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E-cigarettes and smoking in Irish teens: a logistic regression analysis of current (past 30-day) use of e-cigarettes

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E-cigarettes and smoking in Irish teens: a logistic regression analysis of current (past 30-day) use of e-cigarettes

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Abstract

Aim Electronic cigarette (e-cigarette) use among Irish teenagers has risen significantly. In 2019, prevalence of current use (last 30 days) among 15–17-year-olds was 17.3%. We examine social determinants of adolescent e-cigarette current use.

Subject and methods A stratified random sample of 50 schools in Ireland was surveyed in 2019, part of the European School Survey Project on Alcohol and other Drugs (ESPAD), with 3495 students aged 15, 16, and 17. Bivariate and multivariable logistic regression [providing adjusted odds ratios (AORs)] analyses were performed using Stata version 16.

Results Current e-cigarette users were more likely to be male (AOR = 0.55, 95% CI:0.32–0.96, $p < .01$), younger (AOR = 0.34, 95% CI: 0.17–0.67, $p = < .05$), to participate in sport (AOR = 2.21, 95% CI: 1.05–4.65, $p < .05$), to have higher-educated parents (maternal higher education: AOR = 27.54, 95% CI: 1.50–505.77, $p = < .05$, paternal higher education: AOR = 2.44, 95% CI: 1.00–5.91, $p < .05$), and less likely to consider their families better off (AOR = 0.29, 95% CI: 0.13–0.65, $p < .01$), or to report familial support (AOR = 0.78, 95% CI: 0.64–0.95, $p < .05$). They were more likely to be cigarette smokers (AOR = 7.22, 95% CI: 3.97–13.12, $p < .001$), to report problem cannabis use (AOR = 3.12, 95% CI: 1.40–6.93, $p < .01$), to be 'binge' drinkers (AOR = 1.81, 95% CI : 1.00–3.32, $p = .054$), and to have friends who get drunk (AOR = 5.30, 95% CI: 1.34–20.86, $p < .05$).

Conclusion Boys, smokers, binge drinkers, problem cannabis users, and sport-playing teenagers from higher-educated families, are at particular risk. As the number of young people using e-cigarettes continues to rise, including teenagers who have never smoked, improved regulation of e-cigarettes, similar to other tobacco-related products, is needed urgently to prevent this worrying new trend of initiation into nicotine addiction.

Keywords E-cigarettes · Smoking · Gender · Teenagers · Social determinates · Tobacco control

Background

E-cigarette use among young people in Ireland has risen significantly in recent years, and among 15–17-year-olds, prevalence is now 37% for ever-use and 17.3% for current use (Sunday et al. 2020). The increase has been particularly steep since 2016 (Hanafin et al. 2021). Among young people who use e-cigarettes, 67% of them have never smoked combustible cigarettes (Sunday et al. 2020), representing a worrying new trend of initiation into nicotine addiction. Increasing prevalence in Ireland reflects similarly high rates elsewhere in Europe (ESPAD Group 2020; Kapan et al. 2020), the US

(Evans-Polce et al. 2020; Gentzke et al. 2019) and the Asia-Pacific region (Wills et al. 2017). The 2019 European School Project on Alcohol and Drugs (ESPAD) survey (ESPAD Group 2020) of 99,647 students from 35 countries in Europe reported an average of 40% *ever-use* of e-cigarettes among students aged 15–16 years, ranging from 18% in Serbia to 65% in Lithuania. Average *current use* (during the last 30 days) was 14%, which is lower than in Ireland, with a range of 5.4% (Serbia) to 41% (Monaco). Prevalence of regular use in Scotland (once a week or more) was 3% (Scottish Government 2019). Increasing prevalence is not reported everywhere, however. In England between 2016 and 2018 there was no increase, with reported prevalence for current and regular e-cigarette prevalence remaining at 6% and 2% respectively (National Statistics, 2019).

Modern e-cigarettes were commercially developed in 2003 as an alternate nicotine delivery device for tobacco smokers (Bozier et al. 2020). E-cigarettes entered the US marketplace

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around 2007, and since 2014, they have been the most commonly used tobacco product among US youth, having risen to epidemic proportions (U.S. Surgeon General 2018). Between 2017 and 2018, e-cigarette *current use* among high school students increased 77.8% from 11.7% to 20.8% (Gentzke et al. 2019). The more recent evolution of "pod-mod" e-cigarettes such as JUUL introduced in 2015 is associated with an increase in e-cigarette use by youth and young adults in the US (Huang et al. 2018). In European countries, there is a higher prevalence of e-cigarette use among males, adolescents, and young adults, smokers of conventional combustible cigarettes, and former smokers (Kapan et al. 2020).

While it is generally accepted that e-cigarette 'vapour' (i.e., the cloud of aerosol/mist/fog released by an e-cigarette) contains fewer toxicants than tobacco smoke, it still contains numerous toxicants, including nicotine (in the majority of e-liquids), the humectants propylene glycol and glycerine, flavour additives, and the presence of metal contaminants (Bozier et al. 2020). Reports from the Office of the Surgeon General (US Surgeon General 2018; U.S. Department of Health and Human Services 2014, 2016) drew attention to the effects of nicotine exposure during adolescence in terms of its impact on learning, memory, and attention, as well as increased risk for future addiction to other drugs. Adolescents, however, are often uninformed about the constituents of e-cigarettes, both in the US (Fadus et al. 2019) and in Europe (Kinnunen et al. 2020). Pulmonary risks of e-cigarette use have also emerged, including the condition electronic-cigarette/vaping associated lung injury (EVALI) as well as extrapulmonary cardiovascular, immunologic, and neuro-developmental effects (Overbeek et al. 2020).

Recurring themes in debates about e-cigarettes include lack of consensus among the tobacco control community about harm reduction, effects on tobacco control, and whether or not (or the extent to which) e-cigarettes act as a gateway drug, particularly for young people (Grana and Ling 2014). The first UK study to assess whether younger (aged 13–14 years at baseline) adolescent e-cigarette use was associated prospectively (at 12 months) with initiation or escalation of cigarette use found that ever-use of e-cigarettes was robustly associated with initiation but more modestly related to escalation of cigarette use (Conner et al. 2018; McCarthy et al. 2020). Young never-smokers in Scotland who had tried an e-cigarette were more likely to try a cigarette during the following year than those who had not (Best et al. 2018).

Since 1995, smoking prevalence has been decreasing in Ireland, markedly so among young people, with a 66% decline in 16–17-year-olds between 1995 and 2015 (Li et al. 2018). Now, for the first time in 25 years this decrease has stalled, with prevalence rates (30-day use) of smoking among young people in 2019 remaining the same (14.4%) as they were in 2015, accounted for by a notable increase in smoking prevalence among boys (16.2%), and a slight decrease among girls (12.8%) (Sunday et al. 2020). This halt in smoking prevalence reduction despite continued strong tobacco control measures has been accompanied by a rising prevalence of e-cigarette use, pointing to a possible link. Although marketed as a smoking cessation tool, e-cigarettes are rarely used for this purpose in youth (Fadus et al. 2019; Hanafin and Clancy 2020). 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 was for smoking cessation (Sunday et al. 2020). Given the stark increase in e-cigarette experimentation and continued use among 15–17-year-olds in Ireland, we set out to establish a profile of young e-cigarette users. We examine socio-demographic, individual, peer, and familial associations with e-cigarette current use among 15–17-year-olds in Ireland.

Methods

Design, sample, data collection

A total of 3565 students aged 15, 16, and 17 years old were surveyed in 2019 for the Irish arm of ESPAD, the largest cross-national project on adolescent substance use in the world, with the overall aim of repeatedly collecting comparable data on substance use among young people (www.espad.org). ESPAD takes place concurrently every 4 years in some 35 European countries, and is based on a common set of questions and methodology (the full questionnaire is in Supplemental File I). Students were surveyed in a stratified random sample of schools ($n =$ 50) in Ireland, based on geographic region and stratified according to school type (secondary, vocational, community/comprehensive), religious affiliation (Roman Catholic, Church of Ireland, inter-denominational), gender (all-boys, all-girls, mixed), and school-level disadvantage status (DEIS vs non-DEIS). Data were collected between March and May 2019, and completed surveys were entered manually into SPSS v22 exactly as they appeared in the survey. Data entry was cross-checked via double entry for 20% of surveys. Full accounts of the data cleaning procedure have been reported elsewhere (ESPAD Report 2019). The total valid sample was 3495.

Measures

The outcome variable, prevalence of e-cigarette *current use* was measured by the question: 'How often have you smoked e-cigarettes during the last 30 days?' — not at all; less than once per week; at least once a week; and almost every day; recoded as 'current use' no vs yes.

Independent variables (socio-demographic, individual, peer and familial characteristics) are shown in detail in

Table 1 Study variables

Variable	Categories
Age	Year/month of birth
Gender	Male, female
Father's education	Primary school or less, some secondary, completed secondary, some college/university, completed university, N/A
Mother's education	Primary school or less, some secondary, completed secondary, some college/university, completed university, N/A
Perceived wealth	Very much better off, much better off, about the same, less well off, much less well off, very much less well off
Household composition	I live alone, father, stepfather, mother, stepmother, brother(s), sister(s), grandparent(s), others
Average grade	Mostly A's/B's, mostly C's, mostly D's, mostly E's or lower
Read books	Never, a few times a year, once or twice a month, at least once a week, almost every day
Actively participate in sports	
Other hobbies	
Age of alcohol initiation	Never, 9 years or less, 10, 11, 12, 13, 14, 15, 16 years or older
Age of smoking initiation	Never, 9 years or less, 10, 11, 12, 13, 14, 15, 16 years or older
Drank to get high	Number of occasions (lifetime): 0, 1–2, 3–5, 6–9, 10–19, 20–39, 40 or more
Problems with social media use	A 3-item, 5-point scale on social media use Cronbach's alpha:0.67
Problems with internet use	A 14-item, 5-point scale including difficulty stopping, losing sleep, being told by others to stop Cronbach's alpha-0.92
Problems with online gaming	A 12-item ,5-point scale including difficulty stopping, neglecting other activities, loosing tract of time when gaming Cronbach's alpha- 0.95
Problems with gambling	Need to bet more and more money, lying to people important to you about how much gambled
Skipping school	None, 1 day, 2 days, 3–4 days, 5–6 days, 7 or more days
Absent due to illness	None, 1 day, 2 days, 3–4 days, 5–6 days, 7 or more days
Perceived risk of trying e-cigarettes once or twice	No risk, slight, moderate, great, don't know
Ever smoked cigarettes	Number of occasions (lifetime): 1–2, 3–5, 6–9, 10–19, 20–39, 40 or more
Current smoking status	Frequency (last 30 days): Not at all, less than 1 cigarette per week, less than 1 cigarette per day, 6–10 cigarettes per day, 11–20 cigarettes per day, More than 20 cigarettes per day
Ever alcohol use	Number of occasions (lifetime): 0, 1–2, 3–5, 6–9, 10–19, 20–39, 40 or more
Current alcohol use	Number of occasions (last 30 days): 0, 1–2, 3–5, 6–9, 10–19, 20–39, 40 or more
Current binge drinking	None, 1, 2, 3–5, 6–9, 10 or more times (last 30 days)
Ever cannabis use	Number of occasions (lifetime): 0, 1–2, 3–5, 6–9, 10–19, 20–39, 40 or more
Current cannabis use	Number of occasions (last 30 days): 0, 1–2, 3–5, 6–9, 10–19, 20–39, 40 or more
Cannabis problem use	A 6-item, 5-point scale on cannabis dependence and cannabis-related problems Cronbach's alpha:0.83
Ever use of tranquilizers with prescription	No, never, yes, but less than 3 weeks, yes, for 3 weeks or more (lifetime)
Ever use of inhalants	0, 1–2, 3 or more times (lifetime)
Peer risk activities	Peer cigarette use, alcohol use, getting drunk, cannabis use, tranquillisers or sedatives, ecstasy use, inhalant use
Familial support	A 4-item, 7-point scale including families' willingness to support and talk about problems Cronbach's alpha:0.92
Peer Support	A 4-item, 7-point scale on peer support Cronbach's alpha:0.94
Familial regulation	Parent(s) know where student is on Saturday nights: know always, know quite often, know sometimes, usually don't know
Relationship with father and mother	Very satisfied, satisfied, neither nor, not so satisfied, not at all satisfied, there is no such person

Table 1. Socio-demographic variables included age, gender, parental education completed, perceived family wealth, and household composition. Individual behaviours which included polysubstance use as well as potentially protective behaviours were: use of combustible cigarettes, alcohol, cannabis — including problem cannabis use [Cannabis Abuse Screening Test (CAST) (Bastiani et al. 2017)] (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 illness or 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 combustible cigarettes, drink alcoholic beverages, get drunk, smoke cannabis, take tranquilizers/sedatives, take ecstasy, and use 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), familial regulation and relationship with parents.

Statistical analysis

Descriptive statistics were used to calculate prevalence of current use of e-cigarettes reported by young people aged 15,16, and 17 years old. Pearson's X^2 test (for categorical variables) and Student's t test (for continuous variables) were conducted to compare e-cigarette use among current users, with differences being analysed in relation to sociodemographic behavioural factors including (other) substance use, absenteeism, peer risk activities, and familial regulation and support (characteristics of the sample, Table 1). To assess potential multicollinearity, all variables in the study were adjusted by the dependent variable (e-cigarette ever- and current 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 forward stepwise logistic regression analysis was used to assess potential correlates of e-cigarette use, and only variables with a p value of less than 0.7 were retained in the final model and are presented in Table 3. Adjusted odds ratios (AOR) and their 95% confidence intervals were estimated, and associations with a p value of < .05 were considered statistically significant. All analyses were performed using Stata version 16.

Results

Characteristics of e-cigarette current users

A total of 3495 students were included in this survey. Sample characteristics of e-cigarette use among 15–17-year-olds are shown in Table 2. 17.3% ($n = 604$) were current users. Compared with boys, girls were less likely to be current users (54%, $n = 1558$ vs 46%, $n = 1326$, $p < .001$). Current e-cigarette users and non-users differed according to gender, parental education, household composition, absenteeism, ever- and current smoking, absence from school due to illness and skipping school, ever-, current, and binge alcohol use, ever- and current cannabis use, and problem cannabis use, ever-use of tranquilizers with or without prescription, perceived risks of using e-cigarettes, peer risk activities, and familial regulation (all $p < .05$). E-cigarette use is higher than cigarette current use (17.3% vs 13.8%); 44.9% ($n = 270$) of e-cigarette current users are not current smokers, while 95% ($n = 2732$, $p < .001$) of those who are not current e-cigarette users are not current smokers either.

E-cigarette current use: multivariable analysis

Stepwise logistic regression analyses were carried out to identify significant associations with e-cigarette current use and to determine the effects of socio-demographic, individual, peer, and familial variables. Adjusted ORs (AOR) were computed. Multivariable logistic regression analysis (Table 3) indicates that compared with boys, girls were significantly less likely to be e-cigarette current users (AOR = 0.55, 95% CI: 0.32–0.96, $p < .01$). Older students were less likely to be current e-cigarette users (AOR = 0.34, 95% CI: 0.17–0.67, $p = < .05$), as were those who perceived that their families were better off than other families (AOR = 0.29, 95% CI: 0.13–0.65, $p < .01$). Respondents whose parents had college or university education (reference group: completed primary or some secondary education) had significantly higher odds of reporting e-cigarette current use. This was the case for maternal higher education (AOR = 27.54, 95% CI: 1.50–505.77, $p = < .05$) and paternal higher education (AOR = 2.44, 95%CI: 1.00–5.91, $p < .05$). Household composition was not significantly associated with current use.

With regard to individual behaviours, the strongest associations with e-cigarette current use were with current smoking (AOR = 7.22, 95% CI: 3.97–13.12, $p < .001$), problem cannabis use (AOR = 3.12, 95% CI: 1.40–6.93, $p < .01$), and heavy episodic ('binge') drinking (AOR = 1.81, 95% CI: 1.00–3.32, $p = .054$). Current use of e–cigarettes was not significantly associated with ever polysubstance use. Older initiation of smoking was associated with lower odds of current e-cigarette use (AOR = 0.50, 95% CI: 0.26–0.93, $p < .05$). Perceiving a great risk in trying e-cigarettes once or twice

Table 2 Sample characteristics of current e-cigarette users and non-users aged 15, 16, and 17 years

Demographic variable	Total N=3488	Not current e-cigarette users N=2884 (82.7%)	Current e-cigarette users N=604 (17.3%)	P value
Gender				
Female	1828 (52.4)	1558 (54.0)	270 (44.7)	
Male	1660 (47.6)	1326 (46.0)	334 (55.3)	< .001*
Age				
15	795 (22.8)	667 (23.1)	128 (21.2)	
16	1943 (55.7)	1592 (52.2)	321 (58.1)	
17	750 (21.5)	656 (21.7)	125 (20.7)	.406
Father's education				
Some secondary school or completed primary school	723 (24.4)	580 (23.7)	143 (8.0)	
Completed secondary school	609 (20.6)	495 (20.2)	609 (20.6)	
College or university	1629 (55.0)	1375 (56.1)	1629 (55.0)	.026*
Mother's education				
Some secondary school or completed primary school	364 (11.8)	306 (11.9)	58 (11.1)	
Completed secondary school	682 (22.1)	602 (23.4)	80 (15.4)	
College or university	2047 (66.2)	1665 (64.7)	382 (73.5)	< .001*
Perceived wealth				
About the same	1474 (44.1)	1233 (44.4)	241 (42.3)	
Much better off	523 (15.6)	425 (15.3)	98 (17.2)	
Better off	1033 (30.9)	865 (31.1)	168 (29.5)	
Less well off	319 (9.5)	256 (9.2)	63 (11.0)	.300
Household composition				
Two parents	2602 (78.4)	2176 (79.1)	426 (74.9)	
One parent	524 (15.8)	419 (15.2)	105 (18.4)	
Blended families	195 (5.9)	157 (5.7)	38 (6.7)	.085
Average grade				
A's and B's	1509 (45.7)	1267 (46.3)	242 (42.9)	
C's	1386 (42.0)	1134 (41.4)	252 (44.7)	.309
D's or lower	408 (12.3)	338 (12.3)	70 (12.4)	
Read books				
No	2637 (76.9)	2113 (74.4)	524 (88.5)	
Yes	794 (23.1)	726 (25.6)	68 (11.5)	< .001*
Actively participate in sports				
No	549 (15.9)	439 (15.3)	110 (18.5)	
Yes	2907 (84.1)	2421 (84.7)	486 (81.5)	.059
Other hobbies*				
No	1484 (44.4)	1188 (42.9)		
Yes	1855 (55.6)	1581 (57.1)	15.597	< .001*
Age of alcohol initiation				
Below 13 years	841 (35.7)	561 (31.3)	280 (49.6)	
14+ years	1517 (64.3)	1233 (68.7)	284 (50.4)	< .001*
Age of smoking initiation				
Below 13 years	374 (33.7)	178 (28.1)	196 (41.2)	
14+ years	735 (66.3)	455 (71.9)	280 (58.8)	< .001*
Drank to get high				
No	2876 (83.6)	2538 (89.0)	338 (57.4)	
Yes	566 (16.4)	315 (11.0)	251 (42.6)	< .001*
Problems with social media use	2.78±1.06	2.79±1.06	2.70±1.07	.059
Problems with internet use	2.57±0.87	2.55±0.87	2.66±0.92	.008*

Table 2 (continued)

Demographic variable	Total $N = 3488$	Not current e-cigarette users $N = 2884$ (82.7%)	Current e-cigarette users $N = 604$ (17.3%)	P value
Problems with online gaming	1.57±0.78	1.57±0.77	1.57±0.81	.878
Need to bet more money				
No	3121 (92.3)	2604 (92.9)	517 (89.4)	
Yes	260 (7.7)	199 (7.1)	61 (10.6)	< .001*
Skipping school				
None	2320 (79.4)	2006 (83.1)	314 (61.6)	
1–4 days	504 (17.2)	350 (14.5)	154 (30.2)	
5+ days	99 (3.4)	57 (2.4)	42 (8.2)	< .001*
Absent due to illness				
None	1527 (47.9)	1322 (49.9)	205 (37.8)	
1–4 days	1421 (44.6)	1135 (42.9)	286 (52.8)	
5+ days	241 (7.6)	190 (7.2)	51 (9.4)	< .001*
Perceived risk in trying e-cigarettes once or twice				
No risk	1561 (45.3)	1147 (40.3)	414 (69.4)	
Slight risk	1264 (36.7)	1136 (39.9)	128 (21.4)	
Moderate risk	298 (8.7)	277 (9.7)	21 (3.5)	
Great risk	148 (4.3)	130 (4.6)	18 (3.0)	
Do not know	172 (5.0)	156 (5.5)	16 (2.7)	< .001*
Lied gambling frequency				
No	3290 (97.5)	2731 (97.8)	559 (96.5)	
Yes	83 (2.5)	63 (2.2)	20 (3.5)	< .001*
Ever smoked cigarettes				
Ever	1083 (31.1)	611 (21.2)	472 (78.5)	
Never	2397 (68.9)	2268 (78.8)	129 (21.5)	< .001*
Current smoking status				
Yes	480 (13.8)	149 (5.2)	331 (55.1)	
No	3002 (86.2)	2732 (94.8)	270 (44.9)	< .001*
Ever alcohol use				
Ever	892 (26.5)	868 (30.9)	24 (4.2)	
Never	2478 (73.5)	1937 (69.1)	541 (95.8)	< .001*
Current alcohol use				
Yes	2020 (59.3)	1900 (67.3)	120 (20.5)	
No	1387 (40.7)	923 (32.7)	464 (79.5)	< .001*
Current binge drinking				
Yes	2327 (67.1)	2143 (74.6)	184 (30.8)	
No	1142 (32.9)	729 (25.40	413 (69.2)	< .001*
Ever cannabis use				
Ever	2828 (81.7)	2559 (89.2)	269 (45.5)	
Never	632 (18.3)	310 (10.8)	322 (54.5)	< .001*
Current cannabis use				
Yes	3137 (91.3)	2752 (96.4)	385 (66.1)	
No	299 (8.7)	102 (3.6)	197 (33.8)	< .001*
Cannabis problem use	1.09±0.36	1.04±0.24	1.38±0.64	< .001*
Ever use of tranquilizers with prescription				
Ever	3111 (89.9)	2623 (91.7)	488 (81.3)	
Never	349 (10.1)	237 (8.3)	112 (18.7)	< .001*
Ever use of inhalants				
Ever	356 (10.3)	2646 (92.2)	462 (77.7)	

Table 2 (continued)

Demographic variable	Total $N = 3488$	Not current e-cigarette users $N = 2884$ (82.7%)	Current e-cigarette users $N = 604$ (17.3%)	P value
Never	3108 (89.7)	223 (7.8)	133 (22.4)	< .001*
Peer risk activities				
Smoke cigarettes	2309 (69.3)	1887 (68.0)	422 (75.2)	.001*
Drink alcoholic beverages	2924 (87.8)	2408 (86.9)	516 (92.0)	.001*
Get drunk	2727 (82.1)	2237 (81.0)	490 (87.5)	< .001*
Smoke cannabis	1634 (49.2)	1313 (47.5)	321 (57.1)	< .001*
Take tranquilizers/sedatives	429 (12.9)	331 (12.0)	98 (17.6)	< .001*
Take ecstasy	558 (16.8)	444 (16.0)	114 (20.4)	.011*
Take inhalants	515 (15.5)	408 (14.7)	107 (19.1)	.009*
Familial regulation				
Know always	2150 (63.9)	1833 (65.6)	317 (55.5)	
Know quite often	796 (23.7)	634 (22.7)	162 (8.4)	
Know sometimes	303 (9.0)	236 (8.5)	67 (11.7)	
Usually do not know	116 (3.5)	91 (3.3)	25 (4.4)	< .001*
Familial support	5.41±1.69	5.41±1.68	5.38±1.72	.755
Peer support	5.40±1.65	5.41±1.64	5.34±1.70	.365
Relationship with mother				
Very satisfied	1749 (52.8)	1438 (52.4)	311 (54.7)	
Satisfied	1131 (34.1)	946 (34.5)	185 (32.5)	
Not satisfied	433 (13.1)	360 (13.1)	73 (12.8)	.602
Relationship with father				
Very satisfied	1401 (43.9)	1151 (43.5)	250 (45.6)	
Satisfied	1085 (34.0)	904 (34.2)	181 (33.0)	
Not satisfied	707 (22.1)	590 (22.3)	117 (21.4)	.663
Smoking regulation				
Nowhere	1704 (58.9)	1424 (59.0)	280 (56.2)	
Somewhere	1133 (38.9)	936 (38.8)	197 (39.6)	
Anywhere	74 (2.5)	53 (2.2)	21 (4.2)	.027*

* indicates significance

increased the odds by over 10 (AOR = 10.52, 95% CI: 1.25–87.98, $p < .05$) but perceiving a slight or moderate risk did not have a significant effect. However, the majority of current users (69.4%, $n = 414$) perceived no risk and only 3% ($n = 18$) of current users perceived a great risk. Actively participating in sports was associated with higher odds of current e-cigarette use (AOR = 2.21, 95% CI:1.05–4.65, $p < .05$). Academic attainment was not statistically associated.

In terms of peer risk activities, having peers who 'get drunk' was significantly positively associated with e-cigarette current use (AOR = 5.30, 95% CI:1.34–20.86, $p < .05$) whereas familial support was significantly negatively associated with current use (AOR = 0.78, 95% CI: 0.64–0.95, $p < .05$). Neither peer support nor satisfaction with parental relationships was associated with current e-cigarette use.

Discussion

Main findings

E-cigarette use among young people in Ireland has risen dramatically and now stands at 37% *ever-use* and 17.3% *current use* (used in last 30 days). Initially, this rise occurred in tandem with a continuing trend of decreasing smoking prevalence, but latest figures for smoking in Ireland show that this decline in smoking has halted overall and, among boys, smoking has risen from 13% in 2015 (Taylor et al. 2016) to 16% in 2019 (Sunday et al. 2020). Boys are also more likely than girls to use e-cigarettes. Smoking combustible cigarettes and using e-cigarettes are risk activities that are closely aligned. Respondents in our survey who smoked were much more likely to use e-cigarettes. The apparent reversal in

Table 3 Multivariable mixed effects logistic regression of current e-cigarette use, adjusted odds ratios (AOR)

Covariates	AOR*	95% CI for AOR	P value
Age			
15 (reference)			
16	0.34	(0.17, 0.67)	.002*
Gender			
Male (reference)			
Female	0.55	(0.32, 0.96)	.035*
Father's education			
Some secondary school or completed primary school (reference)			
Completed secondary school	1.20	(0.50, 2.86)	.683
College or university	2.44	(1.00, 5.91)	.048*
Mother's education			
Some secondary school or completed primary school (reference)			
Completed secondary school	14.74	(0.79, 274.06)	.071
College or university	27.54	(1.50, 505.77)	.026*
Perceived wealth			
About the same (reference)			
Much better off	0.50	(0.18, 1.43)	.199
Better off	0.29	(0.13, 0.65)	.003*
Less well off	0.60	(0.19, 1.81)	.362
Average grade			
A's and B's (reference)			
C's	1.34	(0.76, 2.36)	.317
Read books: No vs Yes	0.51	(0.24, 1.08)	.078
Actively participate in sports: No vs Yes	2.21	(1.05, 4.65)	.036*
Age of alcohol initiation			
Below 13 years			
14+ years	1.63	(0.89, 2.97)	.113
Age of smoking initiation			
Below 13 years (reference)			
14+ years	0.50	(0.26, 0.93)	.029*
Problems with internet use	0.78	(0.56, 1.09)	.151
Problems with online gaming	1.31	(0.79, 1.62)	.503
Absent due to illness			
None (reference)			
1–4 days	1.42	(0.79, 2.56)	.240
5+ days	0.66	(0.25, 1.75)	.404
Perceived risk in trying e-cigarettes once or twice			
No risk (reference)			
Slight risk	0.54	(0.27, 1.05)	.071
Moderate risk	0.32	(0.08, 1.30)	.111
Great risk	10.52	(1.25, 87.98)	.030*
Do not know	0.66	(0.08, 5.16)	.688
Ever use of cigarettes: Never vs Ever	1.79	(0.35, 9.17)	.482
Current cigarette use: No vs Yes	7.22	(3.97, 13.12)	< .001*
Ever alcohol use: Never vs Ever	4.39	(0.19, 98.57)	.351
Current binge drinking: No vs Yes	1.81	(1.00, 3.32)	.054
Current cannabis use: No vs Yes	1.21	(0.51, 2.84)	.688
Cannabis problem use	3.12	(1.40, 6.93)	.005*
Ever use of tranquilizers with prescription: Never vs ever	1.55	(0.69, 3.48)	.282

Table 3 (continued)

Covariates	AOR*	95% CI for AOR	*P* value
Ever use of inhalants: Never vs Ever	1.73	(0.85, 3.50)	.129
Peer risk activities: No vs Yes			
Smoke cigarettes	0.84	(0.39, 1.80)	.652
Drink alcoholic beverages	0.28	0.06, 1.26)	.098
Get drunk	5.30	(1.34, 20.86)	.017*
Smoke cannabis	1.22	(0.61, 2.43)	.575
Take tranquilizers/sedatives	0.56	(0.18, 1.73)	.312
Take ecstasy	1.79	(0.61, 5,23)	.287
Familial support	0.78	(0.64, 0.95)	.015*
Peer support	1.14	(0.94, 1.38)	.172
Relationship with mother			
Very satisfied (reference)			
Satisfied	0.48	(0.22, 1.05)	.066
Not satisfied	0.45	(0.15, 1.39)	.165
Relationship with father			
Very satisfied (reference)			
Satisfied	1.92	(0.85, 4.32)	.115
Not satisfied	0.76	(0.31, 1.85)	.544

* indicates significance

smoking prevalence, together with the great increase in prevalence of e-cigarette use, has implications for tobacco control policies, including, in particular, health education, regulation, and cessation services for young people (Hanafin and Clancy 2019).

Socio-demographic influences: age, gender, social class, and household composition

E-cigarette use, like smoking, is a gendered activity. Boys are now more likely to be at risk of both smoking and of e-cigarette use, and gender remains a predictor when covariates have been adjusted for. Smoking is well-established as a classed activity, but findings about e-cigarettes and social class have been ambivalent (Kapan et al. 2020). Recent Irish research found that, in a sample in which smoking was patterned by social class, e-cigarette use (*ever-* or *current*) was not (Költő et al. 2020). The prevailing consensus in the sociology of health is that higher socioeconomic status (SES) lowers illness risk (Martin 2019). Therefore, better-off families and having higher-educated parents might be expected to be protective variables but, as with other studies (Kapan et al. 2020), our findings about social class and e-cigarette use are inconsistent. When covariates were adjusted for, perceiving that one's family was better off considerably reduced the odds of current e-cigarette use but having parents who were college/university educated increased the odds. This suggests some differences in young people's views and motivations

with regard to e-cigarettes compared with combustible cigarettes, as the association between smoking and lower socioeconomic status is well-established. The association between SES and use of other addictive substances is also 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 controlling for covariates (Patrick et al. 2012). They are also more likely to use other drugs, and to use alcohol and other substances to cope with stress (Martin 2019). Our findings may indicate that e-cigarette use has more in common with alcohol and other drug use than it has with smoking. Familial support was negatively associated with current use (AOR = 0.78, 95% CI: 0.64–0.95, *p* = .015) suggesting that, as familial support increases, the odds of being an e-cigarette current user decrease.

Individual behaviours

Polysubstance use is highly prevalent among adolescents who use e-cigarettes (Gilbert et al. 2020) and, in our study, the strongest associations with e-cigarette use were found to be with other substance use. Current use of e-cigarettes was strongly associated with current smoking and current cannabis problem use, and to a lesser extent, current heavy episodic ('binge') drinking.

Our initial descriptive analyses suggested that particular individual behaviours were associated with either lower e-cigarette use (being active in sports, reading books for

enjoyment, having hobbies such as art and music) or more e-cigarette use (truancy, early tobacco or alcohol initiation (aged 13 years or younger), using alcohol to get high, problem or compulsive internet/social media/gambling behaviours). When we adjusted for covariates, most of the individual behaviour variables were not significantly associated, but early smoking initiation remained associated with e-cigarette current use. Actively participating in sport showed a 2.2 increased odds of e-cigarette current use pointing again to differences in how adolescents view e-cigarettes compared with combustible cigarettes, perhaps considering them a "healthier" substance.

Peer influences

Adolescents are more likely to engage in risky behaviors in the presence of peers (Gardner and Steinberg 2005; Chein et al. 2011). In our study, we report very strong correlations between all peer substance use and e-cigarette current use. However, we observe that once covariates are adjusted for, peer risk activities are largely not predictive of e-cigarette current use, with the single exception of having peers who "get drunk".

Dependency

E-cigarette users in our survey were more likely to be current users of combustible cigarettes, to have increased odds of problem cannabis use and 'binge' drinking, perhaps indicating problems with substance dependency and they may, therefore, have difficulty quitting e-cigarettes (Wills et al. 2017).

We agree with others (Gilbert et al. 2020) that e-cigarette screening should include the assessment of other substances, with a view to identifying and implementing prevention efforts and improving population health.

Regulation of tobacco products

Smoking prevalence in Irish teens and adults declined significantly during the period 1995 to 2015, and Ireland's very progressive tobacco control policies and legislation have been shown to account for a great deal of this decline (Li et al. 2018, 2020). A study estimating the impact of individual policies implemented between 1995 and 2015 on reduction of smoking prevalence in teenagers in Ireland (Li et al. 2020) examined seven tobacco control interventions: price, Smokefree legislation, health warning on packages, advertising ban, availability of cessation treatment, youth access, and mass media campaigns. For both male and female adolescents, real price increases and legislation banning smoking in workplaces were significantly associated with reductions in smoking.

Implications for regulation of e-cigarettes

Lack of full knowledge of the harms of e-cigarettes and also their potential role in smoking cessation in adults causes hesitancy in introducing regulations. Messaging might need to be more nuanced in terms of smoking cessation in adults, where e-cigarettes may have a role.

Further regulation of e-cigarettes is urgently required in Ireland in order to reduce e-cigarette use among young people and prevent the re-normalisation of tobacco products use in Irish society. The extension of existing regulation and legislation would be an expeditious approach, and there is a convincing argument for a re-framing of the paradigm about e-cigarettes. Re-framed as new tobacco products, they lend themselves to being regulated as are combustible cigarettes. Existing harm-reduction arguments in relation to e-cigarettes only have currency in relation to adult users, but they probably have none in relation to children. Indeed, e-cigarettes may come to represent another twist in the 'safer cigarettes' discourses that have been used by the tobacco industry for many decades (Hanafin and Clancy 2015).

If the effects of Tobacco Control interventions on e-cigarettes in young people mirrored effects on smoking, the greatest efficacy might be expected from price and taxation policies, and extension of Smokefree legislation to include use of e-cigarettes (Li et al. 2020). Price has been identified as a motivator for reduced e-cigarette use among young people (Pesko et al. 2018), with higher prices associated with reduced e-cigarette use among adolescents in the US. Current regulation of e-cigarettes in Ireland is largely confined to compliance with the EC Tobacco Products Directive 2014/40/EU (TPD) (European Parliament and Council 2014). An extension of the existing Irish Smokefree legislation to include e-cigarettes would mean that e-cigarettes would be prohibited in workplaces, enclosed public places, restaurants, bars, education facilities, healthcare facilities, and public transport. Proposed new tobacco control legislation policies by the Irish government, to include age restriction for e-cigarette purchase to over-18s, may have an impact on e-cigarette use among students, as support for tobacco control, including non-combustible products, is high (Wipfli et al. 2020).

Implications for health education and cessation

Future research surveys in adolescents should include intention and readiness to quit e-cigarettes. Health education may have a role in encouraging cessation as there is evidence from adults that learning about nicotine risk through fact sheets may lead to being motivated to re-evaluate the risks of e-cigarettes (Yang et al. 2020).

Perceiving slight or moderate risk in using e-cigarettes appears to be protective against current use, also suggesting a role for health education by providing clear, focused, up-to-

date information for adolescents about the risks of e-cigarette use. It would seem that efforts could 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 (Hanafin and Clancy 2019, Hanafin, Clancy, the SILNE R Partners 2020).

Conclusion

Boys are more likely than girls to be current users of e-cigarettes, as are children of college/university-educated parents; but those who perceive their family to be better off than others are less likely to be current e-cigarette users. Individual risk behaviours, particularly in terms of polysubstance use, are most relevant. *Current smoking* shows the highest odds of *current e-cigarette use,* with adjusted odds of over 7. In this sense, tobacco control remains a primary goal in protecting young people from other substance abuse.

Declarations

Conflict of interest No conflict of interest declared by any of the authors.

Ethical approval Ethical approval was obtained from the Ethics and integrity Committee of the TU Dublin REC-18-26.

Informed consent Parent/guardian information sheet and school information sheets were distributed. Parent non-consent forms were distributed to each student.

No individual data or image is published.

Data available from author on request.

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