Impact of vaping introduction on cigarette smoking among young adults in four high-income countries – An interrupted time series analysis

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Agenda

• Background
• Research Question and Hypotheses
• Methodology
• Results
• Limitations and Implications of study
Background

- Use of electronic nicotine delivery systems (ENDs), particularly e-cigarettes, commonly known as “vaping” has become popular in many high-income countries from around 2013, especially among youths and young adults.
- E-cigarettes mimic the look and feel of conventional cigarettes, as they generate an aerosol containing flavorings, with or without nicotine, creating sensations similar to smoking.
- There has been a long standing debate on the role of vaping as a “gateway” to smoking among youths and young adults.
Research Question and Hypotheses

Q: Does vaping introduction reduce or increase the sex-specific prevalence of smoking among young adults in Canada sub-nationally (where regulations vary across provinces), and at the national level in UK, Japan, and Australia?

H: Introduction of vaping reduced sex-specific prevalence of smoking among young adults in the four countries.
Methodology

• Country selection: Canada, UK, Japan, and Australia selected based on:
  ✓ Availability of data on smoking prevalence, by age and sex
  ✓ Availability of data on cigarettes sales (or consumption)
  ✓ Varied approaches to regulation of vaping
    ▪ Maximum nicotine level permitted in vaping products:
      Canada: 66 mg/mL  UK: 20 mg/mL
      Japan: nicotine levels in HNB is comparable to that in cigarettes;
      Australia: nicotine is not permitted in e-cigarettes
    ▪ E-cigarette taxation policies

• Measures of smoking:
  ➢ Prevalence of smoking among young adults, defined as individuals aged 18 to 30+ years, stratified by sex
  ➢ Annual cigarette sales (consumption) per adult aged 18+ years
## Data Sources

<table>
<thead>
<tr>
<th>Country</th>
<th>Prevalence data source</th>
<th>Age group(s) analyzed</th>
<th>Consumption data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>Canadian Community Health Survey</td>
<td>18- 34 years</td>
<td>Health Canada</td>
</tr>
<tr>
<td>UK</td>
<td>Opinions and Lifestyle Survey</td>
<td>16-24 years, 25-34 years</td>
<td>Euromonitor</td>
</tr>
<tr>
<td>Japan</td>
<td>National Health and Nutrition Survey</td>
<td>20-29 years, 20-39 years</td>
<td>International Smoking Statistics (upto 2015), Cummings et al. (2020) for 2016 to 2018</td>
</tr>
<tr>
<td>Australia</td>
<td>National Health Survey, National Drug Strategy and Household Survey (conducted every 2-3 years; data interpolated to obtain annual prevalence)</td>
<td>15 (16)-17 years, 18-24 years, 25-34 years</td>
<td>Average spending on cigarettes and other tobacco products per capita</td>
</tr>
</tbody>
</table>
Analysis

- Interrupted time series analysis (ITS)
- Intervention: Uptake of e-cigarettes
- Intervention point
  - No fixed intervention point
  - We used the first year when national surveys included questions on the use of e-cigarettes (2016 for Japan when Ploom Tech and glo were introduced)

- Unit of analysis:
  - Province for Canada
  - Country for UK, Japan, and Australia

Model is adjusted for cigarette tax/price as a potential confounder
RESULTS
Alberta, Canada

Smoking prevalence

Males aged 18-34 years

Females aged 18-34 years

Level change:
-3.24, p = 0.058
Slope change:
-1.51, p = 0.057

Level change:
-0.20, p = 0.942
Slope change:
1.06, p = 0.019

Cigarette consumption (sales) per adult

Level change: 80.39, p = 0.021
Slope change: -52.23, p = 0.037
British Columbia, Canada

Smoking prevalence

Males aged 18-34 years

Females aged 18-34 years

Cigarette consumption (sales) per adult

Level change: 3.29, p = 0.311
Slope change: 1.38, p = 0.175

Level change: -1.36, p = 0.570
Slope change: -0.90, p = 0.179

Level change: 4.67, p = 0.904
Slope change: 6.40, p = 0.208
Ontario, Canada

Smoking prevalence

Males aged 18-34 years

Females aged 18-34 years

Cigarette consumption (sales) per adult

Intervention starts: 2013

Level change: -1.24, p= 0.452
Slope change: -2.00, p= 0.017

Level change: -2.21, p= 0.045
Slope change: -1.06, p= 0.056
Quebec, Canada

Smoking prevalence

Males aged 18-34 years

- Level change: -1.48, p = 0.636
- Slope change: -2.12, p = 0.100

Females aged 18-34 years

- Level change: -2.37, p = 0.221
- Slope change: -1.36, p = 0.062

Cigarette consumption (sales) per adult

- Level change: -116.78, p = 0.110
- Slope change: -93.84, p = 0.002
Impact on smoking prevalence in UK, by sex

Males:
- 16-24 years
  - Intervention starts: 2012
  - Level change: -1.65, p = 0.409
  - Slope change: 3.50, p = 0.033

- 25-34 years
  - Intervention starts: 2012
  - Level change: 6.90, p = 0.001
  - Slope change: -1.24, p = 0.189

Females:
- 16-24 years
  - Level change: -1.46, p = 0.453
  - Slope change: -0.06, p = 0.970

- 25-34 years
  - Level change: 3.05, p = 0.016
  - Slope change: -2.80, p = 0.017

Adjusted for price (constant 2018 GBP)
Impact on cigarette consumption per adult (retail value) in UK

Retail value (RSP) in constant 2018 USD

Intervention starts: 2012

Level change: 7.83, p = 0.561
Slope change: 4.34, p = 0.502

Regression with Newey-West standard errors - lag(1)
Impact on smoking prevalence in Japan, by sex

Males:
- 20-29 years
  - Level change: 0.12, p=0.895
  - Slope change: -0.58, p=0.508
- 30-39 years
  - Level change: -0.91, p=0.248
  - Slope change: 0.00, p=0.994

Females:
- 20-29 years
  - Level change: 0.05, p=0.909
  - Slope change: -0.36, p=0.310
- 30-39 years
  - Level change: 0.87, p=0.039
  - Slope change: 0.27, p=0.234

Adjusted for price (constant 2018 JPY)
Impact on smoking consumption per adult (number of sticks) in Japan

Level change: 71.37, p = 0.419
Slope change: -118.83, p = 0.010
Impact on smoking prevalence in Australia among young adults aged 18-24 years, by sex

Males:
- AHS: Level change: 2.22, p= 0.215
  - Slope change: 3.47, p= 0.011
- NDSHS: Level change: -0.46, p= 0.115
  - Slope change: 1.28, p= 0.000

Females:
- AHS: Level change: -0.89, p= 0.465
  - Slope change: -2.03, p= 0.023
- NDSHS: Level change: -0.52, p= 0.352
  - Slope change: -0.38, p= 0.428
Impact on smoking prevalence in Australia among young adults aged 25-34 years, by sex

Males:

- AHS
  - Level change: -0.21, p= 0.826
  - Slope change: -0.85, p= 0.187

- NDSHS
  - Level change: 1.41, p= 0.284
  - Slope change: -1.79, p= 0.093

Females:

- AHS
  - Level change: -0.65, p= 0.789
  - Slope change: 1.54, p= 0.321

- NDSHS
  - Level change: 1.72, p= 0.246
  - Slope change: -0.58, p=0.599
Impact on cigarette consumption per adult (chain volume) in Australia

Intervention starts: 2016

Level change: 34.82, p= 0.037
Slope change: 94.59, p= 0.001

Chain volume in constant 2018 AUD
# Vaping regulations, by country

<table>
<thead>
<tr>
<th>Province/country</th>
<th>Maximum nicotine level permitted in vaping products</th>
<th>Vaping policies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alberta (CA)</td>
<td>66 mg/mL</td>
<td>No provincial legislation</td>
</tr>
<tr>
<td>British Columbia (CA)</td>
<td>66 mg/mL</td>
<td>Not permitted where smoking is not allowed; sales are banned where tobacco sales are banned; promotions in stores are banned</td>
</tr>
<tr>
<td>Ontario (CA)</td>
<td></td>
<td>Sales are banned where tobacco sales are banned</td>
</tr>
<tr>
<td>Quebec (CA)</td>
<td></td>
<td>Similar to BC</td>
</tr>
<tr>
<td>UK</td>
<td>20 mg/mL</td>
<td>Restricted promotions; 20% VAT</td>
</tr>
<tr>
<td>Japan</td>
<td>Similar to cigarettes (HNB)</td>
<td>No regulations on HNB use in public places</td>
</tr>
<tr>
<td>Australia</td>
<td>0</td>
<td>Advertising, promotion, and sponsorship is banned</td>
</tr>
</tbody>
</table>
## Summary of findings

<table>
<thead>
<tr>
<th>Province/country</th>
<th>Age group</th>
<th>Impact of vaping introduction on smoking</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Male smoking prevalence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level change</td>
</tr>
<tr>
<td>Alberta (CA)</td>
<td>18-34 years</td>
<td>-3.24 (-6.63, 0.15)</td>
</tr>
<tr>
<td>British Columbia (CA)</td>
<td>18-34 years</td>
<td>3.29 (-3.98, 10.56)</td>
</tr>
<tr>
<td>Ontario (CA)</td>
<td></td>
<td>-1.24 (-5.00, 2.52)</td>
</tr>
<tr>
<td>Quebec (CA)</td>
<td></td>
<td>1.48 (-8.77, 5.80)</td>
</tr>
</tbody>
</table>

* Measured as number of sticks sold per adult in Canada and Japan, cigarette retail value per adult (2018 USD) in the UK, and cigarette chain volume (2018 AUD) in Australia
## Summary of findings

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<tr>
<th>Province/country</th>
<th>Age group</th>
<th>Male smoking prevalence</th>
<th>Female smoking prevalence</th>
<th>Cigarette consumption per adult</th>
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</thead>
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<tr>
<td></td>
<td></td>
<td>Level change</td>
<td>Trend change</td>
<td>Level change</td>
</tr>
<tr>
<td>UK</td>
<td>16-24 years</td>
<td>-1.65 (-6.01, 2.71)</td>
<td>3.50 (0.37, 6.63)</td>
<td>-1.46 (-5.74, 2.82)</td>
</tr>
<tr>
<td></td>
<td>25-34 years</td>
<td>6.90 (3.91, 9.88)</td>
<td>-1.24 (-3.23, 0.75)</td>
<td>3.05 (0.73, 5.36)</td>
</tr>
<tr>
<td>Japan</td>
<td>20-29 years</td>
<td>0.12 (-2.01, 2.26)</td>
<td>-0.58 (-2.56, 1.39)</td>
<td>0.05 (-1.00, 1.11)</td>
</tr>
<tr>
<td></td>
<td>30-39 years</td>
<td>-0.91 (-2.62, 0.80)</td>
<td>0.00 (-1.59, 1.60)</td>
<td>0.87 (0.06, 1.68)</td>
</tr>
<tr>
<td>Australia</td>
<td>18-24 years</td>
<td>AHS: 2.22 (-1.63, 6.07); NDSHS: -0.46 (-1.06, 0.14)</td>
<td>AHS: 3.47 (1.08, 5.86); NDSHS: 1.28 (0.81, 1.76)</td>
<td>AHS: -0.89 (-3.63, 1.84); NDSHS: -0.52 (-1.75, 0.70)</td>
</tr>
<tr>
<td></td>
<td>25-34 years</td>
<td>AHS: -0.21 (-2.41, 1.99); NDSHS: 1.41 (-1.42, 4.24)</td>
<td>AHS: -0.85 (-2.23, 0.52); NDSHS: -1.79 (-3.95, 0.37)</td>
<td>AHS: -0.65 (-6.21, 4.91); NDSHS: 1.72 (-1.45, 4.91)</td>
</tr>
</tbody>
</table>

* Measured as number of sticks sold per adult in Canada and Japan, cigarette retail value per adult (2018 USD) in the UK, and cigarette chain volume (2018 AUD) in Australia.
Limitations and Implications of the study

• Some of the limitations of our study include:
  • No fixed intervention point
  • Does not account for smoking intensity and frequency
  • Not controlled for vaping laws

• Some of the implications of the study include:
  • Whether vaping acts as a gateway to cigarette smoking among young adults may depend upon the nicotine content in vape products and vaping policies
Questions