

Trend analyses suggest gender-focused, peer-aware, and parent-targeted interventions could reduce teenage e-cigarette use

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Abstract

E-cigarette *ever-use* and *current-use* among teenagers has been increasing worldwide, including in Ireland. Boys are widely observed to have increased prevalence compared with girls.

We use data from two waves of the European School Survey Project on Alcohol and other Drugs (ESPAD) in Ireland and focus on gender and teenage e-cigarette use. We examine changes in *ever and current-use* among 16-year-olds ($n = 3,421$) between 2015 and 2019. We use multivariable logistic regression analyses to explore relative and gendered effects of covariates on teenage e-cigarette use.

E-cigarette *ever-use* increased from 23–39% and *current-use* from 10–18%, (in 2015 vs 2019, respectively). The rate of increase in *ever-use* is significantly greater for girls AOR 2.67 (C.I. 2.02, 3.54) vs 2.04 (C.I. 1.55, 2.68) for boys. Smoking and *e-cigarette use* are linked but never-smokers who try e-cigarettes have risen from 33–67%. Peer smoking is also significantly associated with *e-cigarette ever- and current-use*, particularly for boys if “Most/All friends smoke” AOR 5.90 (C.I. 3.31, 10.52) vs 3.50 (C.I. 1.79, 6.84) for girls. Less parental monitoring is associated with greater *e-cigarette use*, for boys AOR 5.50 (C.I. 2.85, 10.61) vs AOR 5.31 (C.I. 3.01, 9.37) for girls.

Boys currently have a higher prevalence of *e-cigarette use* but girls are increasingly at risk. Targeting by industry through advertising, gaming and social media may contribute to use. Peer influences and parental monitoring are significant risk factors for use and provide a mechanism for intervention to prevent an increasing risk of nicotine addiction.

Introduction

E-cigarette use is increasing worldwide, and e-cigarettes are the most commonly used tobacco product among adolescents (1), including in Ireland (2). A secondary analysis of five Irish health datasets (all stratified random samples in school-based settings) which included data on teenage tobacco use found that e-cigarette use has risen rapidly among adolescents in Ireland in recent years (from 23% *ever-use* in 2014 to 39% in 2019, and from 3% *current-use* in 2014 to 18% in 2019) (3).

Concerns about e-cigarettes at the level of public health and tobacco control have been aired for some time (4), including the effects of the mainstream tobacco industry’s entry into the e-cigarette marketplace and the potential for “renormalization” of combusted cigarette use (4–6). Currently, concerns about e-cigarette harms include negative impact on cardiovascular health (7) and potential hazards such as obstructive lung disease from flavorants in e-cigarettes (8). Passive exposure to second hand aerosol (SHA) from e-cigarettes is also a cause for concern, especially among those with respiratory diseases such as COPD (9, 10), and symptoms of sensory irritation, and general complaints have been reported by non-smokers (11).

Among adolescents, additional and specific potential negative consequences of e-cigarette use have been identified (12, 13). There is “compelling” evidence that nicotine exposure during adolescence causes both long-term structural and functional changes in the brain with multiple adverse health consequences (14). The series of risks identified from nicotine exposure, include altered development of cerebral cortex and hippocampus in the developing adolescent brain (12). The link between teenage e-cigarette use and increased smoking is widely accepted and supported by several reviews (15–17). The gateway theory (18), the common liability theory (19), the catalyst model (20), and the catalyst/ diversion model (whether e-cigarettes are a “catalyst” to conventional smoking or whether they *divert* adolescents from more harmful products (21)) have all been considered.

The upward trend in teenage *e-cigarette use* in Ireland has occurred against the historical backdrop of a two-decade downward trend in teenage cigarette smoking, down from 41% in 1995 to 14% in 2015 (22). Between 2015 and 2019, at the same time that *e-cigarette use* was increasing rapidly, the downward trend in teenage current cigarette use came to a standstill, remaining at 14% overall in 2019 and, in fact, reversed for boys, among whom smoking prevalence rose to 16% in 2019 (2). The decline of *ever cigarette smoking* in Ireland seems to continue, albeit not statistically significantly. Elsewhere, it has been suggested that e-cigarette users do not fit the traditional risk profile of cigarette smokers (23), pointing to a separate need to understand e-cigarette use.

Teenage e-cigarette users are more likely to be male gender, older, have higher amounts of pocket money, and tobacco smoking-related characteristics (including regular and heavier smoking, and having peers who smoke) (24). Gender differences in teenage smoking have been widely researched (e.g. (25)), but gender differences in teenage *e-cigarette use* are “relatively unknown” (1). A recent review of literature on US adolescent e-cigarette use concluded that boys appear to have greater *e-cigarette use*, but “girls may be at increased risk if e-cigarettes are targeted to them, as it has been for cigarettes” (1). The Irish data with its clear upward trend point to much higher levels of *e-cigarette use* among boys than among girls, but little is known about why this is so.

Study

Data are drawn from two Irish waves (2015 and 2019) of the European School Survey Project on Alcohol and other Drugs (ESPAD) (2, 22), which contained comparable questions on e-cigarettes.

Sample

In both 2015 and 2019, students were surveyed in a stratified random sample of schools ($n = 50$) in Ireland, based on geographic region and 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 (Delivering Equality of Opportunity in Schools (DEIS vs. non-DEIS)). Completed survey data were entered manually into SPSS v22 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 (2, 22). The total valid sample for this study was 3,421 16-year-olds, comprising 1,472 students (born in 1999) in the 2015 sample, and 1,949 students (born in 2003) in the 2019 sample.

Measures for multivariable logistic regression analysis

A full list of the questions, and answer categories, from which variables were drawn is in Additional Files1&2 (ESPAD questionnaires 2015 and 2019).

Outcome variables: Ever-use and current-use of e-cigarettes

Two variables measured prevalence, *e-cigarette ever-use* ('Have you ever used e-cigarettes?' yes/no, more than 12 months ago, in the last 12 months, in the last 30 days; recoded 'ever-use' -no vs yes) and *e-cigarette current-use* ('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 'current-use' -no vs yes).

Variables in model

Socio-demographic variables

Variables included gender (male, female), perceived wealth (recoded much better off, better off, about the same, less well off) and household composition (one-parent, two-parent, blended).

Individual, familial, and peer variables

Students were asked about:

Use of cigarettes

Their use of cigarettes (ever-use, current-use, recoded -no vs yes).

Reasons for trying e-cigarettes

Reasons for first trying e-cigarettes, and to select all that applied: out of curiosity, to quit smoking, because friends were using it.

Relationship with tobacco when first tried e-cigarettes

Their relationship with tobacco when they first tried e-cigarettes: had never smoked tobacco, smoked occasionally, smoked regularly.

Absenteeism

To report the number of days they had skipped or “cut” school in the last 30 days (recoded none, 1–4 days, 5+ days).

Parental monitoring

If their parents (mother or father) know where they spend their Saturday nights ('know always', 'know quite often', 'know sometimes', 'usually don't know').

Relationship with mother

Were they satisfied with their relationship with their mother (recoded as satisfied, neither nor, not satisfied).

Peer smoking

How many of their friends smoke cigarettes, ('none', 'a few', 'some', 'most' and 'all'; recoded none, a few/some, most/all).

Statistical analysis

Pearson's chi-square test was used to compare the demographic variables between 2015 and 2019 and to determine whether the differences in the variables between the two waves are statistically significant (Table 1). E-cigarette *ever- and current-use* was examined using a multivariable logistic regression model with *e-cigarette ever-use* (Table 2) and *current-use* (Table 3) as the dependent variable, analysed for all and by gender. All analyses and results are presented as adjusted odds ratios (AOR) and 95% confidence intervals. A p-value of .05 was used as a cut-off for significance. All statistical analyses were conducted using STATA version 16.

Results

Sample differences 2015–2019

Regarding socio-demographic, individual, familial and peer characteristics, there are very few statistically significant differences between the 2015 and 2019 ESPAD waves (Table 1).

Table 1

Changes in socio-demographic, individual, familial, and peer variables between 2015 and 2019 ESPAD Surveys

	ESPAD Year (2015 and 2019) and significance level†		
	2015 (n = 1472)	2019 (n = 1949)	p-value
	n (%)	n (%)	
<i>Gender</i>			
Male	752 (51.1)	946 (48.5)	.140
Female	720 (48.9)	1003 (51.5)	
<i>E-cigarette ever-use</i>	325 (23.0)	754 (39.0)	< .001
Yes	1088 (77.0)	1219 (62.7)	
No			
<i>E-cigarette current-use</i>	143 (10.1)	351 (18.1)	< .001
Yes	1270 (89.9)	1592 (81.9)	
No			
<i>Ever-smoked</i>	473 (32.3)	614 (31.6)	.678
Yes	992 (67.7)	1328 (68.4)	
No			
<i>Current smoking</i>	191 (13.0)	281 (14.4)	.235
Yes	1275 (87.0)	1664 (85.6)	
No			
<i>Household composition</i>	262 (17.8)	371 (19.0)	.010
Single parent	1109 (75.3)	1490 (76.4)	
Two parents	101 (6.9)	88 (4.5)	
Blended families			
<i>Parental Monitoring*</i>	906 (62.7)	1194 (63.2)	.452
Know always	337 (23.3)	455 (24.1)	
Know quite often	128 (8.9)	166 (8.8)	
Know sometimes	73 (5.1)	74 (3.9)	
Usually don't know			
<i>Skipping School</i>	984 (80.1)	1309 (79.6)	.371
None	198 (16.1)	286 (17.4)	
1–4 days	47 (3.8)	50 (3.0)	
5 days+			

† Bold numbers indicate statistical significance at < .05.

* Parents know where child is on Saturday nights

	ESPAD Year (2015 and 2019) and significance level†		
	2015 (n = 1472)	2019 (n = 1949)	p-value
	n (%)	n (%)	
<i>Perceived family wealth</i>			
About the same	696 (48.7)	815 (43.3)	.006
Much better off	223 (15.6)	308 (16.4)	
Better off			
Less well off			
<i>Peers who smoke</i>	370 (25.9)	580 (30.8)	
None	141 (9.9)	179 (9.5)	
A few/some			
Most/all			
<i>Relationship with mother</i>	478 (33.4)	558 (29.8)	.056
Satisfied	802 (56.1)	1125 (60.1)	
Neither nor	150 (10.5)	188 (10.1)	
Not satisfied			
<i>Reasons for trying e-cigarettes</i>	1251 (87.5)	1621 (86.4)	.640
To quit smoking	74 (5.2)	106 (5.6)	
Because friends were using it	105 (7.3)	150(8.0)	
Out of curiosity			
<i>Relationship with tobacco when first tried e-cigarette</i>	51 (17.3)	16 (3.4)	< .001
Never smoked tobacco	63 (21.4)	137 (28.8)	< .001
Smoked tobacco occasionally	186 (63.1)	315 (66.3)	< .001
Smoked tobacco regularly			
† Bold numbers indicate statistical significance at < .05.			
* Parents know where child is on Saturday nights			

Two features of the student samples stand out. Firstly, in 2015, 33% (n = 101) of the e-cigarette sample had never used tobacco; in 2019, this rose to 67%, (n = 461). The number who said that they were regular tobacco users when they first used an e-cigarette dropped from 14.9% (n = 45) to 9% (n = 62) between waves.

Secondly, reasons for trying e-cigarettes changed, with significantly fewer reporting trying e-cigarettes in order *to quit smoking* in 2019 (3.4%, n = 16) than in 2015 (17.3%, n = 51). Trying e-cigarettes *out of curiosity* increased from 63% (n = 186) in 2015 to 66% in 2019 (n = 315), and those who used it *because of friends* increased from 21% (n = 63) in 2015 to 29% (n = 137) in 2019.

However, e-cigarette use is notably different between the two waves, increasing markedly between 2015 and 2019. As shown in Table 1, *ever-use* of e-cigarettes increased significantly, from 23% (n = 325) to 39% (n = 754). *Current-use* of e-cigarettes also increased significantly, from 10% (n = 143) to 18% (n = 351).

Trends in e-cigarette ever-use

Table 2 shows the results of multivariable logistic regression analyses of e-cigarette ever-use in the 2015 and 2019 ESPAD surveys, for the total sample, and separately for boys and girls.

Table 2

Variables associated with *e-cigarette ever-use* in the 2015 & 2019 ESPAD Surveys: multivariable logistic regression

E-cigarette ever-use (Adjusted Odds Ratio (AOR), total sample and by gender)			
	Total (AOR, 95% CI)	Male (AOR, 95% CI)	Female (AOR, 95% CI)
<i>Gender</i>	1	N/A	N/A
Male	0.99 (0.83, 1.20)		
Female			
<i>ESPAD Year</i>	1	1	1
2015	2.29 (1.89, 2.78)	2.04 (1.55, 2.68)	2.67 (2.02, 3.54)
2019			
<i>Ever smoked</i>	1	1	1
No	1.39 (1.10, 1.75)	1.23 (0.89, 1.71)	1.56 (1.12, 2.18)
Yes			
<i>Current smoking</i>	1	1	1
No	1.76 (1.31, 2.38)	2.60 (1.71, 3.93)	1.14 (0.73, 1.79)
Yes			
<i>Household composition</i>	1	1	1
Single parent	0.84 (0.66, 1.08)	0.91 (0.63, 1.30)	0.80 (0.55, 1.15)
Two parents	1.43 (0.93, 2.16)	1.85 (1.02, 3.35)	1.14 (0.61, 2.13)
Blended families			
<i>Parental Monitoring</i>	1	1	1
Know always	1.99 (1.61, 2.46)	1.94 (1.43, 2.62)	2.04 (1.51, 2.75)s
Know quite often	3.12 (2.52, 4.63)	3.15 (2.06, 4.83)	3.68 (2.35, 5.75)
Know sometimes	3.96 (2.54, 6.18)	5.42 (2.72, 10.79)	3.33 (1.84, 6.03)
Usually don't know			
<i>Skipping School</i>	1	1	1
None	0.86 (0.67, 1.10)	0.83 (0.58, 1.18)	0.90 (0.64, 1.27)
1–4 days	1.56 (0.95, 2.56)	2.17 (1.08, 4.36)	1.07 (0.50, 2.30)
5 days+			
<i>Perceived wealth</i>	1	1	1
About the same	1.11 (0.85, 1.45)	1.30 (0.88, 1.91)	0.96 (0.66, 1.40)
Much better off	1.01 (0.81, 1.26)	1.31 (0.96, 1.79)	0.80 (0.59, 1.09)
Better off	1.29 (0.93, 1.78)	0.94 (0.59, 1.51)	1.76 (1.11, 2.78)
Less well off			

†Bold numbers indicate statistical significance at < .05.

E-cigarette ever-use (Adjusted Odds Ratio (AOR), total sample and by gender)			
	Total (AOR, 95% CI)	Male (AOR, 95% CI)	Female (AOR, 95% CI)
<i>Peers who smoke</i>	1	1	1
None	2.74 (2.17, 3.45)	3.12 (2.22, 4.38)	2.47 (1.79, 3.41)
A few/some	6.52 (4.66, 9.15)	7.07 (4.33, 11.55)	6.23 (3.87, 10.02)
Most/all			
<i>Relationship with mother</i>	1	1	1
Satisfied	1.65 (1.13, 2.40)	2.22 (1.33, 3.72)	1.55 (0.65, 2.04)
Neither nor	1.36 (0.98, 1.89)	1.36 (0.85, 2.18)	1.32 (0.83, 2.10)
Not satisfied			

+Bold numbers indicate statistical significance at < .05.

The odds of *ever-using e-cigarettes* increased significantly between 2015 and 2019 (AOR 2.29, 95% CI:1.89–2.78), and the increase was more pronounced for girls (AOR 2.67, 95% CI:2.02–3.54) compared with boys (AOR 2.04, 95% CI:1.55–2.68). Use of combustible tobacco (both ever and current smoking) was associated with increased odds of *ever-using e-cigarettes*, with ever-smoking having higher odds for girls (AOR 1.56, 95% CI:1.12–2.18) and current smoking higher odds for boys (AOR 2.60, 95% CI:1.71–3.93).

Girls who reported that their families were less well-off than other families had increased odds (AOR 1.76, 95% CI:1.11–2.78) of being *ever-users* of e-cigarettes. Boys living in blended families also had increased odds (AOR 1.85, 95% CI:1.02–3.35).

Peer smoking was strongly associated with *e-cigarette ever-use*. Those who reported that “most or all” of their friends smoked had increased odds of ever-using e-cigarettes (AOR 6.52, 95% CI:4.66–9.15) and this was more pronounced for boys (AOR 7.07, 95% CI:4.33–11.55) than for girls (AOR 6.23, 95% CI:3.87–10.02).

Parental monitoring was more important for boys (AOR 5.42, 95% CI:2.72–10.79) than for girls (AOR 3.33, 95% CI:1.84–6.03).

Trends in e-cigarette current-use

Table 3 shows the results of multivariable logistic regression analyses of factors potentially associated with *e-cigarette current-use* in the 2015 and 2019 ESPAD surveys.

Table 3

Variables associated with *e-cigarette current-use* in the 2015 & 2019 ESPAD Surveys: multivariable logistic regression

	E-cigarette <i>current-use</i> Adjusted Odds Ratio (AOR) (total sample and by gender)		
	Total (AOR, 95% CI)	Male (AOR, 95% CI)	Female (AOR, 95% CI)
<i>Gender</i>	1	N/A	N/A
Male	1.03 (0.81,1.30)		
Female			
<i>ESPAD Year</i>	1	1	1
2015	2.41 (1.85, 3.12)	1.96 (1.37, 2.82)	3.11 (2.10, 4.61)
2019			
<i>Ever smoked</i>	1	1	1
No	1.14 (0.84, 1.55)	1.19 (0.77, 1.82)	1.13 (0.72, 1.76)
Yes			
<i>Current smoking</i>	1	1	1
No	1.78 (1.23, 2.55)	2.13 (1.30, 3.51)	1.50 (0.87, 2.59)
Yes			
<i>Household composition</i>	1	1	1
Single parent	0.94 (0.68, 1.29)	1.16 (0.72, 1.84)	0.75 (0.48, 1.62)
Two parents	1.46 (0.89, 2.44)	1.53 (0.72, 3.24)	1.37 (0.68, 2.76)
Blended families			
<i>Parental Monitoring</i>	1	1	1
Know always	2.22 (1.69, 2.92)	2.62 (1.76, 3.90)	1.90 (1.29, 2.81)
Know quite often	3.53 (2.49, 5.01)	4.06 (2.49, 6.63)	3.09 (1.85, 5.15)
Know sometimes	4.48 (2.83, 7.11)	5.50 (2.85, 10.61)	3.50 (1.79, 6.84)
Usually don't know			
<i>Skipping School</i>	1	1	1
None	0.86 (0.63, 1.18)	0.68 (0.42, 1.10)	1.03 (0.68, 1.58)
1–4 days	1.42 (0.81, 2.51)	1.08 (0.49, 2.37)	1.70 (0.74, 3.90)
5 days+			
<i>Perceived wealth</i>	1	1	1
About the same	1.14 (0.82, 1.59)	1.04 (0.65, 1.67)	1.20 (0.75, 1.93)
Much better off	0.77 (0.57, 1.03)	0.81 (0.53, 1.22)	0.73 (0.48, 1.11)
Better off	1.28 (0.87, 1.88)	1.26 (0.72, 2.20)	1.35 (0.79, 2.33)
Less well off			

	E-cigarette <i>current-use</i> Adjusted Odds Ratio (AOR) (total sample and by gender)		
	Total (AOR, 95% CI)	Male (AOR, 95% CI)	Female (AOR, 95% CI)
<i>Peers who smoke</i>	1	1	1
None	2.13 (1.54, 2.96)	2.23 (1.39, 3.59)	2.11 (1.34, 3.33)
A few/some	5.45 (3.65, 8.14)	5.90 (3.31, 10.52)	5.31 (3.01, 9.37)
Most/all			
<i>Relationship with mother</i>	1	1	1
Satisfied	1.23 (0.77, 1.97)	1.37 (0.68, 2.79)	1.25 (0.66, 2.37)
Neither nor	1.55 (1.06, 2.26)	1.40 (0.79, 2.49)	1.64 (0.98, 2.74)
Not satisfied			

†Bold numbers indicate statistical significance at < .05.

The odds of adolescents being *e-cigarette current-users* increased significantly between 2015 and 2019 (AOR 2.41, 95% CI:1.85–3.12); the increase was greater for girls (AOR 3.11, 95% CI:2.10–4.61) compared with boys (AOR 1.96, 95% CI: 1.37–2.82). Being a current smoker increased the odds of *current-use e-cigarette* (AOR 1.78, 95% CI:1.23–2.55), significantly so for boys (AOR 2.13, 95% CI:1.30–3.51). The more peers young people have who smoke, the greater their odds of *e-cigarette current-use*. Those who reported that “most or all” of their friends smoked had greater odds of *e-cigarette current-use* (AOR 5.45, 95% CI:3.65–8.14), and this was more pronounced for boys (AOR 5.90, 95% CI:3.31–10.52) than for girls (AOR 5.31, 95% CI:3.01–9.37).

As with *ever-use* of e-cigarettes increased parental monitoring was also important for adolescents’ *current-use* of e-cigarettes. The odds were increased (AOR 4.48, 95% CI:2.83–7.11) in young people who say that their parents “usually don’t know” where they are on a Saturday night (reference group “parents always know”). Parental monitoring was more important for boys (AOR 5.50, 95% CI:2.85–10.61) than for girls (3.50, 95% CI:1.79–6.84).

Discussion

Results from our two ESPAD samples of 3,421 16-year-olds show that *e-cigarette ever- and current-use* increased significantly between 2014 and 2019 in Ireland. There was a significant rise in never-smokers trying e-cigarettes, with an increase from one-third (33%) to two-thirds (67%) of the sample who had never used tobacco when they first tried an e-cigarette.

Gender differences in e-cigarette use

From the outset, boys in our trend analyses were more likely to be both *ever- and current- users* of e-cigarettes. This is in line with many other studies (1, 24). Various theories have been offered to explain gender and substance use including tobacco and e-cigarettes, such as Connell’s (2005) influential construct of hegemonic masculinity and how it puts men at risk of harmful health behaviours and consequences that can be destructive for them (26), including for teenage boys (27), and Butler’s (28) consequential theory of gender performativity - that gender is not an essential, biologically determined quality or an inherent identity, but is repeatedly performed, based on, and reinforced by, societal norms, this repeated performance of gender being also performative - applied to smoking by women in Australia by Gilbert (29). They argued that smoking is “a gender act that can be internalised and which, when repeatedly performed by women in gender-appropriate ways, constructs a ‘feminine’ gender identity” (28, 29). Such theories and how they relate to our findings on gendered e-cigarette use are outside the scope of our

data. We raise them here to acknowledge that our findings may have a broader, and deeper, context within discourses on gender and substance use.

Boys have higher prevalence of *e-cigarette use* but the *rate of increase* in this study is significantly greater for girls, and this was particularly pronounced for *current-use*, with the trend analysis showing girls having more than 50% higher odds (AOR 3.11, 95% CI 2.10–4.61) than boys (AOR 1.96, 95% CI 1.37–2.82) of being *e-cigarette current-users* in 2019 compared with 2015. This gendered pattern of substance use showing initial high male use, with females subsequently potentially over-taking males may reflect a particular historical pattern of gendered tobacco use, driven by the tobacco industry's gendered marketing and exploitation of social change and social disruption (30–32), such as the post-war targeting of women by the tobacco industry "as an equality and freedom issue" (32). The latter comprised advertising and marketing by the industry, specifically and successfully targeted to women and girls, a market identified as a large untapped lucrative reservoir (30–32). Among the tactics were brand names chosen to appeal to women, development of "slim" cigarettes, and emphasis on qualities identified as desirable such as thinness and female independence (30–32). E-cigarette advertising and direct and covert marketing uses strikingly similar techniques to those used previously by the cigarette industry (33) - featuring young, attractive models, sponsorship of sports events and parties, product placement, and direct payments to social media influencers (33). We add support to Kong et al. (2017) who observed that, while boys in the U.S. appear to have greater use of e-cigarettes, girls may be at increased risk if e-cigarettes are targeted to them "as it has been for cigarettes" and we join in calling for further research on gender differences in e-cigarette use, particularly in gendered rates of increase, and on the role of industry advertising and marketing including the gendered nature of such activities on the internet (1).

Secondly, we suggest that online messaging about e-cigarettes, particularly as a "healthier" alternative to traditional combustible cigarettes, may be especially effective for increasing e-cigarette use among girls and young women. including targeted and sophisticated messaging on social media (33). Teenagers are at the forefront of the transition from traditional to electronic media, especially social media (34) and the vast majority of adolescents search for health-related information online as opposed to more traditional media (34, 35). Teenage girls appear to be at greater risk of consuming unreliable health-related information on social media than are teenage boys (35). One mixed-methods pilot study (34) found that, while girls recognised the potential to encounter false information in health-related content that they saw on social media (often in paid advertisements), their methods for fact-checking were not stringent; rather, for example, they tended to trust posts from people they knew personally (34). As Wartella and colleagues point out, teenagers "virtually always have a digital device at their fingertips" and so "public health interventions and informational campaigns must be tailored"(35). We agree with O'Leary et al. (2019) that, while the state and use of social media are ever changing, the potential to use social media as a form of promotion for healthy behaviours, especially among adolescents, will continue to offer promise (34). Thus, we extend to the domain of tobacco and e-cigarette use their call for education interventions for teenagers (34).

Thirdly, we point to the gendered nature of teenagers' online activities and how these may be exploited in particular ways through marketing, advertising and particularly social influencing (36). Specifically, we draw attention to findings regarding the potentially different online worlds inhabited by teenage girls (social media platforms) and teenage boys (gaming platforms) that have been identified (2, 37). This leads us to speculate, for example, that boys may be targeted through gaming platforms and that girls' rapidly increasing *e-cigarette use* may be related to their greater social media use. We know that heavier exposure to advertisements and e-cigarette content in social media posts is associated with a greater risk for e-cigarette use among adolescents, and even brief exposure to e-cigarette content on social media has been found to be associated with greater intention to use and more positive attitudes toward e-cigarettes (38). The scope within these parallel gendered domains for targeted marketing of e-cigarettes by industry merits further research and we also support calls for regulatory action to prohibit sponsored e-cigarette content on social media platforms used by youth (38, 39).

Gender differences, e-cigarette use and smoking

The link between cigarette smoking and *e-cigarette use* has been well-established (15–17) and our findings support this as, but with gender differences. Girls who had ever-smoked had higher odds (AOR 1.56, 95% CI: 1.12–2.18) of *ever-using e-cigarettes*. Boys who were current smokers had more than twice the odds of being *e-cigarette ever-users* (AOR 2.60, 95% CI: 1.71–3.93).

Differences in experimentation and continuation of both smoking and e-cigarette use appear to be gendered, pointing to different characteristics between the smoking and *e-cigarette* populations or to gender differences that require further exploration, lending support to the findings of Creamer et al. (2021) that, regarding psychosocial risk factors for cigarette smoking, *e-cigarette users* do not fit the traditional risk profile of cigarette smokers, and require further research (23).

Peer pressure and gender

Adolescent peer social networks have been found to be important for health behaviour choices, with health behaviour similarity found to be driven by homophilic social selection and/or social influence (40). Studies of adolescent social networks, including online networks, suggest that friends' online behaviours are a viable source of peer influence (41). Those with more peers who smoke have much higher odds of being *ever-users* of e-cigarettes, and this pattern was particularly strong for boys. Peer smoking was similarly implicated in *e-cigarette current-use* and, again, gender differences showed a somewhat stronger influence of peers on boys than on girls in relation to *current-use of e-cigarettes*. A review of 26 studies examining adolescents' susceptibility to peer pressure to engage in risky behaviours identified two primary trends: one, that adolescent males appear to be more susceptible to peer influences that encourage risk-taking behaviours; and the other, that there are no consistent gender differences (42). McCoy and colleagues conjecture that, as attitudes about gender-appropriate behaviour shift across historical time, it may be that male and female teenage experiences are becoming increasingly similar, for example in experiencing comparable levels of deviant peer pressure around substance use in particular and also that differences across types of risky behaviours may "even out", causing gender differences to disappear. Adding to this, given that many marginalised groups smoke at higher rates and that socioeconomic inequities in smoking prevalence are widening (43), we draw attention to a broader lack of focus on intersectional understandings (44) of adolescent behaviour, noting that there is little or no data on young people, peers, and substance use – and specifically, tobacco/ e-cigarette use – synthesised, for example, across social categories of gender, race, class/SES, disability, sexuality, and religion. Moreover, intersectionality has been identified as a promising framework for addressing health inequities in tobacco cessation, aiming to capture the complex set of factors that may account for tobacco cessation inequities, such as "multiple aspects of identity that may influence access to tobacco cessation treatment and exposure to certain stressors that impede cessation efforts" (43). In turn, this may lead to better design and interventions for individuals at high risk (43), and may be particularly useful in dealing with newly-emergent patterns of e-cigarette use across gender and other identities.

Parental monitoring and gender

Parental monitoring was a separately important factor in explaining *e-cigarette use* and we add further support regarding *e-cigarette use* to previous findings from ESPAD - dating as far back as 2003 (45) and as recently as 2018 (46) - showing that lack of parental monitoring remained a significant predictor for all illicit substance use in the best-fitting models. This finding does not lend support to the suggestion (e.g. (23)) that e-cigarette users have a different risk profile to traditional cigarette users. This finding about parental monitoring was also gendered, being more important for teenage boys than for teenage girls. In our study, lack of satisfaction with the maternal relationship increased the odds of *current-use*.

Conclusion

Teenage boys are currently more likely to be both *ever- and current-users* of e-cigarettes but trend analyses show that the risk to girls has increased significantly more than to boys in the years between 2015 and 2019. This differential in rate of increase may reflect differences in how girls and boys are targeted through advertising, gaming and social media platforms. Peer influences operate differently for girls and for boys, as does parental monitoring. While further research is needed, to understand how *e-cigarette use*, like other tobacco use, is a gendered activity, and into ways, in which industry advertising and marketing is gendered in order to support regulation of this rapidly evolving market of new tobacco products, for now we highlight the role of parental monitoring and peer smoking influence as targets for prevention of this increasing addiction to *e-cigarettes*.

Declarations

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Conflict of interest.

The authors declare that they have no conflicts of interest.

Ethics

Ethics for the ESPAD studies were received from Research Ethics and Integrity Committee of TUDublin ref. REC-18-126.

Consent to participate

Written Consent was obtained from the parents/guardians for the ESPAD surveys.

Information leaflets and consent forms were supplied to each subject.

Availability of data and material

All data are available on reasonable request to the corresponding author

Authors' contribution

Joan Hanafin: Conceptualization, Methodology, Writing- Original draft preparation, Reviewing and Editing, Supervision **Salome Sunday** Formal analysis, Data curation, Statistical examination Reviewing and Editing **Luke Clancy** Conceptualization, Supervision Visualization, Investigation, Reviewing and Editing, Resources, Funding acquisition.

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