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# What types of e-liquid products were more likely to offer price promotions?

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## ABSTRACT

**Introduction** The present study empirically examined the association between price discounts and product attributes of e-liquids sold by online retailers.

**Methods** We analysed 14 000 e-liquid products from five major online e-cigarette retailers between April and May 2021 to determine the association between price discounts and product attributes such as nicotine level and form, flavour and vegetable glycerine/propylene glycol ratio. A fixed-effects model was used in the analysis and discounts were calculated in US cents/mL of e-liquid volume.

**Results** Out of 14 407 e-liquid products, 92.5% were offered at a discounted price. On average, the price discount for the 13 324 products that had discounts was 16.84 cents/mL across the five stores. Among the three forms of nicotine (salt, freebase and nicotine free), salt e-liquids had the highest average price discount.

**Conclusion** Our findings suggest that e-liquids with salt nicotine have a higher average price discount when sold online, which may influence consumer purchasing behaviour. Further research is needed to assess the potential impact of these discounts on youth and adult tobacco use. Policymakers may consider implementing measures to limit online price discounts for e-liquids as a means of reducing sales among young people.

## INTRODUCTION

The tobacco industry spends about 86% of its marketing and promotion budget on price promotion each year.<sup>1</sup> The promotion strategy of offering a discounted price compared with the regular retail price had been used by online e-cigarette retailers.<sup>2</sup> Online e-cigarette retailers offer a large selection of products with a variety of product attributes such as nicotine concentration and form, flavour and the ratio between vegetable glycerine (VG) and propylene glycol (PG). The variety of flavoured tobacco products makes smoking more attractive to youth and adults.<sup>3–7</sup> Moreover, e-cigarettes have been the most commonly used tobacco product among youth and young adults.<sup>8,9</sup>

The e-cigarettes epidemic among youth and young adults has raised concerns in respiratory and public health.<sup>10</sup> To address these issues, the USA has begun to implement policies aimed at regulating the sale and use of e-cigarettes, which included age restrictions on the purchase of e-cigarettes, limits on advertising and marketing and taxes on e-cigarettes. From 2020 to 2021, new federal policies such as the flavour ban on vaping products and the ‘Preventing Online Sales of E-Cigarettes to Children Act’ (S.1253) aimed to regulate the e-cigarette

## WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ E-cigarette product attributes contribute to users’ experience and product preference.
- ⇒ Many youth and young adults obtain their e-cigarettes from online retailers.

## WHAT IMPORTANT GAPS IN KNOWLEDGE EXIST ON THIS SUBJECT

- ⇒ There are very limited data on the product attributes and price discounts for e-cigarette products sold by online retailers.

## WHAT THIS STUDY ADDS

- ⇒ This is the first study to collect and investigate large-scale data on e-liquids sold online at the product level.
- ⇒ The higher price discount of e-liquids with salt nicotine sold online may encourage consumers to purchase these products, and its potential impact on youth and adult tobacco use behaviours warrants a future investigation.

markets including the online market.<sup>11</sup> However, there are still many policy gaps and a lack of regulations surrounding the e-cigarettes such as nicotine level and form, price and promotion. Therefore, it is crucial to monitor e-cigarette products sold online to better inform public health policymakers.

The purpose of this article is to empirically examine and monitor the association between price discounts and product attributes of e-liquids sold by online retailers. The e-liquid attributes examined in this study are crucial to consumers’ vaping experience, which are often factors that are associated with vaping behaviours and price promotions. Nicotine is addictive and provides the main source of throat hit (smoke hit the back of the throat) and e-cigarette flavours impact vaping behaviour such as vaping pattern and nicotine intake.<sup>12,13</sup> The VGPG ratio is crucial in delivering nicotine and flavour, and cloud production, which makes VGPG ratio a strong determinant of users’ vaping experience.<sup>14,15</sup>

## METHODS

We conducted a study of over 14 000 e-liquid products sold by five popular online e-cigarette retailers in the USA from April to May 2021. The sampling and data collection processes were detailed in an article by Ma *et al.*<sup>2,16</sup> We calculated the price discounts in terms of US cents off/mL of e-liquid volume. For products with discounts, we used panel techniques and fixed-effects model to investigate the association between price discounts and



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**Table 1** Summary statistics

Price discounts observed (cents off/mL of e-liquid)	Observed	Frequency (%)	Mean	SD	Min	Max
Yes	13 324	92.5	16.84	8.96	0.07	120.00
No	1083	7.5	N/A	N/A	N/A	N/A
Total	14 407					
Products with price discounts observed						
Independent variables: attributes	Observed	Frequency (%)	Price discounts (cents off/mL of e-liquid)			
			Mean	SD	Min	Max
<b>Nicotine concentration</b>						
No nicotine	3112	23	13.61	5.32	0.07	45.00
1–5 mg	3308	25	13.56	5.38	0.07	45.00
6–11 mg	3306	25	13.58	5.39	0.07	45.00
12–35 mg	1902	14	25.11	10.77	1.67	120.00
35–60 mg	1696	13	26.26	10.45	3.33	67.76
Total	13 324	100	16.84	8.96		
<b>Nicotine form</b>						
None	3112	23	13.61	5.32	0.07	45.00
Freebase	6942	52	13.64	5.42	0.07	45.00
Salt	3270	25	26.71	10.43	2.67	120.00
Total	13 324	100	16.84	8.96		
<b>VGPG ratio</b>						
70/30	6664	50	13.76	6.05	0.07	63.33
50/50	1656	12	22.23	8.62	3.33	56.67
75/25	558	4	14.62	5.65	1.00	60.00
80/20	647	5	12.77	4.65	3.00	45.00
Other	1098	8	17.88	8.28	2.50	56.67
Missing	2701	20	22.15	12.07	2.50	120.00
Total	13 324	100	16.84	8.96		
<b>Flavour</b>						
Tobacco/unflavoured	483	4	18.68	9.53	1.67	63.33
Fruit, no other flavours	4615	35	16.51	8.80	1.00	93.33
Sweets, not menthol or fruit	1083	8	14.42	6.62	2.50	46.67
Any menthol	3642	27	17.15	8.64	1.00	60.00
Nut/spice/alcohol/beverage, not menthol	3501	26	17.45	9.83	0.07	120.00
Total	13 324	100	16.84	8.96		
<b>Bottle volume size (mL)</b>						
1–30	3043	23	26.83	10.11	0.07	45.00
31–60	4401	33	15.61	5.85	0.07	45.00
61–90	206	2	17.22	12.27	0.07	45.00
91–120	4891	37	11.73	4.40	1.67	120.00
≥121	783	6	16.78	7.48	3.33	67.76
Total	13 324	100	16.84	8.96		

The price discount (cents off/mL) is calculated by using the following equation:  $\text{Price\_discount\_per\_mL} = \frac{(\text{regular\_retail\_price\_per\_mL} - \text{discounted\_price\_per\_mL})}{\text{regular\_retail\_price\_per\_mL}} \times 100$  (i denotes product and j denotes store).  
VGPG, vegetable glycerine/propylene glycol.

e-liquid attributes such as nicotine level and form, flavour and VGPG ratio. The fixed-effects model accounts for the correlation among different products sold under the same brand. We treated brands similar to individuals in a panel survey and clustered the SEs at the store level. We also stratified our analysis by nicotine form (ie, nicotine free, salt and freebase), as nicotine form is a critical e-liquid attribute that impacts user experience and behaviour.

## RESULTS

In **table 1**, we present the summary statistics of e-liquid price discounts (cents off/mL of e-liquid volume) by product attributes. Out of the 14 407 e-liquid products, 13 324 (about 92.5%) offered a price discount. For those e-liquid products with discounts, the mean price discount across five stores was

**Table 2** The effects of product attributes on price discounts

Product attributes	Dependable variable: price discounts (cents off/mL of e-liquid)			
	Full sample (Observed: 13 324)	Salt nicotine (Observed: 3270)	Freebase nicotine (Observed: 6942)	Nicotine free (Observed: 3112)
Nicotine concentration	0.007 (0.017)	−0.006 (0.006)	0.011 (0.014)	–
<b>Nicotine form</b>				
Nicotine free	Reference group			
Freebase	0.004 (0.083)			
Salt	15.030*** (1.131)			
<b>VGPG ratio</b>				
70/30	Reference group			
50/50	−4.267*** (0.768)	−2.947** (1.445)	−0.013 (0.544)	−0.123 (0.568)
75/25	−0.426 (0.942)	6.673 (3.837)	0.498 (0.473)	0.575 (0.510)
80/20	−0.143 (0.748)	1.811 (2.833)	−0.524 (0.558)	−0.475 (0.585)
Other	0.329 (0.667)	−2.529 (1.593)	0.834 (0.711)	0.850 (0.727)
Missing	1.356*** (0.457)	0.566 (1.515)	0.212 (0.326)	0.242 (0.334)
<b>Flavour</b>				
Tobacco/unflavoured	Reference group			
Fruit, no other flavours	−1.071 (0.805)	1.060 (2.499)	−1.287 (0.668)	−1.684** (0.831)
Sweets, not menthol or fruit	−1.359 (0.832)	−0.198 (2.837)	−1.379** (0.618)	−1.788** (0.800)
Any menthol	−1.168 (0.781)	0.427 (2.592)	−0.911 (0.601)	−1.259 (0.778)
Nut/spice/alcohol/beverage, not menthol	−0.965 (0.856)	1.487 (2.719)	−1.021 (0.655)	−1.342 (0.831)

Nicotine form: products that were identified as nicotine salt by using keyword matching and with a nicotine concentration > 11 mg/ml were coded as "Salt".  
\*\*\*P<0.01, \*\*0.01<P<0.05  
VGPG, vegetable glycerine/propylene glycol.

16.84 US cents off/mL. As the nicotine level went up, the price discount in general increased. Among three nicotine forms, salt e-liquids had the highest price discount, which was almost two times higher than freebase e-liquids and nicotine-free e-liquids. For VGPG ratio, e-liquids with a 50/50 VGPG ratio (22.23 cents off/mL) and missing VGPG ratio information (22.15 cents off/mL) had the highest price discount, followed by VGPG other (17.88 cents off/mL) and 70/25 (14.62 cents off/mL). For flavours, tobacco/unflavoured e-liquids had the highest price discount (18.68 cents off/mL) compared with other flavoured products. For bottle volume sizes, e-liquids with a bottle volume size of 1–30 mL offered the highest price discount (26.83 cents off/mL), followed by 61–90 mL (17.22 cents off/mL) and ≥121 mL (16.78 cents off/mL).

**Table 2** presents the results of our fixed-effects linear model, which was used to examine the association between price discounts and e-liquid attributes among the 13 324 e-liquid products that offered price discounts in our sample. Nicotine form was found to be a critical factor that impacts price promotion in our sample. Therefore, we also stratified our analysis by nicotine forms. Our results indicated that the price discounts for nicotine-free and freebase nicotine products are very similar. However, salt nicotine products had a significantly higher discount than nicotine-free and freebase nicotine products, that is, 15 cents/mL higher ( $p<0.01$ ).

In addition, when looking at the VGPG ratio, e-liquids with a 50/50 VGPG ratio offered a 4.267-cent lower ( $p<0.01$ ) discount

than those with a common 70/30 VGPG ratio. When analysing the three nicotine forms separately, e-liquids with a 50/50 VGPG ratio offered a 2.947-cent lower ( $p < 0.05$ ) discount/mL respectively than a common 70/30 VGPG ratio. However, there was no significance in the VGPG ratio observed among nicotine-free and salt nicotine e-liquids.

Our analysis also examined the association between price discounts and flavour. In the full sample and in the salt nicotine subsample, we did not observe any significant differences in the discounts offered for different flavours. However, when looking at the freebase nicotine and nicotine-free subsamples, our results indicated that fruit and sweets flavoured e-liquids had a significantly lower discount than unflavoured tobacco e-liquids. This suggests that among freebase nicotine and nicotine-free products, unflavoured tobacco e-liquids may be more heavily discounted than other flavours.

## DISCUSSION AND CONCLUSION

Our study suggests that e-liquid products sold online are more likely to be discounted based on their nicotine form than on their flavours or VGPG ratio. Different forms of nicotine provide users with distinct sensory effects. Salt nicotine is correlated with providing smoother, less harsh, less bitter and more appealing sensory effects and a higher nicotine concentration compared with freebase nicotine.<sup>17–19</sup> With the introduction of salt nicotine in the e-cigarette market, the popularity of e-cigarettes among youth and young adults has seen a significant increase.<sup>18</sup> The study by Chen-Sankey *et al* has shown that receiving e-cigarette price promotions is associated with e-cigarette initiation and ever-regular use.<sup>1</sup> The higher price discount of e-liquids with salt nicotine may encourage consumers to purchase these products, and its potential impact on youth and adult tobacco use behaviours warrants a future investigation. Policies limiting online price discounting of e-liquids may have an impact on reducing sales among youth and young adults.

## LIMITATIONS

Our study has some limitations that should be acknowledged. First, the price mark-up may have played a role in the price discounting observed in our sample, which was not accounted for in our analysis. Additionally, we were not able to determine the market share of the five stores as sales data for these stores were not available. Lastly, the online stores sold a wide range of brands (over 200 in our data), and we were unable to report brands in the result tables due to the large number of brands included in our sample. However, we will share the brand list on request.

**Correction notice** The article has been corrected since it was published online first. The co-author Yanyun He's name was misspelled as Yanun He; this has been corrected now.

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**Contributors** Conceptualisation and study design: CS, SM JC. Data collection and management: SM, ZQ, JC. Data analysis: CS, SM, QY, YH. Writing the paper: QY, SM, CS, YH. Supervised the research: CS, JC, SM.

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