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RESEARCH REPORT

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Understanding long-term trends in smoking in England, 1972–2019: an age–period–cohort approach

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Abstract

Background and aims: Smoking prevalence has been falling in England for more than 50 years, but remains a prevalent and major public health problem. This study used an age–period–cohort (APC) approach to measure lifecycle, historical and generational patterns of individual smoking behaviour.

Design: APC analysis of repeated cross-sectional smoking prevalence data obtained from three nationally representative surveys.

Setting: England (1972–2019).

Participants: Individuals aged 18–90 years.

Measurements: We studied relative odds of current smoking in relation to age in single years from 18 to 90, 24 groups of 2-year survey periods (1972–73 to 2018–19) and 20 groups of 5-year birth cohorts (1907–11 to 1997–2001). Age and period rates were studied for two groups of birth cohorts: those aged 18–25 years and those aged over 25 years.

Findings: Relative to age 18, the odds of current smoking increased with age until approximately age 25 [odds ratio (OR) = 1.48, 95% confidence interval (CI) = 1.41–1.56] and then decreased progressively to age 90 (OR = 0.06, 95% CI = 0.04–0.08). They also decreased almost linearly with period relative to 1972–73 (for 2018–19: OR = 0.30, 95% CI = 0.26–0.34) and with birth cohort relative to 1902–06, with the largest decreased observed for birth cohort 1992–96 (OR = 0.44, 95% CI = 0.35–0.46) and 1997–2001 (OR = 0.35, 95% CI = 0.74–0.88). Smoking declined in the 18–25 age group by an average of 7% over successive 2-year periods and by an average of 5% in those aged over 25.

Conclusions: Smoking in England appears to have declined over recent decades mainly as a result of reduced smoking uptake before age 25, and to a lesser extent to smoking cessation after age 25.

KEYWORDS
Age–period–cohort model, England, long-term trends, smoking prevalence, smoking uptake, smoking cessation, tobacco

INTRODUCTION

Smoking prevalence in the United Kingdom has been falling for many years. Recent reports estimate that 14.4% of adults in England are current regular cigarette smokers [1] and comparative data from the World Health Organization indicate that the United Kingdom has the eighth lowest smoking prevalence in Europe [2]. Despite this success, in England alone there are still 5.9 million smokers at risk of early death or increased morbidity and more than 74 600 deaths caused by smoking each year [3], indicating that further reductions in smoking prevalence are an urgent priority [4].

Age–period–cohort (APC) models have been widely used in public health to explore long-term trends in a diversity of topics such as mortality [5], obesity [6, 7], suicide [8, 9], mental health [10], alcohol consumption [11, 12], substance use [13] and smoking [14–16]. While cohort analysis allows identifying birth cohorts that are more at risk for a specific health outcome, APC models allow disentangling the differentials in risk associated with individuals' age from those associated with their year of birth from those associated with changes in exposure to risks over time [16–18]. Hence, they provide a different approach for understanding long-term trends, with information regarding the distribution of a health outcome while generating essential information for public health surveillance in the long term [17].

In the United Kingdom, studying long-term smoking trends has been a useful way to understand long-term policy effects [19] and population subgroup differences in smoking [20–22], but there are few studies of generational differences in smoking behaviour. A study by Kemm [20] reported birth cohort ever-smoking behaviour and suggested that, as cohorts aged, there was a fairly constant rate of quitting smoking after the age of 25 years. Evandrou & Falkingham [23] reported that smoking prevalence was generally lower and that cessation tended to happen at younger ages among successive birth cohorts. Similarly, Davy [22] also found a clear cohort reduction in smoking prevalence among successive cohorts, but that cohorts born after the 1950s exhibited a slower rate of decrease than those born before the 1950s. However, while these studies demonstrated important differences in patterns of smoking within different subgroups of the population of Great Britain and within different birth cohorts, to our knowledge there has been no APC analysis of smoking patterns and no updated cohort analysis since 2005 [20–23].

We have therefore combined data from nationally representative cross-sectional household surveys of adults aged 18–90 years in England during a 47-year period from 1972 to 2019 to study age and period trajectories in current regular smoking, and to use an APC model to disentangle the influence of age or factors associated with the process of ageing (life-cycle) from the influence of period or factors associated with the context in which individuals are observed (historical) from the influence of cohort or factors associated with the date individuals were born (generational) when studying individual smoking behaviour [24]. To achieve this aim, we used a full APC model to estimate general population age, period and birth cohort smoking behaviour patterns and a reduced APC model to compare age and period rates of transitions into (initiation) and out of smoking (cessation) among successive birth cohorts.

METHODS

Study design and data sources

Yearly cross-sectional individual-level data were taken from the General Household Survey (GHS) from 1972 to 2006 [25–56] (biennially during the period 1980–2000), the Health Survey for England (HSE) core sample (no boost [1]) from 1992 to 2015 [57–80] and the Annual Population Survey (APS) from 2010 to 2019 [81–90]. The three surveys are all nationally representative, include the same method of using two questions (ever smoking and smoking nowadays) to obtain individual smoking status and have been regularly used to report general population smoking prevalence for either Great Britain [91] or England [92].

The GHS was a continuous multi-purpose household survey that collected information annually at household (approximately 9000 households) and individual levels (approximately 16 000 adults aged 16 years and above). It was conducted by the Office for National Statistics in the (ONS) and included general topics related to the household, family and individuals and is representative of the population of Great Britain [93]. The HSE is also a continuous annual survey that collects information annually of a representative sample of individuals living in private households in England (approximately 9000 households) and covers topics related to general health and associated risk factors among individuals in the household [94]. Finally, the APS is also a continuous annual survey collecting information from individuals in private households in the United Kingdom and is representative at local levels. The main topics covered are employment, housing, ethnicity, religion, health and education and has the largest household sample, reaching approximately 320 000 respondents every year [95].

We compared age and age–period trajectories of smoking prevalence by birth cohort and estimated two APC models to compare the likelihood of smoking across age, periods and birth cohorts. To describe smoking uptake and cessation within successive birth cohorts, we studied age and period rates of smoking among the population aged 18–25 years and among the population aged over 25 years.

Measures

Outcome variable

Our main outcome measure was current regular cigarette smoking, based on affirmative responses to two questions: 'Have you ever smoked?' (which was changed to 'Have you ever regularly smoked?' in the APS from 2016) and 'Do you smoke cigarettes at all nowadays?'. If individuals replied affirmatively to these two questions, they were classified as 'current regular cigarette smokers' with the value

'1' and with the value '0' otherwise. Smoking prevalence was defined as the proportion of the population thus defined as current regular cigarette smokers.

Age variable

The GHS included individuals aged 16 years or over, but after 2007 surveys included only individuals aged 18 years or over. Therefore, to make our surveys comparable, we included only individuals aged 18 years or over (which has also been the legal age of sale of tobacco products in England since October 2007), and to avoid problems arising from low numbers at older ages we limited the sample to a maximum age of 90 years. In our analyses we therefore used single-year ages from 18 to 90 and created two groups based on age: a group composed of individuals aged 18–25 years to study uptake and a group for those aged 25 years and above to study cessation.

Period variable

As data were available only biennially for the period 1980–2000, we created a period variable which grouped survey year in 24 2-year periods from 1972–73 to 2018–19.

Birth cohort variable

Year of birth was estimated from the individual's age and the survey year grouped into 5-year birth cohorts, which is conventional [96], creating a total of 20 groups from 1902–06 to 1997–2001. However, we explored our results using 2-, 5- and 10-year birth cohorts in our sensitivity analyses.

The 'identification problem' in APC models

The 'identification problem' in APC models refers to the linear dependence between age, period and cohort as APC [97], which means that there is perfect multi-collinearity between the three variables [24], and it is not possible to identify the three effects separately. There is no unique solution to this problem, but one possibility is to transform the variables in a way that breaks their strict dependence while still allowing identification of the APC effects. Combining each of the variables into age groups, year (or period) groups and year of birth cohort groups [98] under the assumption that individuals in each age, period and birth cohort group are similar in their smoking behaviour patterns will break the exact collinearity and allow identification of the separate effects. We therefore proposed two APC models: first, an APC model in which two of the APC variables (in this case, periods and birth cohorts) were transformed into a 2-year grouped period variable and a 5-year-of-birth grouped cohort variable, while our single-year age variable was used in its original form (not grouped); secondly, we used a reduced-form APC model which only included the single-age variable and the 2-year grouped period variable, estimated for each 5-year birth cohort group.

Statistical analysis

We carried out a visual inspection of the data first by plotting smoking prevalence [with 95% confidence intervals (CI)] for the population of England in each 2-year survey period from 1972 to 2019, comparing the results from GHS, HSE and APS. Secondly, using the series excluding overlapping data, hence GHS 1972–91, HSE 1992–2011 and APS 2012–19, we compared 5-year birth cohort age-trajectories in smoking prevalence by average cohort age (only for cohorts with 100 or more individuals per 2-year period). Thirdly, we used Lexis heat-map diagrams to visualize the age and period trajectories for 5-year birth cohort smoking behaviour through time, in which the smoking prevalence was plotted by average age of the cohort and by 2-year survey period [99].

Next, we estimated two APC models using logistic regression for our binary current regular cigarette smoking variable based on a similar model used by Meng et al. [11]. The first model (model 1) implemented a full APC model, which included our grouped 2-year period variable coded as categorical (dummy variable for each 2-year survey period with period 1972–73 as the reference category), our 5-year birth cohort variable coded as categorical (dummy variable for each 5-year birth cohort with birth cohort 1902–07 as the reference category) and our single-age variable expanded as categorical for each age year from 18 to 90 years (dummy for each age year with 18 years as the reference category). The second model (model 2) implemented a reduced-form APC model which included our period (2-year survey period) and single years of age variable incorporated in a continuous form to study age and period rates. Model 2 was run for each birth cohort as a subgroup analysis for individuals aged 25 years or younger to study smoking uptake (model 2a, run separately for each birth cohort in the range 1947–51 to 1997–2001) and for individuals aged over 25 years to study smoking cessation (model 2b, run separately for each birth cohort in the range 1902–06 to 1987–91). For each model, we reported the APC effects graphically in terms of odds ratios (OR) and the statistical uncertainty around our estimated effects in terms of their associated 95% CIs, and added the average age and period rate in the graphical representation of model 2. We used unweighted survey measures, as survey weights were unavailable before 1999 [100] and there is evidence that the differences between weighted and unweighted data are extremely small [101].

We performed a series of sensitivity analyses to check the validity of our series and the robustness of our APC results. To check the validity of the series without overlap used in all previous analyses, we compared smoking prevalence trends by age group (aged 18–25 years and over 25 years), and ran our APC analyses using different overlaps between the surveys (GHS 1972–2003, HSE 2004–09 and APS 2010–19). These results can be found in Supporting information, Figures S1, S2 and S3. To check the robustness of our APC results we ran the same analysis for model 1 using different groupings for age, period and birth cohort: (a) 2-year age, 2-year period and 2-year birth cohort, (b) 5-year age, 5-year period and 5-year birth cohort and (c) single-age years, 2-year period and 10-year birth cohorts. Results can be found in Supporting information, Figures S4–S6, and showed that our results were robust to different specifications of the APC variables. All the analyses were performed in Stata version 16.1 and were not pre-registered, so results should be considered exploratory.

RESULTS

Data visualization of smoking prevalence in England 1972–2019

There was a marked decline in smoking prevalence in England during the study period (Figure 1) from 46.1% (95% CI = 45.5–46.6%) in 1972–73 to 13.9% (95% CI = 13.7–14.0%) in 2018–19. Although the point estimates obtained with the three surveys differed in the overlapping periods, their confidence intervals overlapped for most periods except 2002–03 and 2004–05, when the GHS estimated 23.9% (95% CI = 23.4–24.4%) and 22.7% (95% CI = 22.2–23.3%), respectively, while the HSE estimated 26.0% (95% CI = 25.4–26.4%) and 21.2% (95% CI = 20.4–21.7%), respectively (Figure 1a).

Age and period trajectories of current regular cigarette smoking within birth cohorts

Data were available for the entire 1972–2019 study period in all 5-year birth cohorts from 1927–31 to 1952–56 and for progressively fewer years in subsequent cohorts, the shortest period of data availability being from 2014 to 2019 in the 1997–2001 cohort.

Figure 2 shows those 5-year birth cohorts for which we were able to observe smoking behaviour before the age of 30 years (those born between 1947 and 2001). In almost all cohorts smoking prevalence reached a peak by the age of 24 years, but in the two youngest birth cohorts (1992–96 and 1997–2001) peak prevalence occurred at 18 years of age, with the most recent birth cohort born 1997–2001 showing almost stable smoking prevalence in the three 2-year survey periods for which data were available. The magnitude of the peak in smoking prevalence within cohorts decreased considerably over time, from 50.5% at age 24 in the 1947–51 cohort to 31.5% at age 22 in the 1987–91 cohort, with the two youngest cohorts (1992–96 and 1996–2001) showing even lower peaks (22.6% for 1992–96 and 14.5% for 1997–2001) and relatively flat prevalence (Figure 2).

A heat-map of age and period trajectories for 5-year birth cohort smoking behaviour demonstrates declining patterns for period trajectories by average cohort age (Figure 3). The highest prevalence for ages between 20 and 60 years was during the 1970s, at above 55%. After that peak, a 10 percentage-point decline was observed for ages between 20 and 60 years at the end of the 1970s and another 10 percentage-point decline for the population aged between 30 and 65 years at the end of the 1980s. Three additional periods of decline were observed for subsets of birth cohorts: first, at the beginning of the 1990s, affecting cohorts with an average age of between 50 and 65 years; secondly, in the mid-2000s, among birth cohorts with an average age of between 25 and 35 years and birth cohorts aged between 40 and 55 years; and thirdly, at the beginning of the 2010s for birth cohorts aged between 35 and 55 years.

In terms of birth cohort transitions into lower percentages of smoking prevalence, two periods can be observed in Figure 3. Between 1972 and 1991 birth cohorts with an average age above 50 years experienced a faster transition into lower smoking prevalences than birth cohorts of similar age after 1991. Transitions into

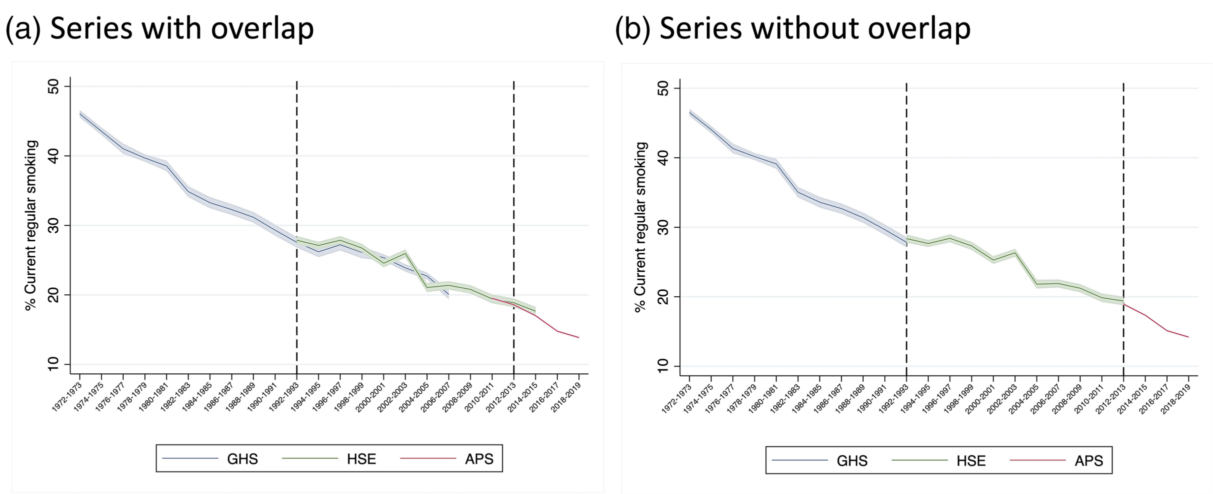

FIGURE 1 Percentage of current regular smoking among general population and 95% confidence intervals by survey in England: (a) series with overlap between General Household Survey (GHS) (1972–2006), Health Survey for England (HSE) (1992–2018) and Annual Population Survey (APS) (2010–19) and (b) series without overlap between surveys GHS (1972–91), HSE (1992–2011) and APS (2012–19)

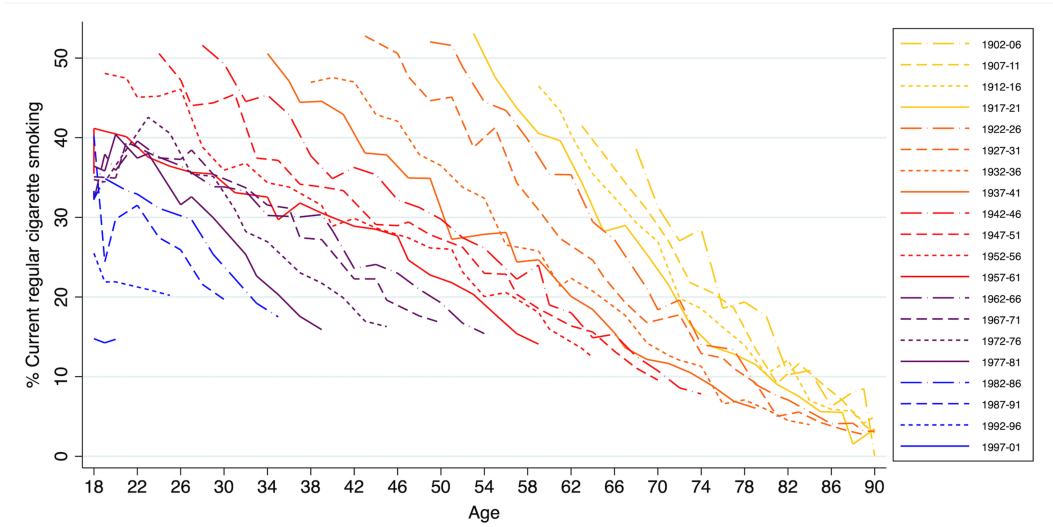

FIGURE 2 Age trajectories of percentage of current regular smokers by 5-year birth cohorts in England using series without overlap between General Household Survey (GHS) (1972–91), Health Survey for England (HSE) (1992–2011) and Annual Population Survey (APS) (2012–19) to cover period 1972–2019

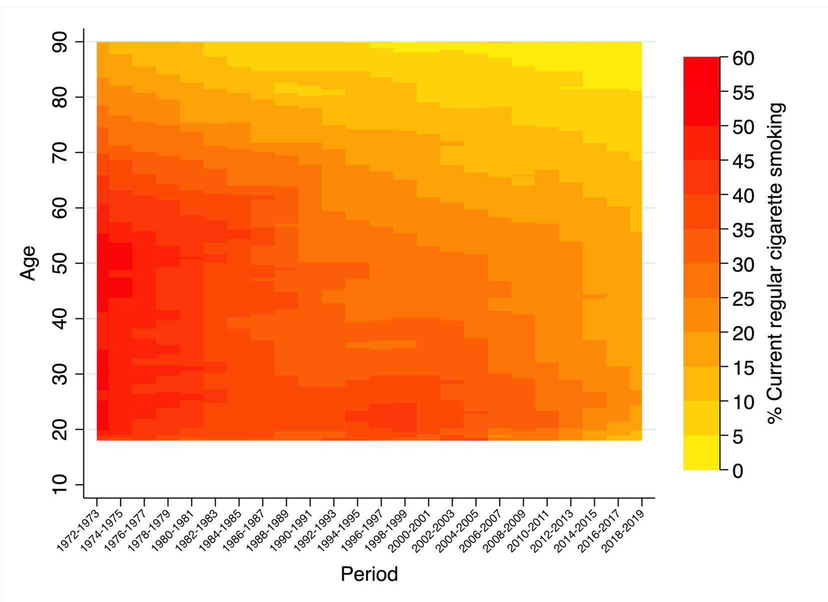

FIGURE 3 Age and period trajectories of percentage of current regular smoking for 5-year birth cohorts in England using series without overlap between General Household Survey (GHS) (1972–1991), Health Survey for England (HSE) (1992–2011) and Annual Population Survey (APS) (2012–19) to cover period 1972–2019 using 2-year survey periods

higher smoking prevalences were observed among birth cohorts with an average age below 25 years during the period 1994–99, while from the mid-2000s birth cohorts with an average age below 25 years showed little or no transition to higher smoking prevalence, reaching lower peak percentages than birth cohorts before the mid-2000s. Birth cohorts aged below 25 years had a smoking prevalence of approximately 44% during 1970s, 37% in the 1980s and 1990s, 33% in the 2000s and 21% in the 2010s showing that, as time passed, younger birth cohorts successively reached lower percentages of population classified as current regular cigarette smokers during the ages at which smoking initiation takes place.

APC regression analysis: model 1

The results of model 1 are shown in Figure 4, with full regression results presented in Supporting information, Tables S1–S3. Compared to our age reference category (18 years), there was a clear increase in the odds of being a current regular cigarette smoker until approximately 25 years of age (at 25 years, OR = 1.48, 95% CI = 1.41–1.56) and decreasing odds afterwards (at 55 years, OR = 0.84, 95% CI = 0.76–0.94 and at 90 years, OR = 0.06, 95% CI = 0.04–0.08). Between the ages of 36 and 42 years, the odds of being a smoker were not statistically different from those at age 18, but they

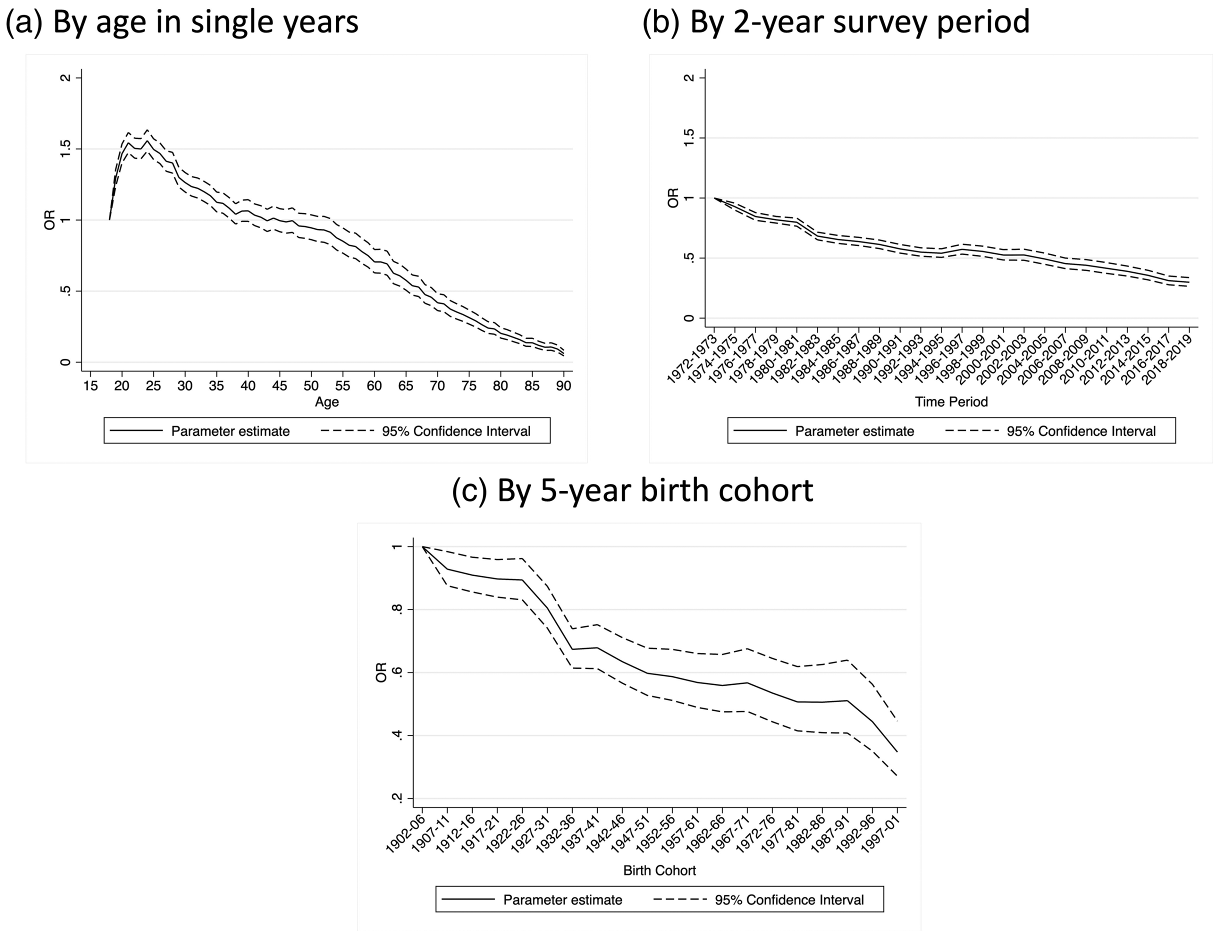

FIGURE 4 Regression results, model 1: estimated odds (OR) of being a current regular cigarette smoker and 95% confidence intervals by age, 2-year survey period and 5-year birth cohort in England, 1972–2019. Reference category for (a) is age 18 years, for (b) is period 1972–73 and for (c) is birth cohort 1902–06

decreased almost linearly from ages 43 to 90 years (Figure 4a). The odds of being a current regular cigarette smoker also decreased steadily over time compared to our 1972–73 reference category to an OR of 0.30 (95% CI = 0.26–0.34) for the period 2018–19, with the exception of a period of relative stability evident during the 1990s (Figure 4b). Finally, for all 5-year birth cohorts born after and including 1907 the odds of being a current regular cigarette smoker were lower than those of the 1902–06 birth cohort, with a bigger reduction from their predecessors among birth cohorts 1927–31 (OR = 0.81, 95% CI = 0.74–0.88) and 1932–36 (OR = 0.67, 95% CI = 0.63–0.74), and then among the two most recent, i.e. youngest birth cohorts born in 1992–96 (OR = 0.44, 95% CI = 0.35–0.46) and 1997–2001 (OR = 0.35, 95% CI = 0.27–0.44) (Figure 4c).

APC regression analysis: model 2

Results from model 2 are shown in Figure 5, with full regression results presented in Supporting information, Tables S4 and S5. Figure 5a shows that for birth cohorts aged 18–25 years, for which changes in smoking prevalence suggest changes in smoking initiation, period effects tended to be lower than 1 (OR < 1) but age effects higher than 1 (OR > 1). Hence, the likelihood of smoking increased with age for all birth cohorts during the age period 18–25 years but decreased through time. The figure also shows that birth cohorts 1957–61, 1962–66, 1967–71 and 1977–81 showed overlapping age and period rates that were not significantly different from OR = 1. This suggests that there was no significant change in smoking prevalence with age or period for these birth cohorts using our reduced-form model. Among cohorts there was an average 5% increase by age year and an average 7% decrease by period, suggesting that period effects dominated over age effects, allowing for smoking levels at younger ages to become lower with time.

Figure 5b shows that for birth cohorts aged over 25 years, for which declines in smoking prevalence are likely to reflect smoking cessation, age and period rates were very similar and for most cohorts they were significantly below 1 (OR < 1), which means that both age and period rates were associated with a decrease in the odds of current smoking. The age rate of decrease was higher for birth cohorts 1902–06 to 1922–26 (approximately 6% decrease per age year, which is higher than the 4% average decrease), and relatively similar at an approximate 3% decrease per year of age thereafter. The

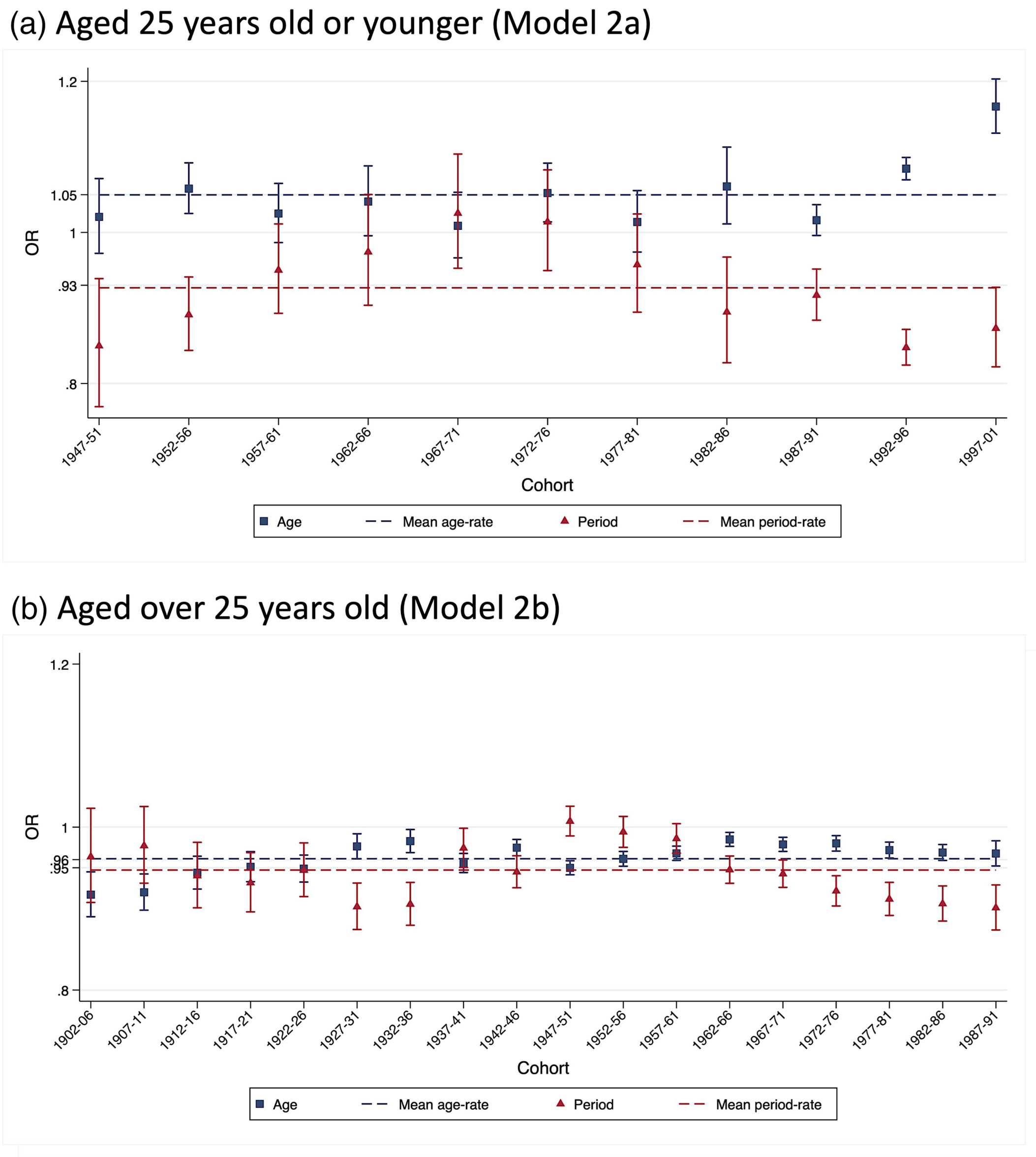

FIGURE 5 Regression results, model 2: age and period rates in terms of odds (OR) of being a current regular cigarette smoker and 95% confidence intervals by birth cohort for (a) individuals aged 25 years or younger and (b) for individuals aged more than 25 years, England 1972–2019

average period rate of decrease was 5%, but was higher (at approximately 9% per period) for birth cohorts 1927–31, 1932–36 and those born after 1972.

DISCUSSION

This study combines three data sources to create the most extensive APC analysis of smoking behaviour in England reported to date. Overall, our findings demonstrate that the steady long-term decrease in smoking prevalence observed in the general population during a period of nearly five decades arises primarily from reduced smoking initiation in successive birth cohorts, while rates of decline in smoking within cohorts, after reaching a peak by 25 years, has remained relatively constant by age and period. This suggests that UK tobacco control policy during the past five decades has delivered substantial reductions in smoking initiation, but has had relatively little effect on quit rates among established smokers.

Strengths of this study

This study presents the most recent update analysis of birth cohorts' smoking behaviour and the first time an APC approach has been used to study smoking behaviour in England. Studying APC effects requires data from large sample sizes collected over long periods of time, and we were able to obtain suitable data for England by combining three large national survey data sets. Further analysis for Great Britain could be performed using restricted-access data sets that were unavailable to us at the time of writing due to restrictions arising from measures to contain the COVID-19 pandemic [102]. However, as the great majority of the UK population lives in England (84% of the population in the United Kingdom, according to the latest population estimate), it is likely that our findings apply more generally to the entire United Kingdom.

Limitations of this study

As our analysis is based solely upon prevalence data, we are unable to distinguish the extent to which smoking prevalence changes reflect changes in uptake, cessation or premature mortality among smokers. Based on a study on smoking initiation in Europe [103] (and similar to the assumption used previously in a UK study [19]) we have assumed that up to age 25 the increasing prevalence of smoking reflects a dominant pattern of smoking uptake, while after 25 declining smoking prevalence is likely to be due to quitting among younger adults and to both quitting and premature mortality in older adults. However, as mortality changes through time it can be considered to be related to our period variable. By using an APC model we have thus controlled for major changes in mortality over time, although further research should test the validity of this approach.

We were also unable to directly address smoking initiation using never or ever smoking behaviour among the young population, because the questions related to smoking in the national survey changed in 2016. Similarly, we could not use weights because there were no weights available for the whole series, and we could not adjust for socio-demographics because their definitions changed through time or differed between surveys. However, we believe that by using nationally representative surveys with large samples we can be confident that our results can be generalizable to the population of England.

Our analysis does not directly account for the role of alternative nicotine delivery products, and their effect on smoking prevalence declines. However, the literature suggests that more than limiting smoking declines, e-cigarettes have contributed to those declines by helping smokers to quit successfully [19]. In this case their effect would be included in our period variable, as the effect of tobacco control policies and other contextual variables are contained within that variable. With respect to the association between e-cigarettes and initiation, although our analysis does not directly account for the effect of the increase in e-cigarette use in England after 2014, the large decrease in the likelihood of being a current smoker among the two youngest birth cohorts in our study (1992–96 and 1997–2001) observed between the ages of 18 to 24 years suggests that the increase in e-cigarette use during the period 2014–19 seems not to have contributed to an increase in the most concerning cigarette consumption pattern (regular smoking at least one cigarette per day), in line with previous analyses for the United States [104, 105] and England [106].

Contribution to the literature

Our research extends the work of Kemm [20] and Davy [22] by adding more periods and by using an APC model for the first time in the analysis of English data. Separating APC effects has been a topic of some controversy in the literature due to the linear dependency of these effects [107, 108]. We have used both a descriptive analysis and two models to address those limitations. Our descriptive results are in line with previous literature studying smoking behaviour among UK birth cohorts, which suggest that there was a clear reduction in smoking among successive birth cohorts [20, 22], but our age and period trajectories go further and identify five clear moments in time in which all or a large proportion of cohorts experienced a sudden decrease in current smoking. To our knowledge, our regression analysis using an APC approach has not been used before and uncovers two important facts: (a) that the decrease in smoking has not been equal among birth cohorts and (b) that the age decrease in smoking prevalence after the age of 25 years slows down between the ages of 36 and 42 years, proving not to be linear, as previously suggested [20].

Our study can also be related to the literature about birth cohorts' smoking histories using cross-sectional data [109–112]. In line with this literature, our results have also shown that even though age trajectories can follow the same pattern between birth cohorts their smoking trajectories can differ significantly, suggesting that the exposure to the whole experience of tobacco varies considerably between birth cohorts, especially when using a long time-period. Therefore, the use of an APC approach can provide a new way to understand long-term effects of historical smoking prevention and reduction strategies [15, 110], and future studies should exploit this route.

Implications for policy

Our age and period trajectories and our decreasing period effect found in both of our APC analyses provide indirect evidence towards the effectiveness of tobacco control policies in reducing smoking prevalence in England, while our age and birth cohort effects provide evidence towards an unequal decrease in smoking prevalence among different ages and different birth cohorts. However, for a direct analysis of the effectiveness of tobacco control policies we would need a different approach (such as time-series analysis) or use a different solution to the 'identification problem' that would allow us to further understand the association between tobacco control policies and changes in age and birth cohort smoking behaviour. Conversely, the differences by age, the sustained decrease in the period effect and the sharp decrease in the birth cohort effect among the youngest birth cohorts in our study suggest that future policies should continue to support the decrease in smoking initiation among the young population, but also suggest that the use of a more focused smoking cessation effort could be effective to support groups with smaller smoking prevalence decreases, such as populations aged between 32 and 46 years.

CONCLUSIONS

Our study suggests that the sustained decline in smoking prevalence in England has been achieved in particular by reducing smoking uptake, which is particularly relevant in the context of the latest Tobacco Control Plan for England and its target of creating a smoke-free generation [4]. However, while undoubtedly a public health success, further efforts are needed to strengthen the focus upon the population of current smokers in England who will experience the almost entire public health burden of death and disease caused by smoking in the short- and medium-term future. Therefore, it is now essential that tobacco control policy focuses upon helping established smokers to quit by integrating universal and systematic interventions to support cessation into routine health service care, and using medicinal and consumer products to encourage smokers who prove unable or unwilling to quit to switch to less harmful tobacco products [113, 114].

DECLARATION OF INTERESTS

None.

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AUTHOR CONTRIBUTIONS

Magdalena Opazo Bretón: Data curation; formal analysis; funding acquisition; investigation; methodology; project administration; visualization. **Duncan Gillespie:** Conceptualization; formal analysis; project administration; visualization. **Robert Pryce:** Conceptualization; data curation; methodology. **Ilze Bogdanovica:** Supervision. **Colin Angus:** Conceptualization; methodology; visualization. **Monica Hernandez Alava:** Formal analysis; methodology; supervision; validation. **Alan Brennan:** Conceptualization; methodology; supervision; validation. **John Britton:** Conceptualization; supervision; validation.

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