

# Uptake of e-cigarettes among a nationally representative cohort of UK children

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## ABSTRACT

**INTRODUCTION** Using nationally representative data this study examined experimentation with and regular use of e-cigarettes among children not using tobacco at age 11 years, followed up to age 14 years.

**METHODS** Data come from 10 982 children in the UK Millennium Cohort Study. Logistic regression assessed experimentation with and current use of e-cigarettes by age 14 years. We considered associations of sociodemographics at age 11 years with subsequent e-cigarette use, including data on family income, peer and caregiver smoking. Subsequent models were adjusted for current tobacco use to assess both the strength of the associations between e-cigarette use and tobacco, and whether sociodemographics were associated with e-cigarettes independently of tobacco.

**RESULTS** Among 10 982 children who reported never smoking at age 11 years, 13.9% (1525) had ever tried an e-cigarette by age 14 years, and of these 18.2% (278) reported being current users. Children in lower income households were more likely to have tried an e-cigarette than those in higher income households (Adjusted Odds Ratio, AOR 1.89,  $p=0.002$ ). Children who reported friend (AOR 2.28,  $p<0.001$ ) or caregiver smoking (AOR 1.77,  $p<0.001$ ) at age 11 years were more likely to have tried an e-cigarette by age 14 years. After adjusting for current tobacco use, there was some attenuation of these associations, although associations of friend and caregiver smoking with e-cigarette use remained statistically significant.

**CONCLUSIONS** Children from lower income families were more likely to experiment with e-cigarettes by age 14 years, although this was heavily mediated by concurrent tobacco use. Caregiver and friend smoking are linked to trying e-cigarettes, although these relationships are less clear for regular e-cigarette use.

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## INTRODUCTION

Adolescents constitute a key population in the heated debate about electronic cigarettes (e-cigarettes). E-cigarettes are more popular among younger individuals, who are also more likely to believe that they are less harmful than cigarettes in the United Kingdom, but the patterns and pathways of use among adolescents remain unclear<sup>1-3</sup>. A key question in the debate is whether experimentation and use among adolescents is a gateway to smoking tobacco<sup>4,5</sup>. While multiple studies have shown that regular use of e-cigarettes and, to some extent, experimentation

with the product are rare among non-smokers, the cross-sectional nature of these studies precludes conclusions with regards to transition from e-cigarettes to combustible tobacco and vice versa<sup>1,6</sup>.

Recently, longitudinal studies among adolescents in Europe and the United States have shown that students who try e-cigarettes are subsequently more likely to smoke cigarettes<sup>7-11</sup>. This association could indicate that the use of e-cigarettes is causally linked to smoking or simply reflects personal and psychosocial factors that are associated with adolescents' propensity to use nicotine and/or

tobacco products in general. Little attention has been given to the factors that are associated with the initiation of e-cigarette use among adolescents, which could help to disentangle the complex relationship between e-cigarette and cigarette use during adolescence.

The aim of this study was to explore social and demographic factors associated with experimentation and current e-cigarette use in a longitudinal and nationally representative sample of adolescents in the United Kingdom.

## METHODS

### Data source

Data come from the UK Millennium Cohort Study (MCS), which is a longitudinal national birth cohort study of children born in the UK from September 2000 to January 2002<sup>12</sup>. The study uses a stratified cluster sampling design and over-sampling of smaller population groups including children in more disadvantaged areas.

This study uses data from the most recently available waves of the MCS (waves 5 and 6), conducted in 2011 and 2015, respectively, when children were aged approximately 11 and 14 years. Both waves involve administration of questionnaires to both children and their caregivers. The full sample size was 13 287 at age 11 years and 11 726 at age 14 years. We restricted the sample to children who reported never having tried smoking tobacco at age 11 years and were followed up at age 14 years, and had a sample of 10 982 of which 9 961 had complete data and were included in our regression analysis.

### Variables

E-cigarette use was assessed in the wave 6 survey by asking children to denote which best describes them: 'I've never used or tried electronic cigarettes (e-cigarettes)'; 'I have used e-cigarettes but don't at all now'; 'I now smoke e-cigarettes occasionally but not every day'; 'I smoke e-cigarettes every day'. All but the first answer were considered ever use of e-cigarettes, while the last two answers were categorised as current use of e-cigarettes.

Tobacco use at age 14 years was categorised as never, former or irregular (having tried smoking once, being a previous smoker, or smoking less than one cigarette a week) and regular (at least weekly

smoking tobacco). Friend smoking at age 11 years was assessed using the question: 'How many of your friends smoke cigarettes?' with answers ranging from 'none of them' to 'all of them', categorised as a binary variable.

Our models included data on age at follow-up (13 vs 14/15 years), gender (boys vs girls), country (England, Scotland, Wales, Northern Ireland), equivalised family income in five groups<sup>13</sup>, friend smoking (yes vs no) and caregiver current smoking (yes vs no, reported by the caregiver).

### Analyses

Associations between ever use of e-cigarettes by age 14 years with sociodemographics and exposure to caregiver or friend smoking at age 11 years were examined using logistic regression. These models were additionally adjusted for tobacco use at age 14 years. These same models were used to examine associations with current use of e-cigarettes at age 14 years among those who reported ever using e-cigarettes. We ran both sets of models initially without adjusting for tobacco use at age 14 years. Subsequent models were then adjusted for current tobacco use to assess both the strength of the relation between tobacco and e-cigarettes, and whether sociodemographics were associated with e-cigarette use independently of tobacco use.

Previous research has linked both tobacco and e-cigarette use to high levels of rebelliousness, low levels of parental support and a willingness to smoke<sup>14</sup>. Here we also present sensitivity analyses among children considered at high risk of initiating smoking based on their parental support and antisocial behaviour (a binary variable for ever: being so noisy in public that people complained; stolen something from a shop; performed graffiti; damaged something in public on purpose). However, as we do not have data on pre-existing willingness to smoke, we did not use these data in our primary analyses.

All analyses and percentages reported were weighted using survey weights constructed by the MCS team to correct for differential non-response and to ensure national representativeness<sup>16</sup>.

## RESULTS

Characteristics of the sample are shown in **Supplementary table 1**.

Among 10 982 children who reported never trying tobacco at age 11 years, 13.9% (1525) had ever tried an e-cigarette by age 14 years, and of these 18.2% (278) reported being current users of e-cigarettes. Details of the breakdown of e-cigarette use by tobacco use status are shown in **Supplementary table 2**. Among those who had never tried cigarettes by age 14 years, e-cigarette ever use was 7.2%, while among those who smoked cigarettes at least weekly, 84.3% had tried e-cigarettes.

In models not adjusted for current tobacco use (Table 1), children in lower income households were more likely to have tried an e-cigarette than those in higher income households (AOR 1.89,  $p=0.002$ ). Children who reported friend (AOR 2.28,  $p<0.001$ ) or caregiver smoking (AOR 1.77,  $p<0.001$ ) at age 11 years, were more likely to have tried an e-cigarette

by age 14 years. After adjusting for current tobacco use there was some attenuation of these associations, although they were both still statistically significant (AOR 1.86,  $p=0.002$  for friend smoking; and AOR 1.36,  $p=0.008$  for caregiver smoking). Differences across family income groups were not evident.

Only caregiver smoking was associated with an increased likelihood of being a current e-cigarette user (AOR 1.56,  $p=0.039$ ). Family and friend smoking was not associated with being a current e-cigarette user in models adjusting for tobacco use status, while children in lower income households were less likely to be current users (AOR=0.43,  $p=0.011$ ).

In analyses among children considered at risk of tobacco smoking based on their antisocial behaviours or lack of parental support, friend smoking was

**Table 1: Associations of age 11 socio-demographics with e-cigarette use at age 14 among a cohort of UK children (2011–2014)**

	Ever tried e-cigarettes					Current e-cigarette use among ever users				
	%	Odds Ratio	p-value	Odds Ratio	p-value	%	Odds Ratio	p-value	Odds Ratio	p-value
<b>Age at follow-up</b>										
13 years	12.3	ref	ref	ref	ref	23.7	ref	ref	ref	ref
14/15 years	17.0	1.32	0.002	1.21	0.080	17.8	0.68	0.081	0.63	0.030
<b>Gender</b>										
Boys	16.4	ref	ref	ref	ref	19.0	ref	ref	ref	ref
Girls	15.3	0.91	0.309	0.66	<0.001	18.7	1.08	0.656	0.89	0.524
<b>Country</b>										
England	15.6	ref	ref	ref	ref	19.7	ref	ref	ref	ref
Wales	16.2	0.98	0.885	0.97	0.831	18.3	1.02	0.959	1.03	0.933
Scotland	19.1	1.25	0.464	0.83	0.324	14.5	0.69	0.338	0.47	0.113
N. Ireland	13.7	0.77	0.098	0.86	0.342	15.3	0.76	0.462	0.95	0.883
<b>Income</b>										
Highest	11.3	ref	ref	ref	ref	22.4	ref	ref	ref	ref
Second	12.1	0.95	0.669	0.96	0.748	18.0	0.72	0.282	0.67	0.216
Middle	16.0	1.32	0.010	1.32	0.020	18.6	0.76	0.319	0.73	0.268
Fourth	15.7	1.09	0.535	0.90	0.415	19.5	0.82	0.497	0.64	0.152
Lowest	22.4	1.89	0.002	1.34	0.092	17.6	0.64	0.142	0.43	0.011
<b>Friend smoking</b>										
No	15.0	ref	ref	ref	ref	19.3	ref	ref	ref	ref
Yes	31.2	2.28	<0.001	1.86	0.002	17.0	0.79	0.442	0.67	0.168
<b>Caregiver smoking</b>										
No	13.2	ref	ref	ref	ref	17.3	ref	ref	ref	ref
Yes	23.8	1.77	<0.001	1.36	0.008	21.9	1.56	0.039	1.31	0.229
<b>Tobacco use at follow-up</b>										
Never	8.1	-	-	ref	ref	9.7	-	-	ref	ref
At least ever	57.4	-	-	15.50	<0.001	22.6	-	-	2.88	<0.001
At least weekly	84.0	-	-	57.75	<0.001	38.1	-	-	8.50	<0.001

Current E-cigarette use defined as at least weekly

associated with being an ever e-cigarette user, while there were no associations between household income and ever or current e-cigarette use (Supplementary table 3).

## DISCUSSION

Using nationally representative longitudinal data from the UK we found that children from lower income families were more likely to try e-cigarettes but that this association was heavily mediated by their tobacco use. We also found that 7.2% of 14-year olds that had never tried cigarettes had experimented with e-cigarettes. Further research into the characteristics of this group and their potential trajectories towards tobacco use is warranted.

Having friends and caregivers who smoke has been identified as an important predictor of smoking tobacco in young age in other work and our analysis suggests that similar influences are important in the use of e-cigarettes<sup>17</sup>. E-cigarette use is much more frequent among adult smokers compared with non-smokers<sup>1</sup>; therefore, this finding could reflect exposure to e-cigarettes in the proximate social environment, which has been associated with adolescent e-cigarette use<sup>18</sup>. Nonetheless, whether there is an independent association between caregiver or peer smoking and the likelihood of trying e-cigarettes remains an open question<sup>19</sup>. We also conducted analyses focused on the subset of children considered at high-risk of smoking due to their antisocial behaviours or lack of parental support following on from research that has attempted to disentangle these effects<sup>14</sup>. These analyses found that friend smoking, but not caregiver smoking, was associated with trying e-cigarettes and that the differences across income groups may be explained by these factors.

The main strengths of this study are the nationally representative sample and the longitudinal design, which allowed us to identify the potential association of certain sociodemographic factors with e-cigarette use within a period of three years. Importantly, this was the period between ages 11 and 14 years, which is a time when many adolescents start experimenting with tobacco and nicotine products<sup>20</sup>. However, the UK Millennium Cohort Study did not assess use of e-cigarettes at age 11 years, hence we could not reliably identify new e-cigarette users between ages

11 and 14 years. The prevalence of e-cigarette use at the time wave 5 was conducted was relatively low in the UK and we excluded those who had already tried cigarettes from the analysis<sup>1,21</sup>. As the majority of young people will not try tobacco products until later in adolescence<sup>20</sup>, we expect that only a very small number of individuals included in our study had already tried e-cigarettes by age 11 years. It should be noted that use of e-cigarettes was additionally assessed using a single question that did not include details on whether the e-cigarettes used contained nicotine or the intensity of use. While adolescence is an important period for experimentation with e-cigarettes and other products, further work should also focus on long-term changes.

## CONCLUSIONS

In nationally representative data from the United Kingdom, 13.9% had tried e-cigarettes by the age of 14 years, and of these 18.0% reported being current users of e-cigarettes. Those from lower income families were more likely to experiment with e-cigarettes by age 14 years, although this is heavily mediated by their tobacco use. Similar to tobacco smoking, caregiver and friend smoking are linked to trying e-cigarettes, although these relationships are less clear for regular use of e-cigarettes.

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#### CONFLICTS OF INTEREST

Authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none was reported.

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