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# Development of the UNC Perceived Message Effectiveness Scale for Youth

Seth M Noar ,<sup>1,2</sup> Nisha Gottfredson,<sup>3</sup> Rhyann N Vereen,<sup>1</sup> Rachel Kurtzman,<sup>3</sup> Jennifer Mendel Sheldon,<sup>2</sup> Elizabeth Adams,<sup>1</sup> Marissa G Hall,<sup>2,3</sup> Noel T Brewer<sup>2,3</sup>

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<sup>1</sup>Hussman School of Journalism and Media, University of North Carolina, Chapel Hill, North Carolina, USA

<sup>2</sup>Lineberger Comprehensive Cancer Center, University of North Carolina, Chapel Hill, North Carolina, USA

<sup>3</sup>Department of Health Behavior, Gillings School of Global Public Health, University of North Carolina, Chapel Hill, North Carolina, USA

## Correspondence to

Dr Seth M Noar, Hussman School of Journalism and Media, University of North Carolina, Chapel Hill, NC 27599, USA; [noar@unc.edu](mailto:noar@unc.edu)

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## ABSTRACT

**Purpose** Tobacco prevention media campaigns are an important tool to address youth tobacco use. We developed a theory-based perceived message effectiveness (PME) Scale to use when vetting messages for campaigns.

**Methods** Participants were a national sample of N=623 US adolescents (ages 13–17 years) recruited from a national probability-based panel. In an online experiment, we randomised adolescents to view tobacco prevention ads. All participants viewed an ad on smoking or vaping from the US Food and Drug Administration's *The Real Cost* campaign and a control video, in a random order. After ad exposure, we assessed PME using nine candidate items and constructs for convergent and criterion validity analyses. We used confirmatory factor analysis and examined information curves to select the scale items.

**Results** A brief PME scale with three items ( $\alpha=0.95$ ) worked equally well for demographically diverse adolescents with different patterns of tobacco use. *The Real Cost* ads generated higher PME scores than the control videos for both vaping and smoking (convergent validity;  $p<0.05$ ). Higher PME scores were associated with greater attention, fear, cognitive elaboration and anticipated social interactions (convergent validity;  $r=0.31$ – $0.66$ ), as well as more negative attitudes toward and lower susceptibility to vaping and smoking (criterion validity;  $r=-0.14$  to  $-0.37$ ). A single-item PME measure performed similarly to the three-item version.

**Conclusions** The University of North Carolina PME Scale for Youth is a reliable and valid measure of the potential effectiveness of vaping and smoking prevention ads. Employing PME scales during message development and selection may help youth tobacco prevention campaigns deploy more effective ads.

those numbers may begin to rise if youth who begin vaping progress to cigarette smoking.<sup>6</sup>

Youth tobacco prevention media campaigns reduce the initiation, prevalence and progression of tobacco use.<sup>7–10</sup> To slow the vaping epidemic, national campaigns such as the US Food and Drug Administration's (FDA) *The Real Cost* are increasingly focusing on vaping prevention.<sup>11</sup> The process of developing and selecting ads often involves the use of ratings of perceived message effectiveness (PME).<sup>12</sup> PME measures are applied by gathering target audience ratings of the likely impact of persuasive messages on attitudes and behaviours,<sup>13</sup> and they predict the impact of smoking cessation ads.<sup>14 15</sup>

Several PME measures have been developed in the context of adult smoking cessation,<sup>15–17</sup> but we are unaware of measures for adolescents or vaping prevention.<sup>12</sup> Many social, emotional and physical changes take place during adolescence, making this age group susceptible to initiating tobacco product use.<sup>18</sup> Given this, tobacco prevention campaigns often target adolescents,<sup>19</sup> and PME measures developed for this context are needed.

Moreover, a growing literature suggests that PME measures tend to involve *message* or *effects* perceptions.<sup>12 20</sup> *Message* perceptions are judgements about whether a message promotes further processing that leads to persuasion (eg, 'This ad is informative'), while *effects* perceptions are judgements about a message's potential to change behaviour (eg, 'This ad discourages me from wanting to vape').<sup>20</sup> Several studies have found that *effects* perceptions better predict the impact of ads on tobacco-related beliefs and behaviours than do *message* perceptions.<sup>21–23</sup> Therefore, an effects orientation may provide a fruitful basis for PME measures.

In the current study, we sought to develop and preliminarily validate a brief, theory-based effects perception PME measure for youth tobacco prevention in a national sample of US adolescents.

## METHODS

### Participants

Participants were a national probability sample of US adolescents (ages 13–17 years) recruited in September and October of 2020 from the Ameri-Speak panel, a probability-based panel maintained by the National Opinion Research Center (NORC) at the University of Chicago in the USA. NORC randomly selected US households using area probability and address-based sampling, with a known, non-zero probability of selection from the NORC National Sample Frame. For the current study,

## INTRODUCTION

Tobacco use among youth continues to be a major public health issue. Globally, youth smoking prevalence is 11.3% in boys and 6.1% in girls aged 13–15 years,<sup>1</sup> while use of other tobacco products (OTPs) (including e-cigarettes) is 11.2% in boys and 7% in girls. While cigarette smoking has been declining in most countries, use of OTPs has remained unchanged or is increasing.<sup>1</sup> We define tobacco use to include all tobacco products including e-cigarettes. In the USA, e-cigarettes have been the most commonly used tobacco product among high school-aged adolescents since 2014,<sup>2 3</sup> and recent data reveal that 1.72 million high school youth continue to use e-cigarettes.<sup>4</sup> While current cigarette smoking is at historical lows in the USA,<sup>5</sup>



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adolescents were drawn from AmeriSpeak panel households. To address panel attrition due to the COVID-19 pandemic, NORC also invited adolescents aged 13–17 years living in AmeriSpeak panel households who had not yet joined the teen panel to take part in the study. In total, 1351 households had age-eligible children and received information about the study. Parents from 1002 households (74% of those eligible) provided informed consent, and 624 adolescents assented and completed the survey (62% of households whose parents consented; 46% of all eligible households). One participant had extensive missing data and was excluded from analyses, resulting in N=623.

### Study design and procedures

To assess validity for the PME Scale, we randomised adolescents to view either vaping or smoking prevention 30-second video ads (online supplemental figure 1). All participants viewed an ad from the US FDA's *The Real Cost* campaign and a neutral control ad, in a random order. For *The Real Cost*, participants saw one of six ads; for control, participants viewed an ad we developed with neutral information about vaping or smoking. To create control ads, we adapted content from Wikipedia and other sources, such as product definitions and production methods, using parallel language for cigarettes and e-cigarettes. The control ads featured black text on a white screen with audio narration. After watching the first ad (twice to maximise exposure), participants answered PME and message reactions items, followed by vaping and smoking outcomes. They then watched the second ad—again twice—and answered PME and message reactions items.

Participants received a \$12 cash equivalent incentive through the NORC panel. We preregistered our study on aspredicted.org (<https://aspredicted.org/g8fr.pdf>).

### PME measure

We conceptualised our youth PME Scale as an 'effects perception' measure and developed items in three theoretically informed domains based on the Reasoned Action Approach,<sup>24</sup> with parallel items for vaping and cigarette smoking. We selected these domains because the goal of tobacco prevention messages is typically to affect beliefs, attitudes and motivation, with the goal of changing behaviour.<sup>25 26</sup> The first domain was *beliefs about the consequences* of tobacco use, with a focus on health harm and addiction consequences.<sup>27</sup> The second domain was *attitudes about the behaviour*, with a focus on unfavourable perceptions of tobacco use.<sup>24</sup> The final domain was *motivation*, with a focus on intentions to avoid using tobacco.<sup>24</sup> We developed candidate items in each of the theoretical domains informed by the PME literature,<sup>12</sup> including items from our previously developed PME Scale.<sup>20</sup> When developing items, we focused on accessible language, linguistic appropriateness and theoretical relevance.

Through an iterative process of drafting, revising and winnowing items, we developed a set of 11 candidate items across the three domains. Next, we conducted two rounds of cognitive interviews via telephone with 10 adolescents a piece (N=20 total),<sup>28</sup> focusing on readability, comprehension and item meaning.<sup>29</sup> Based on findings from the cognitive interviews, we refined our items and selected nine items for use in the present study (table 1; see Kurtzman *et al*<sup>28</sup>). Prior PME measures have shown positive skew, limiting the ability to distinguish between messages at higher levels of PME,<sup>20</sup> so we adopted a unipolar response scale ('not at all' to 'a great deal') rather than a bipolar response scale ('strongly disagree' to 'strongly agree') in an

**Table 1** Frequencies of the nine PME items in the national survey (calibration sample, N=623)

Construct and definition	Item name	'How much does this ad...'	Response scale and frequencies
<b>Beliefs about consequences</b> How much an ad makes person believe the negative consequences of using the tobacco product	'Harm'	make you think vaping (smoking cigarettes) will harm you?	Not at all 16% Very little 12% Somewhat 17% Quite a bit 21% A great deal 34%
	'Negative effects'	make you concerned about the negative effects of vaping (smoking cigarettes)?	Not at all 14% Very little 13% Somewhat 20% Quite a bit 18% A great deal 31%
	'Worry'*	make you worry about what vaping (smoking cigarettes) will do to you?	Not at all 18% Very little 13% Somewhat 18% Quite a bit 17% A great deal 34%
<b>Attitude about behaviour</b> How much an ad gives person an unfavourable perception of the tobacco product	'Convince'	convince you that vaping (smoking cigarettes) is bad?	Not at all 18% Very little 13% Somewhat 16% Quite a bit 18% A great deal 36%
	'Bad idea'*	make you think vaping (smoking cigarettes) is a bad idea?	Not at all 14% Very little 13% Somewhat 17% Quite a bit 19% A great deal 36%
	'Unpleasant'	make vaping (smoking cigarettes) seem unpleasant to you?	Not at all 16% Very little 13% Somewhat 18% Quite a bit 15% A great deal 38%
<b>Motivation</b> How much an ad motivates person to <u>not</u> use the tobacco product	'Avoid'	make you want to avoid using vapes (smoking cigarettes)?	Not at all 16% Very little 13% Somewhat 18% Quite a bit 16% A great deal 37%
	'Motivate'	motivate you to be someone who doesn't vape (smoke cigarettes)?	Not at all 17% Very little 13% Somewhat 19% Quite a bit 14% A great deal 37%
	'Discourage'*	discourage you from vaping (smoking cigarettes)?	Not at all 16% Very little 15% Somewhat 15% Quite a bit 18% A great deal 35%

\*Indicates items used in the final scale. PME, perceived message effectiveness.

attempt to reduce this skew; this new response scale was well understood by adolescents in the cognitive interviews.

### Other measures

#### Message reactions

To support analyses of convergent validity (the extent to which PME is associated with variables that it should theoretically relate to), the survey assessed several constructs from the Tobacco Warnings Model,<sup>30</sup> with hypothesised positive correlations with PME (except reactance for which negative correlations were expected). The survey assessed attention with the item, 'How much does this ad grab your attention?'; negative affect with the item, 'How much does this ad make you feel scared?' and cognitive elaboration with the item, 'How much does this ad make you think about reasons for not vaping (smoking cigarettes)?'. The survey also assessed reactance with the item, 'How much does this ad annoy you?' and avoidance with the item, 'How much does this ad make you want to look away?'. The survey assessed anticipated social interactions with three items,

including 'How much does this ad make you want to talk to your friends about the harms of vaping (smoking)?'. All message reaction items had a 5-point scale that ranged from 'Not at all' (coded as 1) to 'A great deal' (5).

### Psychosocial outcomes

The survey additionally assessed several outcomes<sup>24 31</sup> for purposes of criterion validity (the extent to which PME predicts a relevant outcome). The survey assessed perceived likelihood of harm with the item, 'If you regularly vaped (smoked cigarettes), what is the chance that you would one day get vaping-related (smoking-related) health problems?' on a 5-point scale ranging from no chance (coded as 1) to certain (5). The survey assessed attitudes about vaping/smoking with the item, 'Do you think vaping (smoking cigarettes) is....' on a 5-point scale ranging from very bad (1) to very good (5). Finally, the survey assessed susceptibility to vaping/smoking using a three-item susceptibility scale: 'Do you think you might use an e-cigarette or vape soon?', 'Do you think you will use an e-cigarette or vape in the next year', and 'If one of your best friends were to offer you an e-cigarette or vape (cigarette), would you use (smoke) it?'.<sup>31</sup> Responses were on a 4-point scale from definitely not (1) to definitely yes (4).

### Vaping/smoking status

The survey assessed whether youth had vaped or smoked cigarettes in the past 30 days, and those who had were classified as a *current user*. If they had used the tobacco product before, but not in the past 30 days, we assessed whether they thought they would use the product in the future, on a 4-point scale ranging from definitely not (1) to definitely yes (4).<sup>31</sup> If they answered anything other than 'definitely not', we classified them as *at risk* of vaping/smoking. For youth who had never used the tobacco product at all, the survey assessed whether they had ever been curious about using the tobacco product,<sup>32</sup> and also if they thought they would use the tobacco product in the future.<sup>31</sup> If they answered anything other than 'definitely not' to both questions, we classified them as *at risk* of vaping/smoking. We classified all other adolescents as *not at risk* of vaping/smoking.

### Demographics and OTP use

The survey assessed age, gender, race, ethnicity, parents' education, sexual attraction and use of OTPs in the past 30 days.

### Data analysis

Our overarching goal was to develop a brief youth PME Scale using the following criteria: (1) the scale should include one item from each theoretical domain for adequate coverage of the PME construct; (2) the scale should be unidimensional; (3) items should work equally well across demographic subgroups; (4) the scale should not have ceiling or floor effects; and (5) the scale should have good convergent and criterion validity.

To achieve these goals, we created a *calibration* sample and a *validation* sample using a random number generator. Because each participant evaluated two ads, half the sample contributed their first PME rating to the calibration sample and their second rating to the validation sample. The other half of the sample did the opposite. This process resulted into two datasets, each with  $N=623$  independent observations.

To evaluate dimensionality of the PME measure, we conducted an exploratory factor analysis (EFA) on the calibration sample using *Mplus* V.8.4. We drew from the EFA results to construct a confirmatory factor analysis (CFA), evaluating model fit with a unidimensional model with all nine items. Fit indices were the

confirmatory fit index (CFI; adequate fit  $>0.95$ ), Tucker Lewis Index (TLI; adequate fit  $>0.95$ ) and root mean square error of approximation (RMSEA; adequate fit  $<0.08$ ). To evaluate potential floor and ceiling effects, we calculated item information from the item intercept and factor loading.

To evaluate suitability of the PME measure for diverse populations, we investigated measurement non-invariance (also called differential item functioning) by regressing factor loadings and item intercepts on covariates of interest<sup>33 34</sup> to determine whether items operated differently across several covariates. We used the MNLF package in R<sup>35</sup> to test each item iteratively while using the other items as anchors.

To pare down the scale, we removed theoretically and empirically redundant items that had the lowest levels of item information, as well as items exhibiting measurement non-invariance. We also evaluated the performance of a 'best' item to use if a study only has room for a single PME item.

Finally, we conducted analyses on the validation sample using a structural equation model, regressing the latent PME factor (the final three-item scale) on demographic and tobacco use variables, controlling for ad product type and type of ad. We repeated this analysis with the single 'discourage' item in a proportional odds regression model with a probit link function estimated using *Mplus* V.8.4.

## RESULTS

### Participant characteristics

The mean age of adolescents was 15 years. Most participants reported being female (53%) and white (65%), and roughly one-fifth (19%) identified as Hispanic. Nearly half (49%) of adolescents had a parent with a bachelor's degree or higher. Fourteen percent of the sample were current vapers (8% were smokers), while 47% were at risk of vaping (33% for smoking) and 39% were not at risk of vaping (59% for smoking). Use of OTPs was low (1%–6%). Thirty-six percent reported family member tobacco use in the home (online supplemental table 1).

### Psychometric analyses with the calibration sample

About one-third of participants answered 'a great deal' to PME items, the high end of the scale (table 2). This somewhat limited our ability to discriminate scores at the high end of PME. Inter-item correlations were all high (polychoric  $r=0.89$ – $0.90$ ), a strong indication of unidimensionality and redundancy among the full set of nine items.

### Factor analyses

In the EFA, almost all items loaded onto one factor. The largest eigenvalue was 8.3, followed by 0.2 (suggesting a single factor), but likelihood ratio tests suggested that the two-factor model fit better than the one-factor model, and the three-factor model fit better than the two-factor model. The one-factor model had a CFI-TLI of 1.00 (indicating excellent fit), but an RMSEA of 0.10 (indicating poor fit). For the two-factor model, CFI-TLI was 1.00 (excellent fit) and RMSEA was 0.07 (only minimally acceptable); while for the three-factor model, CFI-TLI was 1.00 (excellent fit) and RMSEA was 0.03 (good). Factor loadings for the three-factor model appear in online supplemental table 2.

In the three-factor model, all items except 'convince' loaded well on the first factor. 'Convince' was by itself loading on a second factor, with no loading on the first factor. 'Harm', 'negative effects', 'worry' and 'unpleasant' all had small (ranging from 0.06 to 0.25) but statistically significant loadings on the third factor, suggesting that they shared some common variance.



**Table 2** Correlations between the UNC PME Scale for Youth and convergent and criterion validity outcomes (validation sample, N=623)

Outcomes	3-item vaping PME	1-item vaping PME	3-item smoking PME	1-item smoking PME
<b>Message reactions (convergent validity)</b>				
Attention	0.53**	0.48**	0.32**	0.31**
Fear	0.43**	0.37**	0.34**	0.33**
Cognitive elaboration	0.58**	0.53**	0.47**	0.45**
Avoidance	0.09	0.05	0.21**	0.23**
Reactance	0.04	0.03	-0.02	0.00
Anticipated social interactions	0.66**	0.62**	0.53**	0.52**
<b>Beliefs (criterion validity)</b>				
Perceived likelihood of harm (vaping/smoking)	0.37**	0.37**	0.10	0.10
Positive attitudes toward vaping/smoking	-0.26**	-0.23**	-0.17*	-0.14*
Susceptibility to vaping/smoking	-0.32**	-0.32**	-0.15*	-0.18*

\*p&lt;0.05, \*\*p&lt;0.001.

Table reports correlations using Pearson's r

PME, perceived message effectiveness; UNC, University of North Carolina.

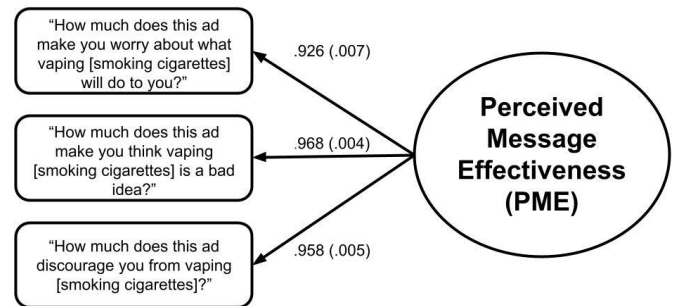
Because 'convince' did not load with the other eight items, we dropped it from the CFA.

In the CFA, we tested a bifactor model for the remaining eight items to determine the extent to which each of the four cross-loading items ('harm', 'negative effects', 'worry' and 'unpleasant') reflects the PME factor of interest versus the orthogonal 'nuisance' factor, thereby isolating the common item variance due to PME alone. The bifactor model fit well (CFI-TLI=1.00; RMSEA=0.02). All items loaded between 0.94 and 0.97 on the first factor, which we now term PME. On the second factor, the four items identified above had small but statistically significant loadings (0.05–0.26).

Item information curves showed that all items contributed information along a similar range of PME, from -1.5 SD below the mean to +1 SD above the mean. 'Worry', 'bad idea' and 'discourage' exhibited the highest information, and each of these items represented a different theoretical domain (online supplemental figure 2). Thus, these items became candidates for the scale. We used the 'discourage' item in the single-item analyses, because (1) we viewed it as theoretically closest to behaviour; (2) it had high information; and (3) it has been used successfully in prior studies of tobacco and sugary drink warnings research.<sup>36</sup>

When testing for measurement non-invariance, we found that participants viewing smoking ads were more likely to endorse the 'unpleasant' item, and that current smokers were less likely to endorse the 'avoid' item. Given that each of the three candidate items for the scale exhibited measurement invariance, meaning that measurement characteristics of these items were stable across all of the demographic variables that we tested, we selected 'bad idea', 'discourage' and 'worry' for the three-item scale.

The three-item scale is just identified, meaning that fit indices are not informative. However, all factor loadings were statistically significant and high, ranging from 0.93 (for 'worry') to 0.97 (for 'bad idea') (figure 1). Consistent with these factor loadings, item information remained highest for 'bad idea' and 'discourage' and slightly lower for 'worry'. Coefficient alpha for the three-item scale was very high ( $\alpha=0.95$ ), indicating the scale is reliable.

**Figure 1** Confirmatory factor analysis of the UNC PME Scale for Youth (factor loadings with SEs; calibration sample, n=623). UNC, University of North Carolina.

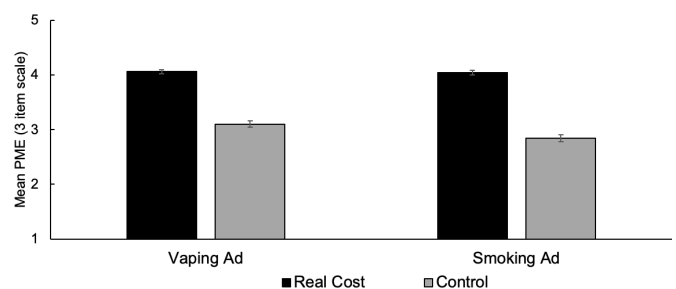
### Validity analyses with the validation sample

Youth rated ads from *The Real Cost* campaign as more effective than neutral control ads ( $p<0.05$ ; see figure 2). The vaping *The Real Cost* condition yielded PME scores that were 1.43 (95% CI: 0.92 to 1.94) units higher than control, while the smoking *The Real Cost* condition yielded PME scores that were 1.10 (95% CI: 0.57 to 1.63) units higher than control. This demonstrates convergent validity of the scale. PME was also positively associated with attention, fear, cognitive elaboration and anticipated social interactions (all  $p<0.05$ ), further demonstrating convergent validity (table 2). PME was moderately associated with avoidance (for smoking ads only,  $p<0.05$ ) and *not* associated with reactance.

PME was also moderately associated with perceived likelihood of harm (for vaping only) and negatively associated with attitudes toward vaping and smoking and susceptibility to vaping and smoking, demonstrating criterion validity (all  $p<0.05$ ). All correlations were in the expected direction. The one-item PME measure performed similarly to the three-item measure for most validity constructs.

### Predictors of three-item and one-item PME scores

Patterns of statistical significance and magnitude of effects were remarkably consistent for the three-item and one-item PME Scales (table 3). Adolescents whose parents had less than 4 years of college reported higher PME than adolescents whose parents had at least a college degree ( $b=0.53$  for the three-item scale and  $b=0.61$  for the single-item scale), and heterosexual adolescents reported higher PME than youth attracted to others of the same sex ( $b=0.41$  and  $b=0.36$ ). Adolescents who vaped ( $b=-0.36$  and  $b=-0.41$ ) or who smoked ( $b=-0.70$  and  $b=-0.61$ ) had lower PME scores compared with adolescents who were not at risk

**Figure 2** Impact of *The Real Cost* and control ads on three-item UNC PME Scale for Youth (scores with  $\pm 1$  SE bars; validation sample, n=623). PME, perceived message effectiveness; UNC, University of North Carolina.

**Table 3** Multivariable correlates of UNC PME Scale for Youth (validation sample, N=623)

Predictors	3-item PME b (SE)	1-item PME b (SE)
Male (vs female)	0.00 (0.10)	0.01 (0.11)
Lower parent education (vs higher)	0.53** (0.10)	0.61** (0.11)
Race		
Black (vs other)	0.17 (0.20)	0.04 (0.23)
White (vs other)	−0.02 (0.17)	−0.03 (0.19)
Hispanic/Latino	0.09 (0.18)	0.04 (0.21)
Attracted to opposite sex only (vs all others)	0.41** (0.11)	0.36* (0.12)
Vaping status		
Current vaper (vs not at risk)	−0.36* (0.18)	−0.41* (0.20)
At risk of vaping (vs not at risk)	−0.16 (0.12)	−0.24 (0.14)
Smoking status		
Current smoker (vs not at risk)	−0.70* (0.22)	−0.61* (0.24)
At risk of smoking (vs not at risk)	−0.39* (0.12)	−0.36* (0.14)

Analysis controlled for ad product type and type of ad (*The Real Cost* vs control).  
Table reports weighted regression coefficients (b) and SEs.  
\*p<0.05, \*\*p<0.001.  
PME, perceived message effectiveness; UNC, University of North Carolina.

of tobacco use. Adolescents who were *at risk* of smoking had significantly lower PME scores than adolescents who were *not at risk* of smoking (b=−0.39 and b=−0.36).

## DISCUSSION AND CONCLUSION

Youth tobacco prevention media campaigns are a key tool to reduce tobacco use, but the field has lacked an effects-oriented youth PME measure for vetting messages for campaigns. In this study, we developed and preliminarily validated such a measure—the University of North Carolina (UNC) PME Scale for Youth, which assesses the potential effectiveness of tobacco prevention messages for youth (see online supplemental table 3 for the final scale).

The UNC PME Scale for Youth exhibited experimental evidence of convergent validity with both smoking and vaping prevention ads, distinguishing between ads from the US FDA's *The Real Cost* campaign and control ads. The scale demonstrated convergent validity through correlations with a series of message processing variables,<sup>30</sup> including attention, negative affect, cognitive elaboration and anticipated social interactions. The scale also showed criterion validity through correlations with perceived likelihood of harm (for vaping only), attitudes and susceptibility, consistent with prior work.<sup>13 22 37</sup> This begins to build support for the validity of this new scale across tobacco products.

This work grew out of our work developing the original UNC PME Scale<sup>20</sup> and synthesising existing measurement<sup>12</sup> and validation<sup>14</sup> of PME research. The original UNC Scale was developed with adults in the context of cigarette health warnings, and has since been applied to several health contexts,<sup>36 38</sup> mostly with adults but also with youth.<sup>20</sup> In health warning studies that include adults and youth, a single scale may be desired, and for those applications the appropriate choice may be the original UNC PME Scale. In applications to youth tobacco prevention campaigns, however, the UNC PME Scale for Youth is likely to be the optimal choice. Additional work should also examine whether our new measure is applicable to tobacco prevention and control campaigns for young adults, as well as adapting it for use with youth in other behavioural areas beyond tobacco use.

Finally, since PME measures are often used to evaluate many messages,<sup>39 40</sup> brevity is important. Given this, both the original

UNC PME Scale and the UNC PME Scale for Youth were designed to be brief. Given this, we also tested the single 'discouragement' item compared with the full three-item PME measure, finding little loss of information. Thus, our findings indicate that in contexts where researchers need to reduce response burden, they can feel confident using the single 'discouragement' item.

Strengths of our study include the iterative development process of a theory-based measure, cognitive testing of items, use of a national probability sample and item response theory analyses. Our study was limited in that we only tested the PME measure with vaping and smoking ads; a future study could adapt this measure for OTPs. Also, this study was unable to examine whether this PME measure foretells the impact of tobacco prevention ads on adolescents' beliefs and behaviour over time. Future studies should rigorously evaluate the extent to which PME ratings correspond with actual message impact over time.<sup>12 14</sup>

In conclusion, this study developed the UNC PME Scale for Youth, a measure that assesses the potential effectiveness of tobacco prevention ads. The scale can be used to help select messages for vaping and other tobacco prevention campaigns, and can also be used to assess receptivity to messages that have been deployed.<sup>41</sup> This measure can further be used in validation studies examining the extent to which PME foretells ad impact. Improving PME measurement may lead to better use of campaign resources and ultimately more impact in preventing tobacco use and its associated consequences among youth.

## What this paper adds

### What is already known on this subject

⇒ Tobacco prevention campaigns commonly select messages based on perceived message effectiveness (PME) ratings.

### What important gaps in knowledge exist on this topic

⇒ Researchers have yet to systematically develop and validate PME measures for youth or for vaping prevention.

### What this paper adds

⇒ The University of North Carolina PME Scale for Youth—a new brief three-item measure—worked equally well for demographically diverse adolescents with different patterns of tobacco use.  
⇒ The scale distinguished between the USA's *The Real Cost* campaign ads and neutral control ads for both vaping and smoking.

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**Data availability statement** Data will be available after publication of all papers from this dataset based on reasonable request.

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#### ORCID iD

Seth M Noar <http://orcid.org/0000-0002-3453-5391>

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