ($n = 83$), daily physical activity ($n = 788$), typical week of physical activity ($n = 245$), toning ($n = 156$). The final sample size was 38 977 grade 9 to 12 students.

Statistical Analyses

We estimate a multivariable logistic regression model with random effects in order to explore the association between the dependent variables of sport participation, physical activity, and sedentary behavior and the covariates of interest. This kind of model is appropriate in this context because it models the individual (subject-specific) probabilities rather than the overall (population-averaged) probabilities as ordinary logistic regression.³⁹ Regression models estimate the relationship for students for whom the reported activity levels were based on their “typical weekly physical activity”. Furthermore, we adjusted for clustering of students by school since we are using school-level individual data. We examine the general sample and then stratify by gender to explore whether any significant differences exist. Furthermore, we use Pearson’s chi-square test of independence to examine subgroup differences by males and females. To indicate statistical significance, we set the p value to .01 and .05. Stata version 14.2 was used.⁴⁰

Results

Descriptive Statistics

Table 1 describes the final study sample, and the sample stratified by gender. As shown in Table 1, 12.3% of male respondents and 7.0%

Table 1. Descriptive Statistics and Chi-Square Tests of Significance, of the Large Sample of Youth From Year 3 of the COMPASS Study, Full Sample and by Gender

	Full	Female	Male	Chi-square	p value
Age					
14 or younger	21.6 (8404)	21.3 (4159)	21.8 (4245)	1.173	0.279
15	27.2 (10 588)	27.0 (5268)	27.3 (5320)	0.384	0.535
16	24.8 (9661)	25.4 (4954)	24.2 (4707)	8.245*	0.004
17	20.4 (7970)	20.8 (4055)	20.1 (3915)	3.011	0.083
18	6.0 (2354)	5.4 (1057)	6.7 (1297)	26.160**	0.000
Gender					
Female	50.0 (19493)				
Male	50.0 (19484)				
Ethnicity					
White	74.4 (29003)	75.8 (14 784)	73.0 (14 219)	41.999**	0.000
Black	4.2 (1628)	3.3 (647)	5.03 (981)	71.671**	0.000
Asian	5.4 (2107)	5.4 (1059)	5.4 (1048)	0.056	0.814
Aboriginal	3.2 (1261)	3.0 (590)	3.4 (671)	5.416***	0.020
Latin American/Hispanic	2.1 (816)	2.0 (380)	2.2 (436)	3.952***	0.047
Other/Mixed	10.7 (4162)	10.4 (2033)	10.9 (2129)	2.529***	0.112
Spending money					
zero	16.4 (6389)	15.8 (3082)	17.0 (3307)	9.602*	0.002
“1–20”	28.3 (11 044)	28.8 (5612)	27.9 (5432)	3.979***	0.046
21–100	25.9 (10 097)	27.1 (5276)	24.7 (4821)	27.389**	0.000
>100	17.2 (6687)	15.2 (2972)	19.1 (3715)	100.067**	0.000
Don't know not stated	12.2 (4760)	13.1 (2551)	11.3 (2209)	27.811**	0.000
E-cigarette use and smoking status					
E-cigarette user	9.6 (3757)	7.0 (1366)	12.3 (2391)	309.999**	0.000
Non-smoker	93.3 (36 354)	94.7 (18 467)	91.8 (17 887)	133.552**	0.000
Current smoker	5.9 (2290)	4.6 (899)	7.1 (1391)	112.544**	0.000
Former smoker	0.8 (333)	0.7 (127)	1.1 (206)	18.940**	0.000
Dual use of e-cigarettes and cigarettes	2.7 (1052)	1.9 (365)	3.5 (690)	102.331**	0.000
Sport participation					
Participates in intramurals					
Yes	39.6 (10 386)	36.8 (4633)	42.1 (5753)	75.636**	0.000
No	60.4 (15 875)	63.2 (7952)	58.0 (7923)		
Participates in competitive sports					
Yes	44.3 (11 629)	38.8 (4888)	49.3 (6741)	290.122**	0.000
No	55.7 (14 632)	61.2 (7697)	50.7 (6935)		
Participates in team sport					
Yes	51.9 (13 637)	46.3 (5823)	57.2 (7814)	310.059**	0.000
No	48.1 (12 624)	53.7 (6762)	42.8 (5862)		
Physical activity and sedentary behavior					
Sedentary less than 2 h daily	3.9 (1019)	4.3 (535)	3.5 (484)	8.909*	0.003
Sedentary 2 h or more daily	96.1 (25 242)	95.7 (12 050)	96.5 (13 192)		
Physical activity ≥60 min daily	52.1 (13 672)	43.9 (5522)	59.6 (8150)	648.596**	0.000
Physical activity less than 60 min daily	47.9 (12 589)	56.1 (7063)	40.4 (5526)		
Resistance training 3 or more times a week	56.3 (14 792)	51.9 (6533)	60.4 (8259)	191.561**	0.000
Resistance training less than 3 times a week	43.7 (11 469)	48.1 (6052)	39.6 (5417)		

* $p < 0.01$; ** $p < 0.001$; *** $p < 0.05$.

of female respondents reported using e-cigarettes in the past 30 days. 7.1% of male respondents and 4.6% of female respondents were current smokers, whereas 1.1% of male respondents and 0.7% of female respondents were former smokers. 91.8% of male respondents and 94.7% of female respondents were non-smokers.

A larger proportion of males participate in intramurals (42.1%), competitive sports (49.3%) and team sports (57.1%) than females (36.8% intramurals, 38.8% competitive sports, 46.3% team sports). Similarly, more males follow the physical activity recommendations with 59.6% physically active at least 60 min per day and 60.4% tone 3 or more times a week compared to females (43.9% physically active at least 60 min daily and 51.9% tone less than 3 times a

week). In contrast, a larger proportion of females are sedentary less than 2 hours daily (4.3%) compared to males (3.5%).

Predictive Model Results

Full Sample

As shown in Table 2, there is a statistically significant association between sport participation and e-cigarette and smoking status. E-cigarette users are more likely to participate in intramural sports (OR = 1.10) compared to non-e-cigarette users while current smokers (OR = 0.50) and former smokers (OR = 0.44) are less likely than non-smokers to participate in intramural sports. E-cigarette users are more likely than non-users to participate in competitive sports

(OR = 1.26) while current smokers (OR = 0.52) and former smokers (OR = 0.49) are less likely to participate in competitive sports. Finally, youth e-cigarette users are more likely to participate in team sports (OR = 1.30) compared to non-e-cigarette users. In contrast, current smokers (OR = 0.55) and former smokers (OR = 0.45) are less likely than non-smokers to participate in team sports. Youth e-cigarette users are more likely than non-users to undertake physical activity at least 60 min or more daily (OR = 1.29) and to tone at least 3 times per week (OR = 1.30). Current smokers are more likely than non-smokers to undertake physical activity at least 60 min or more daily (OR = 1.24) but less likely than non-smokers to tone at least 3 times per week (OR = 0.81). Finally, youth who are e-cigarette users are less likely than non-users to be sedentary less than 2 h daily. No significant relationship exists for smokers and sedentary behavior.

Males Only

As shown in Table 3, male e-cigarette users are more likely to participate in intramurals (OR = 1.24), competitive sports (OR = 1.49) and team sports (OR = 1.45) compared to male non-e-cigarette users. In contrast, male current smokers are less likely than male

non-smokers to participate in intramurals (OR = 0.55), competitive sports (OR = 0.54) and team sports (OR = 0.59) and male former smokers are less likely than non-smokers to participate in intramurals (OR = 0.52), competitive sports (OR = 0.57), and team sports (OR = 0.48). In contrast, there is no association between e-cigarette use and smoking status with sedentary behavior of males. Male e-cigarette users and smokers are more likely to be physically active at least 60 minutes per day (OR=1.36 and OR=1.19, respectively) compared to non-e-cigarette users and non-smokers. Finally, male e-cigarette users are more likely than non-users to tone at least 3 times a week (OR = 1.38) while current smokers are less likely than non-smokers to tone at least 3 times in the week (OR = 0.83).

Females Only

As shown in Table 4, the association between sport participation and e-cigarette use is not statistically significant for females. However, current smokers and former smokers are less likely than non-smokers to participate in intramurals, competitive sports and team sports. Finally, female e-cigarette users are more sedentary, that is they are less likely to be sedentary less than 2 h daily (OR = 0.43) compared to non-e-cigarette users. E-cigarette users are also more likely to be

Table 2. Regression Results of the Association Between Sport Participation, Physical Activity and Sedentary Behavior and Cigarette Smoking Status and E-Cigarette Use, From a Large Sample of Youth From Year 3 of the COMPASS Study, Full Sample

Outcome	Participates in intramurals	Participates in competitive sports	Participates in team sport	Sedentary <2 h daily	Physical activity ≥60 min daily	Tones ≥3 times a week
	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]
Gender						
Female	1.0	1.0	1.0	1.0	1.0	1.0
Male	1.22 [1.14–1.31]	1.55 [1.45–1.65]	1.59 [1.49–1.70]	0.84 [0.73–0.97]	1.89 [1.79–2.00]	1.42 [1.32–1.52]
Smoking status						
Non-smoker	1.0	1.0	1.0	1.0	1.0	1.0
Current smoker	0.50 [0.44–0.57]	0.52 [0.46–0.59]	0.55 [0.50–0.62]	0.77 [0.53–1.13]	1.24 [1.10–1.40]	0.81 [0.72–0.92]
Former smoker	0.44 [0.32–0.60]	0.49 [0.36–0.67]	0.46 [0.34–0.61]	0.94 [0.44–1.99]	1.10 [0.84–1.44]	0.88 [0.66–1.17]
E-cigarette use status						
Does not use e-cigarettes	1.0	1.0	1.0	1.0	1.0	1.0
Uses e-cigarettes	1.10 [1.01–1.21]	1.26 [1.12–1.41]	1.30 [1.18–1.44]	0.62 [0.47–0.80]	1.29 [1.16–1.43]	1.30 [1.19–1.42]

The dependent variable is the measure of sport participation, physical activity or sedentary behavior, and each model is estimated separately controlling for age, ethnicity and spending money (\$/week). Data are retrieved from Year 3 of the COMPASS Study. OR = odds ratio, CI = confidence interval. The full sample includes all students with full information on all measures within a typical week of physical activity ($n = 26261$). Bold denotes significance at the $p < .01$ level, bold and italic denotes significance at the $p < 0.05$ level.

Table 3. Regression Results of the Association Between Sport Participation, Physical Activity and Sedentary Behavior and Cigarette Smoking Status and E-Cigarette Use, From a Large Sample of Youth from Year 3 of the COMPASS Study, Subsample Males

Outcome	Participates in intramurals	Participates in competitive sports	Participates in team sport	Sedentary <2 h daily	Physical activity ≥60 min daily	Tones ≥3 times a week
	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]
Smoking status						
Non-smoker	1.0	1.0	1.0	1.0	1.0	1.0
Current smoker	0.55 [0.46–0.65]	0.54 [0.47–0.63]	0.59 [0.52–0.67]	0.82 [0.53–1.26]	1.19 [1.01–1.42]	0.83 [0.71–0.97]
Former smoker	0.52 [0.36–0.77]	0.57 [0.40–0.83]	0.48 [0.33–0.71]	1.31 [0.59–2.90]	0.99 [0.73–1.34]	0.92 [0.63–1.33]
E-cigarette use status						
Does not use e-cigarettes	1.0	1.0	1.0	1.0	1.0	1.0
Uses e-cigarettes	1.24 [1.10–1.40]	1.49 [1.30–1.73]	1.45 [1.29–1.63]	0.73 [0.53–0.99]	1.36 [1.18–1.58]	1.38 [1.20–1.58]

The dependent variable is the measure of sport participation, and each model is estimated separately, controlling for age, ethnicity and spending money (\$/week). Data are retrieved from Year 3 of the COMPASS Study. OR = odds ratio, CI = confidence interval. The sample includes all male students with full information on all measures within a typical week of physical activity ($n = 13676$). Bold denotes significance at the $p < .01$ level, Bold and Italic denotes significance at the $p < .05$ level.

Table 4. Regression Results of the Association Between Sport Participation, Physical Activity and Sedentary Behavior and Cigarette Smoking Status and E-Cigarette Use, From a Large Sample of Youth From Year 3 of the COMPASS Study, Subsample Females

Outcome	Participates in intramurals	Participates in competitive sports	Participates in team sport	Sedentary <2 h daily	Physical activity ≥60 min daily	Tones ≥3 times a week
	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]
Smoking status						
Non-smoker	1.0	1.0	1.0	1.0	1.0	1.0
Current smoker	0.40 [0.32–0.50]	0.47 [0.37–0.61]	0.48 [0.37–0.62]	0.72 [0.37–1.42]	1.31 [1.13–1.52]	0.75 [0.62–0.90]
Former smoker	0.26 [0.12–0.58]	0.32 [0.16–0.64]	0.40 [0.22–0.70]	0.35 [0.05–2.51]	1.31 [0.76–2.23]	0.79 [0.50–1.27]
E-cigarette use status						
Does not use e-cigarettes	1.0	1.0	1.0	1.0	1.0	1.0
Uses e-cigarettes	0.86 [0.72–1.02]	0.88 [0.74–1.04]	1.07 [0.91–1.27]	0.43 [0.24–0.79]	1.15 [1.00–1.32]	1.18 [1.03–1.36]

The dependent variable is the measure of sport participation, and each model is estimated separately, controlling for age, ethnicity and spending money (\$/week). Data are retrieved from Year 3 of the COMPASS Study. OR = odds ratio, CI = confidence interval. The sample includes all female students with full information on all measures within a typical week of physical activity ($n = 12\,585$). Bold denotes significance at the $p < .01$ level, Bold and Italic denotes significance at the $p < .05$ level.

physically active at least 60 min per day (OR = 1.15) and to tone at least 3 time per week (OR = 1.18) compared to non-e-cigarette users. Current smokers are more likely to be physically active at least 60 min daily (OR = 1.31) and less likely to tone at least 3 times in the week (OR = 0.75) compared to non-smokers.

Discussion

The results provide evidence that e-cigarette users are more likely to engage in various types of physical activity compared to non e-cigarette users, particularly for males. Youth who use e-cigarettes are more likely to be active while youth who smoke are less likely to be active. This highlights the importance of addressing e-cigarette use in youth who undertake health promoting behaviors, not just youth who may undertake health compromising behaviors (ie, substance use), which to date has been the primary focus of discussion around e-cigarette prevention, especially within the domain of tobacco control. Prevention efforts targeting these youths may well convey the message that the health effects of e-cigarettes are largely unknown. Evidence of the short-term impact of e-cigarette use identifies that the vapor produced and inhaled by e-cigarette users impact lung health and have harmful health effects in the airways of young people.^{41–43} This may in turn affect the physical activity and sport performance of youth who are using e-cigarettes.

Consistent with previous research,³⁴ this study identified that about 10% of this large sample were considered current e-cigarette users compared to 6% being considered current smokers in the 2014–2015 school year. With respect to e-cigarettes, this represents a 35% relative increase in current e-cigarette use compared to results identified one year earlier with the 2013–2014 school year COMPASS data.⁴⁴ Even though e-cigarette aerosol may contain fewer toxicants than cigarette smoke, studies evaluating whether e-cigarettes are less harmful than cigarettes are inconclusive.^{45–47} Nevertheless, e-cigarettes are not harmless⁴⁸ and with increased uptake among youth, prevention efforts should consider the differing profile of e-cigarettes users accordingly. The results of this study provide evidence of the apparent differing profile of e-cigarette users and cigarette smokers and their sport participation and activity level. On the one hand, e-cigarette users are more likely than non-users to participate in intramural, competitive, and team sports

while current smokers and former smokers are less likely than non-smokers to participate in these same sports. This study sheds light on the importance of engaging e-cigarette prevention efforts outside of the traditional avenues used for tobacco control. This would result in efforts reaching other youth who use e-cigarette products. These results provide preliminary evidence that it may be important to target e-cigarette prevention messaging to youth sport clubs at school or in the community.

Participation in sports and physical activity decreases with age and previous evidence suggests a lower prevalence of e-cigarette use among older smokers,^{49–51} this is important insight for program planners as it may be important to target prevention efforts to younger youth populations. While it is challenging to disentangle the causal relationship between substance use and physical activity, using the longitudinal COMPASS data for further study may enable us explore the relationship between e-cigarette use, tobacco use and physical activity over time. Gender differences are robust and males are more likely than females to participate in sports and physical activity. Males are not as likely to be sedentary compared to females. Yet, male e-cigarette users appear to drive the association between e-cigarette use and sport participation suggesting that male e-cigarettes users may perceive e-cigarettes to have a low health impact and may be an at-risk population for public health stakeholders to consider.

This study contributes evidence about the association between youth e-cigarette use and sport participation and physical activity and new analysis of the profile of e-cigarette users and non-users and cigarette smokers, former cigarette smokers and non-smokers. It appears from the results that youth who are more active are more likely to use e-cigarettes compared to those who are not. The current study is not without its limitations. It uses a cross section of data to interpret the association of the use of e-cigarettes and cigarette smoking with participation in team, competitive and intramural sports, physical activity and sedentary behavior. While it provides important insights into these relationships, for which there is no research, further studies should use longitudinal data in order to model co-occurrence and onset patterns over time. Using COMPASS data longitudinally, this study provides support for examination of a temporal/causal link between e-cigarette use and activity level and sport participation. Similarly, future studies would benefit from more detailed information related to type and quantity of e-cigarettes used.

Furthermore, inherent in observational survey data is the drawback of self-reported data which may introduce some recall bias. While we recognize the drawback, we are not concerned that our data are not reflective of the current youth population. Having said that, future research might aim to collect direct measured data to study the relationship between e-cigarette use, smoking status and physical activity. Overall, there are fruitful avenues for further research into this important topic.

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Declaration of Interests

None declared.

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