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Association between electronic cigarette use and changes in quit attempts, success of quit attempts, use of smoking cessation pharmacotherapy, and use of stop smoking services in England: time series analysis of population trends

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What are e-cigarettes?

- Electronic device that vaporizes a fluid
  - Nicotine
    - Main addictive substance in cigarettes
  - Propylene glycol
    - Additive that is "generally recognized as safe" for use in food (FDA)
  - Glycerine
    - Used as a sweetener
  - Flavourings

- Does not contain the other ‘carcinogenic and poisonous’ chemicals in a cigarette
Background

- There has been a steady rise in the use of e-cigarettes

- This has raised several concerns:
  - Could undermine quit attempts (Kalkhoran et al, 2016; Pulvers et al, 2015; Pearson et al, 2015; Vickerman et al, 2013)
  - Be responsible for the decline in use of licensed smoking cessation medication (i.e. NRT) and Stop Smoking Services (SSS) (Health and Social Care Information Centre, 2014; Shubber et al, 2014)
Background

“The shapes of trajectories . . . suggest that electronic cigarettes are probably not responsible for the decline in use of licensed nicotine products”

“… EC containing nicotine increased the chances of stopping smoking in the long term compared to using an EC without nicotine”
Objectives

• This study used data from England to address the concerns that have been raised

• England is a country with a relatively liberal regulatory framework for e-cigarettes and has seen considerable growth in their use

• Unique time-series data to be able to estimate changes over time in key quitting activities as a consequence of e-cigarette use
Aims

• Aimed to assess, using time series analysis, whether changes in e-cigarette use at a population level have been associated with prevalence of:
  • Attempts to quit smoking
  • Successful quit attempts
  • NRT use (over-the-counter & on prescription)
  • Licensed medication use (NRT, Varenicline & bupropion)
  • Number setting a quit date at stop smoking services
Design

- Data came from two main sources
  - The Smoking Toolkit Study
    - Monthly household survey of adults aged 16+
    - Representative of the population in England
      (Fidler et al, 2011)
  - English NHS SSS
    - Quarterly data collected from Local Authorities by NHS Digital (formerly HSCIC)
Analysis

- Pre-registered on Open Science Framework (https://osf.io/fbgj2/)

- Adjusted for tobacco control policies (mass media expenditure, increase in age-of-sale of cigarettes, smoking ban and move of SSS to local authority control)

ARIMAX

Autoregressive Integrated Moving Average with Exogenous input
Analysis

- **ARIMAX** can be viewed as a “filter” that separates the signal from the noise.

- The signal is then extrapolated into the future to obtain forecasts:

  \[ Y_t \rightarrow \text{AR filter} \rightarrow \text{Integration filter} \rightarrow \text{MA filter} \rightarrow \varepsilon_t \]
  
  (long term) (stochastic trend) (short term) (error)

- **AR filter** models **autoregressive autocorrelation**
  - Any given value \( X(t) \) can be explained by some function of its previous value, \( X(t-1) \), plus some unexplainable random error, \( E(t) \).

- **MA filter** models **moving average autocorrelation**
  - Any given value of \( X(t) \) is directly related to the random error in a previous period, \( E(t-1) \), and to the current error, \( E(t) \).
Analysis

• **Integration filter** aims to make the series **stationary**
  - Statistical properties such as mean and variance are all **constant over time**
  - **Aids prediction** as properties will be the same in the future as they have been in the past
  - We can achieve this through:
    a) **Transformations** (e.g. logarithmic)
    b) **Differencing** which removes underlying trends and seasonality (e.g. 1 2 3 → 1 1 1)

"I have seen the future and it is very much like the present, only longer"

Kehlog Albran
Results

- The success rate of quit attempts increased by 0.098% for every 1% increase in the prevalence of e-cigarette use by smokers (p<0.001)

- The success rate of quit attempts increased by 0.058% for every 1% increase in the prevalence of e-cigarette use during a recent quit attempt (p<0.001)

- There was no clear evidence for an association between e-cigarette use by smokers and rate of quit attempts (β 0.025; p=0.41)


Fig 1: Quarterly prevalence of (a) self reported quit attempts, success of quit attempts, and current e-cigarette use and (b) success of quit attempts and e-cigarette use during a quit attempt in England.
Results

- There was no clear evidence for an association between e-cigarette use during a quit attempt and:
  - Use of NRT bought over-the-counter (β 0.006; p=0.89)
  - Use of prescription medication (β -0.070; p=0.10)
  - Use of behavioural support (β -0.013; p=0.78).

- There was a negative association between e-cigarette use during a quit attempt and NRT obtained on prescription (β -0.098; p=0.04).


Fig 2: Quarterly prevalence of e-cigarette use during a quit attempt and (a) prescription treatment during a quit attempt, (b) NRT obtained over the counter during a quit attempt, (c) NRT on prescription during a quit attempt, and (d) quarterly number of smokers setting a quit attempt with stop smoking services in England
Conclusion

• The increase in e-cigarette use in England has been positively associated with the success rates of quit attempts.

• No clear association has emerged between e-cigarette use and:
  • Quit attempts
  • Use of licensed NRT bought over-the-counter
  • Prescription treatment
  • Behavioural support

• Use of e-cigarettes in quit attempts has been negatively associated with use of NRT on prescription.

E-cigarettes have contributed to 54,288 additional short to medium term quitters in 2015 [18,000 additional long term ex-smoker]
Strengths and limitations

- First empirical study to estimate the population impact of e-cigarettes using a time series approach
- Use of a large representative sample of the English population, in addition to service use data
- Findings might not generalise to other countries

- Future studies should assess the impact on use among never smokers
  - Regular use is rare (Berg et al, 2014; Dockrell et al, 2013)

www.smokinginengland.info
Thank you for listening

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