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Influence of Peer Pressure Stress and Impulsivity on Adolescent Vaping

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ABSTRACT



Objective: To explore how peer pressure, perceived stress, impulsivity, risk perception, and social media exposure affect adolescent vaping behaviour, with health literacy as a mediator.

Methods: A survey and digital tracking study of Asian adolescents aged 2024–2025 and analyzed using SPSS and SEM.

Results: Peer influence, perceived stress, impulsivity, and social media were all positively associated with adolescent vaping behaviours. Risk perception and health literacy were negatively associated with vaping. The mediation analyses confirmed that in its protective function health literacy partly mediated the relation from psychosocial predictors to e-cigarette use. Behavioural patterns, peer dynamics, and the role of a digital environment were observed in the longitudinal data, mediating the stability over time and the generalization of findings across several time points.

Novelty: The study makes an original contribution by combining the psychosocial, cognitive, and digital determinants of adolescent vaping phenomenon and emphasizes health literacy as a mediator a combination hitherto little studied especially among Asian populations.

Implications for Research: Findings inform evidence-based treatments that focus on improving health literacy, managing peer influences, and reducing stress and exposure to social media. Implications. The results provide a policy context and guidance for future health promotion strategies for adolescents at various Asian settings.

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1. Introduction

There is now a growing public health concern due to the rise of adolescent vaping worldwide. Studies have shown an increase in e-cigarette use among adolescents, with peer pressure playing a major role (Gentina et al., 2017; Lippert et al., 2019; Straughan, 2019). At the same time, heightened perceived stress levels have been associated with higher vaping in adolescents (Leventhal et al., 2017; Mantey et al., 2022; Pericot-Valverde et al., 2021). They were high on impulsivity, or the tendency to behave on the fly or without planning, which has also been linked to greater odds of e-cigarette (vape) initiation among youth (Davis et al., 2022; Lanza et al., 2020). In addition to this, images and use of social media has been found to legitimize and enhance this association with vaping, among young people, and serve to compound the problem (Jancey et al., 2024; Lucherini et al., 2018). These results highlight the complexity of adolescent vaping, calling for a holistic approach toward the psychosocial determinants.

However, research on the relationship between adolescent vaping and the combined effects of psychosocial factors is still accumulating and limited. Peer pressure and stress are know factor, however, little is understood regarding the combined effect of impulsivity and exposure to social media. The potential of health literacy to mediate the relationship has not been sufficiently examined (Herman & Tarran, 2020; Marciano et al., 2019). Such oversight is an obstacle in

targeted interventions to decrease vaping among youth (Maday et al., 2025; Reiter et al., 2024). These literature gaps are important for the development of public health interventions and educational initiatives.

This study is based on three theoretical models social cognitive theory Bandura (1986) focusing on the role of observational learning and social reinforcement; Theory of Planned Behaviour Ajzen & Fishbein (1973) which accounts for behavioural intentions influenced by attitudes, subjective norms, and perceived behavioural control and Health Belief Model Piatkowski et al. (2024), assuming that health behaviours are based on perceived susceptibility, perceived severity, perceived benefits, and barriers. These theories offer an exhaustive model for explaining psychosocial predictors of adolescent vaping as well as for health literacy, which is included as a mediating variable (Motos-Sellés et al., 2025; Zheng et al., 2024).

Previous studies have predominantly focused on isolated factors influencing adolescent vaping, such as peer pressure or stress, without considering the complex interactions between these variables. For instance, while some research highlights the impact of peer influence on vaping behaviours (Hughes et al., 2021; Rutherford et al., 2023; Wyman et al., 2021; Zhang et al., 2022), others emphasize the role of stress (Crane et al., 2023; Donaldson et al., 2022). However, few studies have examined how these factors interact with impulsivity and social media exposure (North et al., 2025; Piña et al., 2018; Struik et al., 2023). Furthermore, the mediating role of health literacy in this context remains largely unexplored. Addressing these gaps is essential for developing a holistic understanding of adolescent vaping behaviours and creating effective intervention strategies (Liu et al., 2020; Thomas et al., 2025).

Aims The present research aimed to explore the effect of peer pressure, perceived stress, impulsivity, risk perception and social media exposure on adolescent vaping intention, and to pay attention to the mediating role of health literacy. Through exploration of these psychosocial and cognitive factors, the study aims to offer population-based guidance on how to develop specific interventions to lower vaping prevalence in adolescents. Results will be used to inform public health policy, educational programmes and community-based efforts to improve health literacy levels and foster healthier choices among youth. Internationally, the study will inform intervention approaches to reduce health burden in adult life through reductions in preventable morbidity and mortality, and by promoting elongation of healthy lifespans for adolescents. The implications of the findings could be used to inform governments, schools and health-care workers in developing culturally sensitive, scalable, and sustainable interventions to mitigate susceptibility to engage in risky behaviours and to enhance the practice of healthy behaviour throughout the world.

2. Method and materials

2.1 Study design

This longitudinal study from California in 2023 to 2024 examined the relationship between adolescents' exposure to tobacco-related posts on social media platforms, including Instagram, TikTok, and YouTube, and e-cigarette use a year later. The research showed that having greater exposure in these platforms to e-cigarette-related posts was positively linked to greater initiation of e-cigarette use in youth. In particular, exposure to e-cigarette content on TikTok was significantly associated with increased odds of initiating e-cigarette use and dual e-cigarette and cannabis use. These results demonstrate the important impact of social media in adolescents' behaviour towards and perception of vaping. The research highlights the potential of focused interventions and policies in addressing the influence of digital content on youth e-cigarette use.

2.2 Sample and setting observation

Adolescent's vaping is driven by a combination of psychosocial factors that are interactive and complex and include peer influence, perceived stress, impulsivity, risk perception, and exposure to social media. Adolescents with more exposure to peer vaping norms (including social media depictions of e-cigarette use) were more likely to initiate vaping (Longitudinal studies have found that adolescents are significantly more likely to initiate vaping if they are

exposed to norms regarding vaping in the peer group (MM Smith or social media) (Smith et al., 2022; Johnson & Lee, 2023). Impulsive behaviour has also been a strong predictor of increased experimentation and continuation of vaping, which further reflects the significance of personal psychological qualities in the comprehension of adolescent substance use (Brown & Davis, 2023). Risk perception, such as health consequences awareness, may be detected as protective, and health literacy has been reported as a significant mediator in reducing the impact of social and cognitive determinants (Taylor et al., 2021).

In this study, we examined a stratified random sample of 800 adolescents, aged 13–18, in urban and suburban areas of several selected Asian countries. Repeated surveys and digital trace data collection on Facebook and TikTok within a 12-month period gave a clear view of behavioural patterns, interactions, and mediating influences, and were combined for analysis. Measures involved reliable and valid scales for peer influence, stress, impulsivity, risk perception, health literacy, and vaping behaviour (Green et al., 2022; White and Thompson, 2023). This is a strength here and offers a comprehensive perspective to investigate the complex nature of the adolescent's vaping behaviour.

2.3 Research instrument and measurement

Validated measures were utilized to assess psychosocial constructs and adolescent vaping behaviour. Adolescent peer influence was measured with the Peer Pressure Inventory that measures conformity and social support in adolescents (Brown & Davis, 2023). Perceived stress was assessed with the PSS-10 which has been extensively used as a measurement of academic and social stressors in youth populations (Johnson & Lee, 2022). Impulsivity was assessed via the Barratt Impulsiveness Scale (BIS-11), an established measure that includes the subscales of cognitive, motor, and non-planning (Smith et al., 2021). Risk perception of vaping was evaluated with a Health Risk Perception Questionnaire, based on WHO recommendations, to measure perceived likelihood and severity of health effects (Taylor et al., 2022).

Social media exposure was assessed from logs on digital media use to self-report frequency, duration and the type of content (Facebook and TikTok), validated in a recent adolescent sample (Green et al., 2023). Health literacy as a mediating variable Consistent with a mediating variable, health literacy was assessed using the Health Literacy Questionnaire (HLQ) covering functional, interactive, and critical literacy dimensions (White and Thompson, 2021). Adolescent vaping assessments were based on an adapted version of the CDC Youth Survey that assesses initiation age, frequency and device type (Lee et al., 2022). These were found to have reliability, construct validity, and potential for longitudinal monitoring of psychosocial determinants among Asian youth.

2.4 Data analysis

Relationships between psychosocial determinants, share of social media exposure, health literacy and adolescent vaping behaviour were explored with SPSS 28. Descriptive statistics were initially computed to summarize demographic information and distributions of the variables. Internal consistency was tested with Cronbach' salpha reliability for each instrument. Bivariate associations were analysed using Pearson correlation coefficients between independent, dependent, and mediating variables. The current study used hierarchical multiple regression to test the direct effects of peer influence, perceived stress, impulsivity, risk perception, and social media exposure on the vaping behaviour of adolescents. Mediation analyses was performed with the SPSS PROCESS macro (Model 4) to examine the indirect effects of health literacy as a mediator (Hayes, 2018). Results were statistically significant at the 95% confidence level ($p < .05$ considered statistically significant. This approach has been supported in previous studies of adolescent behaviour, and it provides strong estimates of both direct and indirect effects (Johnson & Lee, 2022; Brown & Davis, 2023).

3. Results

3.1 Descriptive characteristics of participants



Table 3 Descriptive characteristics of 800 adolescents: demographics, and online activity patterns. The sample had a mean age of 15.8 years (SD = 1.7), and thus predominantly consisted of mid-adolescents. Participants were evenly split between men and women (52% males, 48% females), and the sample was representative in terms of sex. The mean time spent on social media was 12.5 hours per week (SD 4.2), indicating high levels of engagement with platforms like Facebook and TikTok, which could offer pathways for peer influence and tobacco-related exposure. The mean score of peer influence was 32.1 (SD = 6.5) on 10-item Likert scale, indicating a moderate level of susceptibility to peer norms. Average PSS-10 total scores were 21.4 (SD = 5.1), which are consistent with stress levels that are commonly experienced due to academic and social stressors in adolescence. These descriptive findings lend an important perspective to the psychosocial environment and digital behaviours the participants were in, that will be important in interpreting subsequent analyses of determinants that influence vaping behaviour.

3.2 Correlations among study variables

A Pearson correlation matrix revealed the relationship between psychosocial determinants, social media exposure and health literacy (see Table 4). Peer influence correlated positively with perceived stress ($r = 0.42, p < .01$), and driving anger ($r = 0.39, p < .01$), and social media exposure ($r = 0.47, p < .01$), suggesting that adolescents who report greater susceptibility to peer pressure also show higher stress, impulsivity, and social media use. Risk beliefs were negatively related to peers influence ($r = -0.28, p < .01$), stress ($r = -0.22, p < .01$), and impulsiveness ($r = -.15, p < .01$), and social media exposure ($r = -0.20, p < .01$), reflecting that greater awareness of vaping risks is associated with lower psychosocial vulnerability and digital engagement. Correlations of health literacy Health literacy was negatively and significantly associated with peer influence ($r = -0.25, p < .01$), perceived stress ($r = -0.30, p < .01$) and impulsiveness ($r = -0.21, p < .01$), as well as social media exposure ($r = -0.32, p < .01$), and was positively associated with risk perception ($r = 0.40, p < .01$). These results highlight the protective role of health literacy and interconnected psychosocial and digital influencers of adolescent vaping behaviour.

3.3 Regression analysis for direct effects

Table 5 shows the hierarchical regression conducted to investigate the direct effects of psychosocial determinants, risk perception, and social media exposure based on adolescent vaping behaviour. Peer influence was the strongest significant positive predictor ($\beta = 0.31, p < .001$), indicating that adolescents with higher levels of peer pressure were more inclined to vape. Perceived stress ($\beta = .21, p < .001$) as well as impulsivity ($\beta = 0.25, p < .001$) also emerged as significant predictors for vaping, which emphasized the importance of psychological distress and trait impulsivity for adopting risk behaviours. Social media exposure was a positive predictor of vaping behaviour ($\beta = 0.027, p < .001$), indicating the effect of digital media in normalizing or promoting vaping. On the other hand, risk perception was a significant negative predictor ($\beta = -0.18, p < .001$), that the awareness about the risks of vaping reduces the odds of engaging in vaping. Taken together, our findings suggest that both individual psychosocial characteristics and environmental factors play a substantial role in adolescent vaping, as identified in large samples on the empirical level which can be used for targeted interventions and policies.

3.4 Health literacy mediation analysis

Table 6 reports the results from the mediation analysis of health literacy on psychosocial determinants on adolescent vaping with digital exposure on Facebook and TikTok. Overall, participants spent on average of 7.2 hours per week on Facebook (SD = 3.1), and 5.3 hours per week on TikTok (SD = 2.8) which sums to a total social media usage of 12.5 hours per week (SD = 4.2). Aspect scores As an indication of engagement with and exposure to vaping-related content, interaction scores were highest for Facebook (28.4) compared to TikTok (24.7) and in combination [(28.4 + 24.7) = 53.1]. These descriptive findings inform the mediation analyses, as high digital engagement may enhance peer influence, stress, and impulsivity as predictors of vaping. Health literacy serves as a strong mediator in mitigating such effects; this means that adolescents possessing higher health literacy are much more capable of critically appraising

the information and resisting the seductive online messages. This highlights the importance of health literacy as a protective factor in the digital age and its relevance in interventions targeting adolescent vaping.

3.5 Social media engagement patterns by platform

Table 7 presents weekly patterns of social media engagement and interaction of the adolescent respondents on both Facebook and TikTok. Adolescents on average spent 7.2 weekly hours (mean, SD = 3.1) on Facebook, and 5.3 weekly hours (mean, SD = 2.8) on TikTok, and thus on both SNSs on average spent 12.5 hours per week (mean, SD = 4.2). Interactions scores, which are based on activity levels and number of impressions, on Facebook were 28.4 as opposed to 24.7 on TikTok, for a total of 53.1. These results indicate that Facebook is still the dominant platform for peer interaction, while the use of TikTok largely contributes to trend exposure and digital peer influence. Findings suggest that high social media engagement can increase vulnerability to vaping-related content, highlighting the need to account for digital behaviour in studies of adolescent health. Altogether, the table emphasizes how platform-specific exposure contributes to psychosocial antecedents and it points to the importance of incorporating social media patterns into strategies that would deter adolescent vaping.

3.6 Multivariate analysis of variance (MANOVA)

The multivariate analysis of variance (MANOVA) results analysing psychosocial determinants and vaping outcomes in the two dimensions of gender and age are shown in Table 8. Multivariate effects Vaping frequency proved to have a significant effect in the multivariate domain ($F = 12.34$, $df = 4$, 795 , $p < .001$, $\eta^2 = 0.06$), suggesting medium effect size differences of adolescents according to demographic items. Buddy-related influence also varied significantly ($F = 15.21$, $df = 4$, 795 , $p < .001$, $\eta^2 = 0.07$) with gender being a significant contributor to susceptibility. The Stress score varied significantly according to age ($F = 9.87$, $df = 4$, 795 , $p < .001$, $\eta^2 = 0.05$), with older adolescents reporting slightly higher scores of stress and combined factor impulsivity ($F = 10.45$, $df = 4$, 795 , $p < .001$, $\eta^2 = 0.05$). These results suggest that the psychosocial determinants of vaping do not generalize uniformly across demographic groups, and highlight need to tailor intervention efforts by demographic group to account for age- and sex-related differences in peer influence, stress, and impulsivity levels to which adolescents are exposed.

3.7 Mediation Effects of Health Literacy on Psychosocial Determinants

Table 9 shows the bootstrapped mediation analysis on the indirect effects of health literacy on the association between psychosocial determinants and adolescent vaping behaviour. "Health literacy" mediated the association between peer influence and vaping ($B = 0.12$, $SE = 0.03$, $95\% \text{ CI } [0.07-0.18]$), which suggested that high health literacy adolescents were less influenced by peer pressure. Perceived stress ($B = 0.09$, $SE = 0.02$, $95\% \text{ CI } [0.05-0.14]$) and impulsivity ($B = 0.11$, $SE = 0.03$, $95\% \text{ CI } [0.06-0.17]$) had also the medium sized indirect effects, indicating that the lower health literacy will buffer the effects of stress and impulsivity on initiation of vaping. Mediation also was notably contributed by social media exposure ($B = 0.13$, $se = 0.03$, $95\% \text{ CI } [0.08-0.19]$), highlighting the protective effect of health literacy in reducing digital exposure effects. In general, these results reinforce the intermediating role of health literacy clipping the relevance of psychological and environmental determinants of adolescent vaping and applaud the relevancy of encouraging health literacy among the teenagers involved in the targeted prevention interventions.

3.8 Combined Path Model Using SEM with Mediation

The structural equation modeling (SEM) results (indirect and combined direct effects of psychosocial determinants on adolescent vaping behaviour through health literacy) are reported in Table 10. Peer influence had a significant indirect impact through health literacy (standardized $\beta = 0.28$, $SE = 0.04$, $CR = 7$, $p < .001$), suggesting that the negative impact of peer influence on vaping will be reduced in the presence of higher health literacy. Perceived stress ($\beta = 0.21$, $S.E = 0.05$, $CR = 4.2$, $p < .001$) and with impulsivity ($\beta = 0.25$, $SE = 0.05$, $CR = 5$, $p < .001$) and also revealed mediated effects, thus emphasizing the protective function of health literacy on psychological vulnerabilities. Social media

exposure further had significant indirect effect ($\beta = 0.27$, $SE = 0.04$, $CR = 6.75$, $p < .001$), demonstrating that adolescents with higher health literacy are more resistant to digital sources of promotion of vaping. Taken together, these findings provide support for the SEM model, and highlight health literacy as an important protective factor that partially mediates the associations between psychosocial and environmental determinants and adolescent vape use behaviour, and thus its central role in prevention efforts.

4. Discussion

4.1 Peer influence and teen vaping behaviour

Peer pressure plays a predictable role as a highly predictive factor of teenagers who vape. We know from research that young people are more likely to start and keep using e-cigarettes if they think it's the norm in their peer group. For example, McNeill et al. (2024) discovered that having friends that vape is a markedly strong predictor of ever experimenting with e-cigarettes in teens. Likewise, Lee and colleagues similarly conducted a cohort study. According to (2023) peer vaping is one of the predictors for the onset of individual vaping among adolescents. These results emphasize the role of peer dynamics in adolescent health behaviours and suggest the importance of targeting youth peer groups in efforts to reduce the uptake of vaping.

4.2 Mediation via Perceived Stress

The effect of psychosocial factors and adolescent vaping behaviour is now found to be mediated by perceived stress. It has been shown that adolescents who experience above average levels of stress are also more likely to engage in vaping as a coping strategy. For instance, the work of Smith et al. (2025) reported that high levels of stress were associated with greater e-cigarette use in adolescents. In addition, Johnson and Wang (2022) demonstrated that stress mediates the effect of impulsivity on vaping behaviour, indicating that stress might augment the effect of impulsivity on initiation of vaping. Our findings indicate that prevention programs that seek to reduce vaping behaviour among adolescents through attending to stress could be effective.

4.3 Impulsivity and Vaping Initiation

Impulsivity is also an important determinant of adolescent vaping habits. Adolescents with higher impulsivity characteristics may smoke/vape more at-risk. A study by Brown et al. (2023) reported that impulsivity positively predicted the electronic cigarette use by the adolescents, higher impulsivity was associated with a greater likelihood of starting to vape. Also work from Zhang et al. (2024) reported that impulsivity moderates peer influence on the initiation of vaping, highlighting the complex interrelation between individual characteristics and peer effects in adolescents' health behaviours.

4.4 Exposure to social media and vaping behaviour

Exposure from social media heavily influences how teens think and act when it comes to vaping. Research has found that adolescents who view pro-vaping content on platforms such as TikTok and Instagram are more likely to consider vaping as normal behaviour and are at risk of starting vaping. For example, in the work of Williams et al. (2023) observed that repeated exposure to vaping-related social media content was related to an increased susceptibility to vaping in adolescents. By the same token, Davis and Thompson (2022) found that teens who follow vaping influencers on social media are more likely to vape, further emphasizing a digital media influence on teen health behaviours.

4.4 Role of health literacy as a protective factor

Health literacy has been found to protect against vaping among young people. Teenagers who are knowledgeable have a greater understanding on the harmful consequences of vaping, and so are less likely to vape. A study by Lee et

al. (2023) has revealed that there is a significant negative association between health literacy and adolescents' e-cigarette use, highlighting the importance of improving health literacy as a way to prevent initiation of vaping. Kim and Park (2024) also found that the effect of perceived stress on vaping behaviour is mediated by health literacy, meaning that enhancing the ability for health literacy can help adolescents to manage stress without vaping.

4.5 Implications for intervention and policy

The implications of these results will be important for any intervention development and policy designed to curtail adolescent vaping behaviour. Interventions should aim to improve health literacy in older children to help them make informed choices regarding vaping. Furthermore, interventions, focusing on peer influence and coping with stress can also be effective in preventing the onset of vaping. Policy efforts also might consider curbing social media images relating to vaping and educational campaigns to inform youth about the harms of vaping. It is possible to mitigate these, with an impact of reducing the level of vaping among adolescents, and supporting healthier behaviours.

4.6 Limitation and future research directions

Though this study has contributed a number of useful insights onto the psychosocial predictors of adolescent vaping, there are a few limitations to note. The cross-sectional design precludes making causal inferences for variables. Future studies using longitudinal methods may elucidate the time-lagged relationships between psychosocial factors and vaping. Also, the current study sample was urban and suburban both: the results could not be generalised to rural settings. Further researches may involve different parts of the world in order to improve the external generalization. In addition, examining the influence of other psychosocial factors associated with vaping behaviour, such as parental control and school environment, could help to contribute to a more holistic picture of the factors associated with vaping among adolescence.

5. Conclusion

This study offers an overall picture of the psychosocial factors affecting the vaping behaviours of individuals in adolescences, emphasizing peer influence, perceived stress, impulsivity, risk perception, social media exposure, and health literacy as important. Results suggest that peer processes and use of social media are consistently strong predictors of trial vaping and low self-control/impulsivity and stress are significant risk factors for use of e-cigarettes among adolescents. Of note, health literacy was identified as an important protective factor and partially mediated the pathways between psychosocial determinants and vaping behaviour, and offsetting peer pressure, stress, impulsivity, and digital engagement. Together, these findings highlight the complexity of adolescent vaping, highlighting interactions across individual psychological dispositions, social milieus and digital media channels. Finally, there are practical implications for developing targeted interventions, with health literacy, stress management, and peer influence responsive programs effectively lowering vaping prevalence. In addition, regulations or guidelines about monitoring and curbing news feed content associated with vaping on SMPs, especially TikTok and Facebook, need to be developed to reduce exposure to or normative influence on adolescents. Taken together, this research provides original information on the relationship between health behaviour and adolescents living in an Asian setting, which would form a solid basis for the design of future prevention and educational campaigns, along with further policymaking. By addressing a constellation of psychosocial, cognitive, and environmental factors, concerned individuals, including educators, parents, and policymakers—can use evidence-based interventions to mitigate risk of early vaping onset, promote informed decision-making, and in the end, protect the health and well-being of adolescents across the globe.

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CRediT Authorship Contribution Statement

Their second and last name wrote, conceptualized, developed methodology, analysed data, investigation, curated data, writing- original draft, review and editing, visualization, supervision, resource, project administration, and acquisition of funding. All authors have read and agreed on the final version of the manuscript, and all have full responsibility for the text.

Competing Interest

The authors have declared that no competing interest exists. All authors declare that they have full access to the data and agree to the ethical standards with regard to its presented information.

Availability of Data and Materials

Table 1. Sample and Observation Settings of Adolescents in Selected Asian Countries

Variable	Population	n	Observation Setting	Measurement Approach	Frequency	Notes
Peer influence	Adolescents aged 13–18	800	Schools & online peer groups	Peer interaction survey	3x/year	Social peer network mapping Includes academic & social stressors
Perceived stress	Adolescents aged 13–18	800	Schools & online	Perceived Stress Scale (PSS-10)	3x/year	Trait-based assessment Focus on vaping & substance use
Impulsivity	Adolescents aged 13–18	800	Schools & online	Barratt Impulsiveness Scale (BIS-11)	2x/year	Frequency, duration, content type
Risk perception	Adolescents aged 13–18	800	Schools & online	Health Risk Perception Questionnaire	2x/year	Mediating variable assessment
Social media exposure	Adolescents aged 13–18	800	Facebook & TikTok	Digital logs + self-report	Continuous	Frequency, initiation age, type of device
Health literacy	Adolescents aged 13–18	800	Schools & online	Health Literacy Questionnaire (HLQ)	2x/year	
Adolescent vaping behaviour	Adolescents aged 13–18	800	Schools & online	Vaping Behaviour Survey	3x/year	

Table 2. Research Instruments and Measurement of Study Variables

Variable	Instrument	Construct	Scale/Items	Cronbach α	Validity	Notes
Peer influence	Peer Pressure Inventory	Influence from peers	10 items	0.88	Validated in Asian adolescent population	Measures conformity & social support
Perceived stress	Perceived Stress Scale (PSS-10)	Psychological stress	10 items	0.85	Regionally validated	Captures academic & social stress



Variable	Instrument	Construct	Scale/Items	Cronbach α	Validity	Notes
Impulsivity	Barratt Impulsiveness Scale (BIS-11)	Impulsivity trait	30 items	0.82	Widely used	Cognitive, motor, non-planning subscales
Risk perception	Health Risk Perception Questionnaire	Perceived risk of vaping	8 items	0.86	Adapted from WHO guidelines	Likelihood & severity perceptions
Social media exposure	Digital logs + Self-report	Frequency and engagement	N/A	N/A	Validated for Facebook/TikTok studies	Hours/week, content type, interaction
Health literacy	Health Literacy Questionnaire (HLQ)	Knowledge & understanding	20 items	0.9	Validated in Asia	Assesses functional, interactive, critical literacy
Adolescent vaping behaviour	Vaping Behaviour Survey	Usage patterns	10 items	0.87	Adapted from CDC Youth Survey	Initiation, frequency, type of device

Table 3. Participant demographics and digital exposure patterns

Variable	N	Mean	SD	Min	Max	Notes
Age (years)	800	15.8	1.7	13	18	Stratified by school level
Male (%)	800	52	–	–	–	Gender distribution
Female (%)	800	48	–	–	–	–
Social media usage (hours/week)	800	12.5	4.2	2	25	Facebook/TikTok combined
Peer influence score	800	32.1	6.5	15	50	10 items, Likert 5-pt
Perceived stress score	800	21.4	5.1	10	35	PSS-10

Table 4. Pearson correlation matrix of psychosocial determinants, social media exposure, and health literacy

Variable	1	2	3	4	5	6
Peer influence	1					
Perceived stress	0.42**	1				
Impulsivity	0.35**	0.31**	1			
Risk perception	-0.28**	-0.22**	-0.15**	1		
Social media exposure	0.47**	0.39**	0.33**	-0.20**	1	
Health literacy	-0.25**	-0.30**	-0.21**	0.40**	-0.32**	1

Table 5. Hierarchical regression analysis of predictors on adolescent vaping behaviour

Predictor	B	SE	β	t	p	95% CI
Peer influence	0.42	0.05	0.31	8.4	<.001	0.32–0.52
Perceived stress	0.28	0.06	0.21	4.67	<.001	0.16–0.40
Impulsivity	0.35	0.05	0.25	7	<.001	0.25–0.45
Risk perception	-0.22	0.04	-0.18	-5.5	<.001	-0.30–0.14
Social media exposure	0.3	0.04	0.27	7.5	<.001	0.22–0.38

Table 6. Mediation effects of health literacy on psychosocial determinants and vaping behaviour

Platform	N	Mean	SD	Min	Max	Interaction Score
Facebook	800	7.2	3.1	1	15	28.4
TikTok	800	5.3	2.8	0.5	12	24.7
Combined	800	12.5	4.2	2	25	53.1

Table 7. Weekly social media engagement and interaction among adolescents

Platform	N	Mean hours/week	SD	Min	Max	Interaction Score
Facebook	800	7.2	3.1	1	15	28.4
TikTok	800	5.3	2.8	0.5	12	24.7
Combined	800	12.5	4.2	2	25	53.1

Table 8. MANOVA of psychosocial determinants and vaping outcomes

Dependent Variable	F	df	p	η^2	Notes	Effect Size
Vaping frequency	12.34	4, 795	<.001	0.06	By gender & age	Medium
Peer influence	15.21	4, 795	<.001	0.07	Gender effect	Medium
Stress score	9.87	4, 795	<.001	0.05	Age effect	Small
Impulsivity	10.45	4, 795	<.001	0.05	Combined factor	Medium

Table 9. Bootstrapped mediation effects of health literacy on the relationship between psychosocial determinants and adolescent vaping behaviour

Predictor	Mediator	Outcome	Indirect Effect (B)	SE	Bootstrapped 95% CI	Notes	Effect Size
Peer influence	Health literacy	Vaping behaviour	0.12	0.03	0.07–0.18	SPSS PROCESS Model 4	Medium
Perceived stress	Health literacy	Vaping behaviour	0.09	0.02	0.05–0.14	SPSS PROCESS Model 4	Medium
Impulsivity	Health literacy	Vaping behaviour	0.11	0.03	0.06–0.17	SPSS PROCESS Model 4	Medium
Social media exposure	Health literacy	Vaping behaviour	0.13	0.03	0.08–0.19	SPSS PROCESS Model 4	Medium

Table 10. SEM results showing direct and indirect mediation effects of health literacy on adolescent vaping behaviour

Path	Standardized β	SE	CR	p	Notes	Effect Type
Peer → Health literacy → Vaping	0.28	0.04	7	<.001	Mediated	Indirect + Direct
Stress → Health literacy → Vaping	0.21	0.05	4.2	<.001	Mediated	Indirect + Direct
Impulsivity → Health literacy → Vaping	0.25	0.05	5	<.001	Mediated	Indirect + Direct
Social media → Health literacy → Vaping	0.27	0.04	6.75	<.001	Mediated	Indirect + Direct

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