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Research Paper

Sociodemographic, personal, peer, and familial predictors of e-cigarette ever use in ESPAD Ireland: A forward stepwise logistic regression model

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ABSTRACT

INTRODUCTION E-cigarette ever use has risen significantly in recent years in Ireland, similar to trends elsewhere in Europe, the United States, and Asia-Pacific region. Results from ESPAD Ireland (European School Survey Project on Alcohol and other Drugs) show teenage e-cigarette ever use increased from 18% (2015) to 37% (2019). Given this increase, our aim is to profile e-cigarette ever users and never users in this age group; to examine sociodemographic, personal, peer, and familial factors associated with e-cigarette ever use; and to suggest appropriate measures to reduce use.

METHODS A nationally representative stratified random sample of 50 ESPAD schools was surveyed in 2019, with 3495 students aged 15–17 years. Bivariate and multivariable logistic regression analyses were performed using Stata version 16.

RESULTS E-cigarette ever use was significantly associated with ever smoking (AOR=4.15; 95% CI: 1.29–13.41), ever cannabis use (AOR=2.21; 95% CI: 1.11–4.41) and ever inhalants use (AOR=2.51; 95% CI: 1.07–5.88). Children of university-educated mothers had significantly higher odds of e-cigarette ever use (AOR=3.46; 95% CI: 1.40–8.54). Associated with reduced AORs were reading books for enjoyment (AOR=0.32; 95% CI: 0.16–0.64), living in households where smoking was regulated (AOR=0.53; 95% CI: 0.30–0.94), and perceiving moderate risk in trying e-cigarettes once or twice (AOR=0.20; 95% CI: 0.07–0.67).

CONCLUSIONS E-cigarette ever use is part of a pattern of teenage polysubstance use including cigarette smoking, providing some support for the common liability theory. Regulation of smoking in the home, reading for enjoyment, and perceiving risk from e-cigarette use are associated with decreased likelihood of ever use, and higher parental education with increased likelihood. Thus, health education emphasizing the role of parents and risks of e-cigarette use is indicated to reduce the rise in e-cigarette ever use in teenagers.

INTRODUCTION

E-cigarette use among teenagers in Ireland has risen significantly in recent years and findings from ESPAD Ireland (European School Survey Project on Alcohol and Other Drugs) show that in 2019 in Ireland, among children born in 2003, e-cigarette ever use prevalence was 37%[1]. Increasing prevalence of ever use of e-cigarettes in Ireland reflects similar trends elsewhere in Europe[2], the United States (US)[3,4] and the Asia-Pacific region[5]. In Ireland, current use (30-day) of e-cigarettes among adolescents has also increased significantly from 10% in 2015 to 18% in 2019[6] and has been linked to significantly increased smoking prevalence among teenage boys[7].

The 2019 ESPAD survey[2] of 99647 students from 35 countries in Europe reported an average of 40%

ever use of e-cigarettes among students aged 16 years, ranging from 18% in Serbia to 65% in Lithuania. The United Kingdom did not participate in ESPAD in 2019 but prevalence of ever use of e-cigarettes among Scottish 15-year-olds was reported at 35% in 2018, with boys more likely than girls to have ever used e-cigarettes[8]. Increasing prevalence is not reported everywhere, however. In England, reported prevalence for ever use of e-cigarettes among school pupils aged 11–15 years was 25% in 2018, the same as in 2016[9]. E-cigarettes are now the most commonly used tobacco product among young people in the US[10].

A narrative review[11] of e-cigarette prevalence in Europe among adults and young people found that ever use ranged from 5.5% to 56.6%. Current smokers of conventional cigarettes showed the highest prevalence for e-cigarette ever use with 20.4% to 83.1%, followed by ex-smokers with 7% to 15%. In European countries, there is a higher prevalence of e-cigarette use among males, adolescents and young adults, smokers of conventional cigarettes, and former smokers.

There are concerns that the growing popularity of e-cigarettes promotes tobacco experimentation, particularly among younger children[12]. A Welsh study of primary schoolchildren found that children as young as 7 years have general awareness of e-cigarettes. They perceived vaping to be healthier than smoking, had some recognition that e-cigarettes were used for smoking cessation but showed limited understanding of any health harms[12].

The longitudinal analysis of Tokle[13] found 'a systematic pattern in which adolescents account for vaping as a time-limited trend'. Within this Norwegian sample, over a four-year period, e-cigarettes were devalued from novelty and transgression to childish and uninteresting, leading to the conclusion that e-cigarettes represented fashionable experimentation rather than steady user patterns. Among adolescent cigarette experimenters, using e-cigarettes has been found to be positively and independently associated with progression to current established smoking, suggesting that e-cigarettes 'do not divert from, and may encourage, cigarette smoking in this population'[14].

In Ireland, ESPAD 2019 findings show that, among children born in 2003 who ever used e-cigarettes, 67% have never smoked cigarettes[1], representing

a worrying new trend of initiation into nicotine addiction. From 1995 to 2015, smoking prevalence has been decreasing in Ireland, markedly so, among Irish teenagers[15]. Now, however, for the first time in 25 years this decrease has stalled, with prevalence rates (30-day use) among people aged 15–17 years in 2019 remaining the same (14.4%) as they were in 2015, accounted by an increase in smoking prevalence among boys (16.2%), and a decrease among girls (12.8%)[1]. This halt in smoking prevalence reduction has been accompanied by a rising prevalence of e-cigarette use, particularly among boys, pointing to a possible link[6,7].

The association between cigarette and e-cigarette use in teenagers is established but the mechanisms are uncertain. The longest-standing theory is the Gateway Theory[16] which concerns the centrality of nicotine addiction in the progression to other drugs, but it is insufficient to explain fully the progression to cigarettes from e-cigarettes. The Common Liability Theory[17] allows for wider inputs from environmental and genetic influences giving rise to the use of various tobacco products and psychoactive substances[16-20], while the Catalyst Model[18] helps consider the factors influencing initiation and progression, which could possibly extend to a diversion model preventing progression to smoking[19]. Although marketed as a smoking cessation tool, e-cigarettes are rarely used for this purpose in youth[21]. Among adolescents in Ireland, the main motivation for using e-cigarettes was curiosity (66%) and because friends offered (29%), while only 3.4% said that their motivation for beginning to use e-cigarettes was for smoking cessation[1].

E-cigarette ever use has increased among people aged 15–17 years in Ireland from 18% to 37% between 2015 and 2019[1,22]. Our aim in this study is to profile e-cigarette ever users and never users in this age group; to examine associations with e-cigarette use; and to suggest appropriate measures to reduce use. In our model, we include sociodemographic, personal, peer, and familial associations which are available in the ESPAD dataset and known to be associated with teenage substance use.

METHODS
Design, sample, data collection
The ESPAD survey is the largest quadrennial cross-

national project on adolescent substance use in the world, having the overall aim of repeatedly collecting comparable data on substance use among young people in some 35 European countries (www.espad. org). In the 2019 Ireland (Republic) arm of the ESPAD survey, a total of 3565 students aged 15, 16 and 17 years from a nationally representative, stratified random sample of 50 schools were surveyed. Data were collected between March and May 2019 and full accounts of the sampling, data collection and cleaning procedures have been reported elsewhere[2]. Following data cleaning, the final sample comprised 3495 students.

Dependent variable
Prevalence of e-cigarette ever use was measured by the question: 'Have you ever used e-cigarettes?', No; Yes, more than 12 months ago; Yes, in the last 12 months; and Yes, in the last 30 days; recoded as ever use, no versus yes.

Independent variables
Sociodemographic, personal, peer and familial characteristics are shown in detail with full question and answer categories in the Supplementary file and we summarize them here.

Sociodemographic variables included age, sex, parental education level, perceived family wealth, and household composition. Variables measuring personal risk behaviors as well as potentially protective behaviors were: use of cigarettes, alcohol, cannabis (including problem cannabis use (CAST [Cannabis Abuse Screening Test], a 6-item, 5-point scale, Cronbach's alpha 0.83), inhalants, tranquilizers (with prescription); age of smoking and alcohol initiation; problems with social media use (3-item, 5-point Likert scale, Cronbach's alpha 0.67), internet use (14-item, 5-point Likert scale, Cronbach's alpha 0.92), online gaming (12-item, 5-point Likert scale, Cronbach's alpha 0.95), and gambling; missing school due to truancy; reading books other than school books, actively participating in sport, having other hobbies, and average school grade. Variables measuring peer risk activities were: how many of their friends smoke, drink alcohol, get drunk, use cannabis, tranquilizers/ sedatives, ecstasy, and inhalants. The variable 'peer support' measured friends' help, support, sharing and communication (4-item, 7-point Likert scale,

Cronbach's alpha 0.94). Familial variables measured familial support (a 4-item, 7-point Likert scale, Cronbach's alpha 0.92), relationship with parents, and household rules about smoking (smoking regulation).

Statistical analysis
Pearson's χ^2 test (for categorical variables) and Student's t-test (for continuous variables) were conducted to compare differences in e-cigarette use between ever users and never users in relation to the independent variables above (Table 1). All variables in the study were adjusted by the dependent variable (e-cigarette ever use) using Spearman's correlation coefficient and variance inflation factor (VIF) as appropriate between variables, and a VIF <5 was used to detect multicollinearity. A univariate logistic regression analysis was then performed to assess the association of e-cigarette ever use with the sociodemographic, personal, peer and familial characteristics of respondents. The results are presented in Table 2 as crude odds ratios (ORs) and their respective 95% confidence intervals (95% CIs). This was followed by a stepwise logistic regression analysis to assess predictors of e-cigarette ever use after entering all the variables in the model, and only variables with a p<0.7 were retained in the final model (Table 2). Adjusted odds ratios (AORs) and their 95% confidence intervals were estimated and associations with a p<0.05 were considered statistically significant. All analyses were performed using Stata version 16.

RESULTS
Characteristics of e-cigarette ever users, bivariate analyses
A total of 3495 students were included in the analysis. Sample characteristics of e-cigarette ever use among people aged 15–17 years are shown in Table 1. Overall, 36.6% (n=1278) of students in the sample had ever used e-cigarettes. Girls were more likely than boys to be never users (65.6%, n=1200). In these bivariate analyses, there were significant differences between e-cigarette ever users and never users according to: sex, parental education level, household composition, absenteeism, ever and current smoking, skipping school; ever, current, and binge alcohol use; ever, current, cannabis use and problem cannabis use; ever use of tranquilizers with or without prescription; perceived risks of smoking e-cigarettes; and familial

Table 1. Sample characteristics of e-cigarette ever users and never users aged 15–17 years (N=3495)

Characteristics	Total n (%)	E-cigarette never users n (%)	E-cigarette ever users n (%)	p*
Total	3495 (100)	2209 (63.4)	1278 (36.6)	
Sex				**0.004**
Female	1835 (52.5)	1200 (65.6)	630 (34.4)	
Male	1660 (47.5)	1009 (60.9)	648 (39.1)	
Age (years)				0.263
15	796 (22.8)	523 (65.7)	272 (34.2)	
16	1949 (55.7)	1219 (62.7)	724 (37.3)	
17	750 (21.5)	467 (62.3)	282 (37.7)	
Father's education level				**0.012**
Some secondary school or completed primary school	723 (24.4)	423 (58.5)	300 (41.5)	
Completed secondary school	608 (20.6)	379 (62.3)	229 (37.7)	
College or university	1628 (55.0)	1057 (64.9)	571 (35.1)	
Mother's education level				**<0.001**
Some secondary school or completed primary school	364 (11.8)	245 (67.3)	119 (32.7)	
Completed secondary school	681 (22.0)	494 (72.5)	187 (27.5)	
College or university	2046 (66.2)	1236 (60.4)	810 (39.6)	
Perceived wealth				0.217
About the same	1473 (44.0)	951 (64.6)	522 (35.4)	
Much better off	523 (15.6)	322 (61.6)	201 (38.4)	
Better off	1032 (30.8)	664 (64.3)	368 (35.7)	
Less well off	321 (9.6)	190 (59.2)	131 (40.8)	
Household composition				0.499
Two parents	2602 (78.4)	1661 (63.8)	941 (36.2)	
One parent	524 (15.8)	321 (61.3)	203 (38.7)	
Blended families	195 (5.9)	121 (62.0)	74 (38.0)	
Average grade				0.148
A and B	1511 (45.7)	990 (65.5)	521 (34.5)	
C	1389 (42.0)	862 (62.2)	524 (37.8)	
D or lower	407 (12.3)	254 (62.4)	153 (37.6)	
Read books				**<0.001**
No	2636 (76.9)	1560 (59.2)	1076 (40.8)	
Yes	794 (23.1)	613 (77.2)	181 (22.8)	
Actively participate in sports				0.906
No	551 (15.9)	350 (63.5)	201 (36.5)	
Yes	2904 (84.1)	1837 (63.3)	1067 (36.7)	
Other hobbies[a]				**<0.001**
No	1484 (44.5)	889 (59.9)	595 (40.1)	
Yes	1854 (55.5)	1229 (66.3)	625 (33.71)	
Age of alcohol initiation (years)				**<0.001**
<13	844 (35.8)	333 (39.5)	511 (60.5)	
≥14	1514 (64.2)	870 (57.5)	644 (42.5)	

Table 1. Continued

Characteristics	Total n (%)	E-cigarette never users n (%)	E-cigarette ever users n (%)	p*
Age of smoking initiation (years)				0.001
<13	374 (33.7)	62 (16.6)	312 (83.4)	
≥14	736 (66.3)	185 (25.1)	551 (74.9)	
Drank to get high				<0.001
No	2873 (83.5)	2036 (70.9)	837 (29.1)	
Yes	568 (16.5)	155 (27.3)	413 (72.7)	
Problems with social media use, mean ± SD	2.77 ± 1.06	2.83 ± 1.07	2.68 ±1.03	<0.001
Problems with internet use, mean ± SD	2.57 ± 0.88	2.53 ± 0.86	2.65 ± 0.89	0.001
Problems with online gaming, mean ± SD	1.57 ± 0.78	1.56 ± 0.76	1.58 ± 0.81	0.547
Need to bet more money				<0.001
No	3120 (92.3)	2013 (64.5)	1107 (35.5)	
Yes	261 (7.7)	137 (52.5)	124 (47.5)	
Lied gambling frequency				<0.001
No	3290 (97.5)	2107 (64.0)	1183 (36.0)	
Yes	83 (2.5)	36 (43.4)	47 (56.6)	
Skipping school (days)				<0.001
0	2319 (79.4)	1580 (68.1)	739 (31.9)	
1–4	503 (17.2)	236 (46.9)	267 (53.1)	
≥5	99 (3.4)	33 (33.3)	66 (66.7)	
Absent due to illness (days)				<0.001
0	1524 (47.8)	1041 (68.3)	483 (31.7)	
1–4	1422 (44.6)	850 (59.8)	572 (40.2)	
≥5	241 (7.6)	141 (58.5)	100 (41.5)	
Perceived risk in trying e-cigarettes once or twice				<0.001
No	1559 (45.3)	723 (46.4)	836 (53.6)	
Slight	1263 (36.7)	946 (74.9)	317 (25.1)	
Moderate	299 (8.7)	250 (83.6)	49 (16.4)	
Great	149 (4.3)	117 (78.5)	32 (21.5)	
Don't know	117 (5.0)	143 (83.1)	29 (16.9)	
Ever smoked cigarettes				<0.001
Never	2398 (68.8)	1980 (82.7)	415 (17.3)	
Ever	1084 (31.2)	225 (20.8)	859 (79.2)	
Current smoking status				<0.001
Yes	3001 (86.2)	2147 (71.5)	854 (28.5)	
No	480 (13.8)	62 (12.9)	418 (87.1)	
Ever alcohol use				<0.001
Never	891 (26.5)	822 (92.3)	69 (7.7)	
Ever	2478 (73.5)	1339 (54.0)	1139 (46.0)	
Current alcohol use				<0.001
No	2018 (59.3)	1606 (79.6)	412 (20.4)	
Yes	1388 (40.7)	569 (41.0)	819 (59.0)	

Continued

Table 1. Continued

Characteristics	Total n (%)	E-cigarette never users n (%)	E-cigarette ever users n (%)	p*
Current binge drinking				<0.001
Never	2326 (67.1)	1797 (77.3)	529 (22.7)	
Ever	1142 (32.9)	405 (35.5)	737 (64.5)	
Ever cannabis use				<0.001
Never	2824 (81.6)	2066 (73.2)	758(26.8)	
Ever	635 (18.4)	135 (21.3)	500 (78.7)	
Current cannabis use				<0.001
No	3135 (91.3)	2152 (68.6)	983 (31.4)	
Yes	300 (8.7)	44 (14.7)	256 (85.3)	
Cannabis problem use, mean ± SD	1.09 ± 0.36	1.01 ± 0.16	1.24 ± 0.01	<0.001
Ever use of tranquilizers with prescription				<0.001
Never	3110 (89.93)	2039 (65.6)	1071 (34.4)	
Ever	349 (10.1)	155 (44.1)	194 (55.6)	
Ever use of inhalants				<0.001
Never	3106 (89.7)	2070 (66.6)	1036 (33.3)	
Ever	357 (10.3)	131 (36.7)	226 (63.3)	
Peer risk activities				
Smoke cigarettes	2309 (69.3)	1462 (63.3)	847 (36.7)	0.627
Drink alcoholic beverages	2924 (87.8)	1085 (63.5)	1068 (36.5)	0.724
Get drunk	2727 (82.2)	1728 (63.4)	999 (36.6)	0.630
Smoke cannabis	1634 (49.2)	1035 (63.3)	599 (36.7)	0.901
Take tranquilizers/sedatives	427 (12.9)	274 (64.2)	153 (35.8)	0.767
Take ecstasy	558 (16.8)	350 (62.7)	208 (37.3)	0.672
Take inhalants	515 (15.5)	320 (62.1)	195 (37.9)	0.483
Familial regulation				0.590
Know always	2154 (64.0)	1368 (63.5)	786 (36.6)	
Know quite often	794 (23.6)	514 (64.7)	280 (35.3)	
Know sometimes	302 (9.0)	188 (62.2)	114 (37.7)	
Usually don't know	116 (3.5)	68 (58.6)	48 (41.4)	
Familial support, mean ± SD	5.41 ± 1.69	5.40 ± 1.70	5.41 ± 1.68	0.865
Peer support, mean ± SD	5.40 ± 1.65	5.42 ± 1.64	5.36 ± 1.66	0.310
Relationship with mother				0.361
Very satisfied	1749 (52.8)	1119 (64.0)	630 (36.0)	
Satisfied	1132 (34.2)	726 (64.1)	406 (5.9)	
Not satisfied	433 (13.1)	262 (60.5)	171 (39.5)	
Relationship with father				0.318
Very satisfied	1402 (43.9)	884 (63.1)	518 (36.9)	
Satisfied	1085 (34.0)	708 (65.2)	377 (34.8)	
Not satisfied	707 (22.1)	438 (61.9)	269 (38.0)	
Smoking regulation				0.384
Nowhere	1706 (58.6)	1077 (63.1)	629 (36.9)	
Somewhere	1131 (38.8)	728 (64.4)	403 (35.6)	
Anywhere	74 (2.5)	42 (56.8)	32 (43.2)	

Table 1. Continued

Characteristics	Total n (%)	E-cigarette never users n (%)	E-cigarette ever users n (%)	p*
Relationship with mother				0.361
Very satisfied	1749 (52.8)	1119 (64.0)	630 (36.0)	
Satisfied	1132 (34.2)	726 (64.1)	406 (5.9)	
Not satisfied	433 (13.1)	262 (60.5)	171 (39.5)	
Relationship with father				0.318
Very satisfied	1402 (43.9)	884 (63.1)	518 (36.9)	
Satisfied	1085 (34.0)	708 (65.2)	377 (34.8)	
Not satisfied	707 (22.1)	438 (61.9)	269 (38.0)	

*Statistical significance at p<0.05. a Other hobbies (play an instrument, sing, draw, write).

regulation (p<0.05). E-cigarette ever use was higher than cigarette ever use. More than a third (36.6%) of the sample were e-cigarette ever users compared with 31.2% who were ever smokers and 17.3% (n=415) of those who had never tried combustible cigarettes were e-cigarette ever users. Bivariate analyses, shown in Table 2, indicate that respondents' other risk behaviors – cigarette, alcohol, cannabis, and inhalant use – have the strongest associations with e-cigarette ever use.

Multivariable analysis of e-cigarette ever use

As with the bivariate analyses, multivariable analysis (Table 2) also shows that a respondent's other risk behaviors have the strongest associations with e-cigarette ever use. Those who had ever tried cigarettes had an AOR of 4.15 (95% CI: 1.29–13.41, p<0.05) for e-cigarette ever use while those who had ever used cannabis had an AOR of 2.21 (95% CI: 1.11–4.41, p<0.05), and those who had ever used inhalants had an AOR of 2.51 (95% CI: 1.07–5.88, p<0.05).

Compared with respondents whose parents were less well-educated, respondents with mothers who had college or university education had significantly higher odds of e-cigarette ever use (AOR=3.46; 95% CI: 1.40–8.54, p<0.05). A small number of variables had significantly lower adjusted odds ratios for e-cigarette ever use, including reading books (excluding schoolbooks) for enjoyment (AOR=0.32; 95% CI: 0.16–0.64, p<0.05), living in a household where some rules or restrictions pertained in relation to smoking cigarettes in the house (AOR=0.53; 95% CI: 0.30–0.94, p<0.05), and perceiving moderate (AOR=0.20; 95% CI: 0.07–0.67, p<0.05) risk in using e-cigarettes even once or twice. Current alcohol use was also negatively associated with e-cigarette ever use (AOR=0.44; 95% CI: 0.20–0.96, p<0.05).

Table 2. Bivariate and multivariable (stepwise) logistic regression of e-cigarette ever use among people aged 15–17 years (N=3495)

Covariates	OR (95% CI)*	AOR (95% CI)*
Age (years)		
15 (Ref.)	1	1
16	1.14 (0.96–1.35)	0.79 (0.34–1.85)
17	1.16 (0.94–1.43)	0.43 (0.117–1.08)
Father's education level		
Some secondary school or completed primary school (Ref.)	1	1
Completed secondary school	0.85 (0.68–1.06)	2.10 (0.97–4.55)
College or university	**0.76 (0.64–0.91)**	–

Continued

Table 2. Continued

Covariates	OR (95% CI)*	AOR (95% CI)*
Mother's education level		
Some secondary school or completed primary school (Ref.)	1	1
Completed secondary school	0.78 (0.59–1.03)	**3.46 (1.40–8.54)**
College or university	1.35 (1.06–1.71)	-
Perceived wealth		
About the same (Ref.)	1	1
Much better off	1.14 (0.92–1.40)	0.48 (0.59–1.47)
Better off	1.01 (0.86–1.19)	0.49 (0.24–1.02)
Less well off	1.26 (0.98–1.61)	-
Household composition		
Two parents (Ref.)	1	1
One parent	1.12 (0.92–1.35)	1.34 (0.34–5.32)
Blended families	1.07 (0.80–1.46)	0.72 (0.17–3.11)
Average grade		
A and B (Ref.)	1	1
C	1.15 (0.99–1.34)	1.19 (0.66–2.16)
D or lower	1.14 (0.91–1.44)	1.40 (0.53–3.74)
Read books, no vs yes	**0.43 (0.36–0.51)**	**0.32 (0.16–0.64)**
Actively participate in sports, no vs yes	1.01 (0.84–1.22)	1.17 (0.57–2.41)
Other hobbies, no vs yes	**0.76 (0.66–0.87)**	1.38 (0.77–2.46)
Age of smoking initiation (years)		
<13 (Ref.)	1	1
≥14	**3.49 (3.03–4.02)**	0.70 (0.36–1.35)
Skipping school (days)		
0 (Ref.)	1	1
1–4	**2.42 (1.99–2.94)**	1.19 (0.62–2.89)
≥5	**4.27 (2.79–6.55)**	0.57 (0.17–1.83)
Absent due to illness (days)		
0 (Ref.)	1	1
1–4	**1.45 (1.25–1.69)**	1.17 (0.66–2.07)
≥5	**1.53 (1.16–2.02)**	**0.23 (0.09–0.61)**
Perceived risk in trying e-cigarettes once or twice		
No (Ref.)	1	1
Slight	**0.29 (0.25–0.34)**	0.86 (0.46–1.58)
Moderate	**0.17 (1.22–0.23)**	**0.20 (0.07–0.67)**
Great	**0.24 (0.16–0.35)**	0.42 (0.07–2.56)
Don't know	**0.17 (0.12–0.26)**	-
Ever use of cigarettes, never vs ever	**18.21 (15.2–21.83)**	**4.15 (1.29–13.41)**
Current cigarette use, no vs yes	**16.90 (12.83–22.39)**	1.64 (0.85–3.16)
Ever alcohol use, never vs ever	**10.13 (7.83–13.11)**	2.38 (0.31–18.52)
Current alcohol use, no vs yes	**5.61 (4.82–6.53)**	**0.44 (0.20–0.96)**
Current binge drinking, no vs yes	**6.18 (5.29–7.22)**	1.80 (0.91–3.55)
Cannabis ever use, no vs yes	**10.09 (8.20–12.42)**	**2.21 (1.11–4.41)**

Table 2. Continued

Covariates	OR (95% CI)*	AOR (95% CI)*
Cannabis problem use	**16.79 (10.75–26.23)**	2.78 (0.97–7.99)
Ever use of inhalants, never vs ever	**3.45 (2.74– 4.33)**	**2.51 (1.07–5.88)**
Peer risk activities, no vs yes		
Get drunk	1.05 (0.87–1.26)	1.32 (0.61–2.86)
Smoke cannabis	1.01 (0.88–1.16)	1.80 (0.93–3.47)
Take tranquilizers/sedatives	0.97 (0.78–1.20)	0.45 (0.15–1.35)
Take inhalants	1.07 (0.88–1.30)	1.54 (0.52–4.62)
Familial regulation		
Know always (Ref.)	1	1
Know quite often	0.95 (0.80–1.12)	0.52 (0.26–1.04)
Know sometimes	1.05 (0.82–1.35)	1.68 (0.45–6.22)
Usually don't know	1.23 (0.84–1.80)	-
Peer support	0.98 (0.94–1.02)	1.06 (0.88–1.27)
Relationship with mother		
Very satisfied (Ref.)	1	1
Satisfied	0.99 (0.85–1.16)	1.45 (0.66–3.16)
Not satisfied	1.16 (0.93–1.44)	1.87 (0.63–5.52)
Relationship with father		
Very satisfied (Ref.)	1	1
Satisfied	0.91 (0.77–1.07)	-
Not satisfied	1.05 (0.87–1.26)	0.50 (0.20–1.22)
Smoking regulation		
Nowhere (Ref.)	1	1
Somewhere	0.94 (0.81–1.11)	**0.53 (0.30–0.94)**
Anywhere	1.30 (0.81–2.09)	0.54 (0.05–7.04)

AOR: adjusted odds ratio. *Bold indicates statistical significance at p<0.05.

DISCUSSION

Sociodemographic influences: social class, sex, and household composition

To date, findings about e-cigarette use and social class have been ambivalent. Recent Irish research found that, in a sample in which smoking was patterned by social class, e-cigarette ever use was not[23]. This study found that perceived relative wealth was not statistically significantly associated with e-cigarette ever use but that parental education level was. This suggests some differences in teenagers' views and motivations regarding e-cigarettes compared with cigarettes. The association between smoking and lower socioeconomic status is well-established, but the association with other substances is more ambivalent. For example, young adults with the highest family background SES have been found to be most prone to alcohol and marijuana use, even after adjusting for covariates[24]. They have also been found to be more likely to use other drugs, and to use alcohol and other substances to cope with stress[25]. Our findings about increased e-cigarette ever use among people aged 15–17 years with higher-educated mothers (AOR=3.46; 95% CI: 1.40–8.54) may indicate that e-cigarette ever use has more in common with alcohol and other drug use than it has with smoking or that more-educated parents have different attitudes to e-cigarettes than less-educated parents.

Other familial behaviors and supports were also implicated in adolescent e-cigarette ever use. Even after adjusting for covariates, living in a household where some rules or restrictions were in place

regarding whether or where people could smoke in the house lowered the odds of people aged 15–17 years e-cigarette ever use (AOR=0.53; 95% CI: 0.30–0.94)

Parental anti-smoking communication and encouragement reduces teenage smoking[26]. Our findings extend the role of parental influence, including having no-smoking rules in the home, from cigarette smoking to e-cigarette ever use, suggesting an encouraging role for parents in reducing nicotine consumption in teenagers.

Personal behaviors

Polysubstance use is highly prevalent among adolescents who use e-cigarettes[27]. E-cigarette ever use was strongly associated with ever use of tobacco, cannabis, and inhalants, and the association was especially strong for cigarette smoking. Risk-taking, indicated by experimenting with many substances, may be implicated in e-cigarette ever use and these findings provide some support for the common liability theory[17]. We agree[28] that e-cigarette screening should include the assessment of other substances, especially cigarettes, alcohol, and cannabis, with a view to identifying and implementing prevention efforts and improving population health.

When we adjusted for covariates in our regression model, reading books for enjoyment remained protective against e-cigarette ever use (AOR=0.32; 95% CI: 0.36–0.51). Perceiving moderate risk in using e-cigarettes is indicated as protective against e-cigarette ever use (AOR=0.20; 95% CI: 0.07–0.67), suggesting a role for health education in providing clear, focused, up-to-date information for adolescents about the risks of e-cigarette ever use. Efforts should be stepped up in the junior cycle of post-primary schooling to develop health education curricula that are appropriate in terms of content, pedagogy, resources and evaluation[29].

Peer influences

Studies have shown that adolescents are more likely to engage in risky behaviors in the presence of peers[30,31]. In our model, we tested correlations between all peer substance use [use of tobacco, alcohol (including getting drunk), cannabis, tranquilizers/sedatives, ecstasy, inhalants] and e-cigarette ever use and increased odds ratios were noted but data were not sufficiently sensitive to detect differences.

Experimentation, continuation, and cessation

E-cigarette ever use is largely associated with teenagers' other substance use. Experimentation is widely recognized as a feature of adolescence and others have drawn 'a positive, linear relation between substance use and psychopathology, such that the more frequently children and adolescents use illegal substances, the greater their risk for exhibiting internalizing or externalizing psychiatric disorders'[32], suggesting that complete abstinence among children and adolescence is seen as a desirable outcome. At a minimum, an increased proportion of those who ever use e-cigarettes experimentally will go on to become addicted users of nicotine[33], or possibly dual users of e-cigarettes and combustible tobacco[34,35]. Marijuana use has also been found to increase at a faster rate among e-cigarette users when compared to their peers who used cigarettes or a combination of cigarettes and e-cigarettes (dual users)[36]. Unlike tobacco, e-cigarettes in Ireland are currently largely unregulated. The findings suggest a role for health education highlighting the important link in e-cigarette ever use with peer and personal polysubstance use.

Limitations

The study captures the associations of ever use of e-cigarettes at a point in time of school-going people aged 15–17 years in Ireland. It cannot tell us about the small percentage of students who do not attend school in Ireland at that age and may be different. ESPAD questionnaires are completed by students in a school setting therefore self-reporting bias is a consideration. Social desirability bias is a further consideration given the sensitive nature of the behavior under study – teenage substance use. Also, e-cigarette use is changing rapidly so advice on regulation and control needs regular up-dating. The use of the stepwise regression method produces confidence intervals around the parameter estimates that are too narrow and p-values that are too low due to multiple comparisons. Longitudinal and qualitative studies are certainly needed to improve our understanding and predictions for the future, but these exploratory analyses give us valuable insights in the present situation.

CONCLUSIONS

E-cigarette ever users are more likely to be male and to have higher-educated mothers. While sex and

parental education level are associated with e-cigarette ever use, our multivariable analyses show that these influences wane in comparison with teenagers' personal risk behaviors, particularly in terms of their polysubstance use, but cigarette use is the most strongly associated with e-cigarette ever use with odds greater than 4 times. Our findings emphasize the importance and usefulness of regulation of cigarette smoking in the home in preventing ever use of e-cigarettes. The perception of risk of e-cigarette use is also shown to be associated with ever use and this also may be influenced by e-cigarette regulation in the home. Education at school about e-cigarette use is largely absent or inadequate in many European countries, including Ireland, and needs strengthening[29]. Parents are important modifiers of adolescents' nicotine use and we recommend that school-based education be extended to include interventions aimed at parents. Parental attitudes on the dangers of teenagers' e-cigarette ever use are not well-known and need further study.

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