

Original Paper

Suicidal Behaviour among E-cigarette Users: A Systematic Review of Recent Evidence

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Abstract

Objectives: Prior evidence reported inconsistently that there is an association between e-cigarette use and suicidal behaviours. The aim of this study was to systematically review the recent literature that explored the association between e-cigarette use and suicidal behaviour such as ideation, planning and attempts. **Methods:** PubMed and Web of Science databases were searched to include studies between 2017 to 2021. Two reviewers screened all studies and narrative data synthesis was conducted. **Results:** This review analysed eight cross-sectional studies, which involved a total of 6,84,478 participants where only 4.9% were e-cigarette users (33,714 of 6,84,478). The suicidal ideation/thoughts, planning and attempts were measured among e-cigarette users based on diverse variables such as smoking status, gender, asthmatic, and depressive conditions. Suicidal ideation/thoughts, planning and attempts were higher among male, smoker, asthmatic, and depressive e-cigarette users than lifetime and never e-cigarette users. **Conclusions:** Public health researchers and policymaker should consider these variables as crucial factors to design any intervention or helpline services to prevent suicidal behaviour among e-cigarette users.

Keywords

Suicidal Ideation, Suicidal Planning, Suicidal Attempts, E-cigarette, Vaping

1. Background

There is growing evidence that people who smoke have a three-fold higher risk of Covid-19 infection, hospitalization, and mortality than people who do not smoke (Rosoff, Yoo, & Lohoff, 2021; Clift, von Ende, Tan, Sallis, Lindson, Coupland, ... Hopewell, 2022). Similarly, a recent study showed that vaping (using e-cigarettes) may increase the risk of transmission, susceptibility, and severity of Covid-19 (Li, Croft, Ossip, & Xie, 2020). Another study mentioned that higher stress was associated with increased cigarette smoking and vaping during pandemics (Kalkhoran, Levy, & Rigotti, 2021). Furthermore, the impacts of the Covid-19 pandemic, physical distancing and isolation leads to stress,

anxiety, depression which were associated with thoughts of suicide (Elbogen, Lanier, Blakey, Wagner, & Tsai, 2021).

Globally one person every 40 seconds die from suicide every year, even the suicide rate for men is twice as high as for women (Roth, Abate, Abate, Abay, Abbafati, Abbasi, N., ...Abdollahpour, 2018). Suicide can result from complex interactions between multiple stressors and risk factors, for example, family crisis, financial distress, or health concerns (World Health Organization, 2014). Several studies also have reported an association between tobacco use (Poorolajal & Darvishi, 2016), alcohol consumption (Rizk, Herzog, Dugad, & Stanley, 2021) and substance abuse disorders (Rizk, Herzog, Dugad, & Stanley, 2021) with suicidal behaviours. Additionally, the association between e-cigarette use and suicidal behaviours findings addressed inconsistently. The aim of this study was to systematically review the recent literature that explored the association between e-cigarette use and suicidal behaviour such as ideation, planning and attempts.

2. Methods

The current review resulted from a search for publications related to suicidal behaviour on vaping. Searches were undertaken in July 2020 and updated in January 2022 on PubMed and Web of Science. The following Medical Subject Headings (MeSH) search terms were used: (Suicide OR Suicidal behaviour) AND (E-cigarettes OR Vaping). Studies were considered if they had been published within the last five years in peer-reviewed journals and written in English. The search years of published articles were kept between 2017-2021 to uncover the latest evidence of suicidal behaviour among e-cigarette users. We included empirical studies of primary research, observational or participatory studies. Opinion pieces, editorials, conference abstracts, study or review protocols, and book chapters were not selected.

Two reviewers performed the searches and the screening for articles. The first screening was conducted independently, and later data were merged for full-text review and the resolution of the disagreements were done mutually. The search identified 113 studies; duplicates, or unrelated articles were excluded at the title and abstract screening phase. We screened the full text of 23 studies and a total of 8 studies were eligible for inclusion in this review. For this current review, we have interpreted the suicidal behaviour terminologies as suicidal ideation/thoughts (defined as seriously considered suicide in the past 12 months); suicide planning (defined as making any specific plans for suicide in the past 12 months) and suicide attempts (defined as attempted suicide in the past 12 months). After selection and assessment of the articles (by both UR and SA), the lead author (SA) performed the narrative synthesis focused on suicidal behaviour among e-cigarette users and AJ provided critical revision.

3. Results

3.1 Study Characteristics

After the full-text review, 8 studies (Kim, Jeong, Park, & Jang, 2021; Huh & Cho, 2021; Kim, Kang, Jung, J. W., Jung, S. Y., Park, H. J., Park, J. S., ... Korean Smoking Cessation Study Group, 2021; Lee, Oh, Kim, Kong, & Moon, 2020; Kim, C. W., Jeong, Kim, J. Y., Lee, J. S., Lee, J. H., Jo, & Kim, S. H., 2020; Pham, Williams, Bhattarai, Dore, Isherwood, & Patten, 2020; Lee, Y. & Lee, K. S., 2019; Chadi, Li, Cerda, & Weitzman, 2019) were included in the analysis (Table 1). All the studies used cross-sectional designs that were conducted in East Asia (Kim, Jeong, Park, & Jang, 2021; Huh & Cho, 2021; Kim, Kang, Jung, J. W., Jung, S. Y., Park, H. J., Park, J. S., ... Korean Smoking Cessation Study Group, 2021; Lee, Oh, Kim, Kong, & Moon, 2020; Kim, C. W., Jeong, Kim, J. Y., Lee, J. S., Lee, J. H., Jo, & Kim, S. H., 2020; Lee, Y. & Lee, K. S., 2019), Canada (Pham, Williams, Bhattarai, Dore, Isherwood, & Patten, 2020), and the United States (Chadi, Li, Cerda, & Weitzman, 2019). A total of 6,84,478 participants were included in all 8 studies (Kim, Jeong, Park, & Jang, 2021; Huh & Cho, 2021; Kim, Kang, Jung, J. W., Jung, S. Y., Park, H. J., Park, J. S., ... Korean Smoking Cessation Study Group, 2021; Lee, Oh, Kim, Kong, & Moon, 2020; Kim, C. W., Jeong, Kim, J. Y., Lee, J. S., Lee, J. H., Jo, & Kim, S. H., 2020; Pham, Williams, Bhattarai, Dore, Isherwood, & Patten, 2020; Lee, Y. & Lee, K. S., 2019; Chadi, Li, Cerda, & Weitzman, 2019) where only 4.9% were e-cigarette users (33,714 of 6,84,478). The range of the participant's ages was varied between 12 to 80 years. Participants smoking status was mentioned in all the included studies except one study (Lee, Oh, Kim, Kong, & Moon, 2020). Only one study (Lee, Oh, Kim, Kong, & Moon, 2020) was funded, five studies (Huh & Cho, 2021; Kim, Kang, Jung, J. W., Jung, S. Y., Park, H. J., Park, J. S., ... Korean Smoking Cessation Study Group, 2021; Kim, C. W., Jeong, Kim, J. Y., Lee, J. S., Lee, J. H., Jo, & Kim, S. H., 2020; Pham, Williams, Bhattarai, Dore, Isherwood, & Patten, 2020; Chadi, Li, Cerda, & Weitzman, 2019) declared no funding source and two studies (Kim, Jeong, Park, & Jang, 2021; Lee, Y. & Lee, K. S., 2019) had missing funding information. The authors have indicated they have no potential conflicts of interest to disclose in all included studies (Kim, Jeong, Park, & Jang, 2021; Huh & Cho, 2021; Kim, Kang, Jung, J. W., Jung, S. Y., Park, H. J., Park, J. S., ... Korean Smoking Cessation Study Group, 2021; Lee, Oh, Kim, Kong, & Moon, 2020; Kim, C. W., Jeong, Kim, J. Y., Lee, J. S., Lee, J. H., Jo, & Kim, S. H., 2020; Pham, Williams, Bhattarai, Dore, Isherwood, & Patten, 2020; Lee, Y. & Lee, K. S., 2019; Chadi, Li, Cerda, & Weitzman, 2019).

Table 1. Overview of the Included Studies in the Systematic Review

Author	Sample size (N)	Age (Range, Years) Mean \pm SD	Smoking Status	E-cigarette use Status	Reported suicidal outcome with e-cigarette use
Kim et al. 2021 Korea	2,55,887	NR 15.0 \pm 1.8	Smoker: 14.3% Non-smoker: 84.1%	Current user: 1.6% (4,262)	<p><u>Suicidal ideation</u>: 18.2% (779 of 4,262)</p> <ul style="list-style-type: none"> • Suicidal ideation (initial e-cigarettes vs conventional cigarettes) among male: AOR, 1.26; 95%CI, 1.12-1.42; P < 0.001 • Suicidal ideation (initial e-cigarettes vs conventional cigarettes) among female: AOR, 1.20; 95%CI, 0.99-1.45; P < 0.06 <p><u>Suicidal planning</u>: 9.7% (417 of 4,262)</p> <ul style="list-style-type: none"> • Suicidal planning (initial e-cigarettes vs conventional cigarettes) among male: AOR, 1.63; 95%CI, 1.40-1.89; P < .001 • Suicidal planning (initial e-cigarettes vs conventional cigarettes) among female: AOR, 1.55; 95%CI, 1.23-1.95; P < .001 <p><u>Suicidal attempts</u>: 7.3% (312 of 4,262)</p> <ul style="list-style-type: none"> • Suicidal attempts (initial e-cigarettes vs conventional cigarettes) among male: AOR, 1.55; 95%CI, 1.28-1.87; P < .001 • Suicidal attempts (initial e-cigarettes vs conventional cigarettes) among female: AOR, 1.64; 95%CI, 1.29-2.10; P < .001
Huh et al. 2021 South Korea	57,069	13-18 NR	Never 86.3% Former 6.5%	user: Current user: 0.3% (172) user:	<p><u>Suicidal thoughts</u>: 18.5%</p> <ul style="list-style-type: none"> • Suicidal thoughts (e-cigarettes vs never user): OR, 2.29; 95%CI, 1.44-3.65; P < 0.001 <p><u>Suicidal plans</u>: 9.5%</p> <ul style="list-style-type: none"> • Suicidal plans (e-cigarettes vs never user): OR, 3.38, 95%CI, 1.81-6.33; P < 0.001 <p><u>Suicidal attempts</u>: 7.3%,</p> <ul style="list-style-type: none"> • Suicidal attempts (e-cigarettes vs never user): OR, 4.26, 95%CI, 2.16-8.38; P < 0.001
Kim et al. 2021 Korea	28,059	≥ 19 NR	Smoker: 33.0% Non-smoker: 60.5%	Current user: 6.4% (1,832)	<p><u>Suicidal ideation</u>: 6.5%</p> <ul style="list-style-type: none"> • Suicidal ideation (e-cigarettes vs non-smoker) among male: OR, 1.569; 95%CI, 1.83-3.58; P < 0.001 • Suicidal ideation (e-cigarettes vs smoker) among male: OR, 1.36; 95%CI, 0.95-1.95; P < 0.092 <p><u>Suicidal plans</u>: 2.4%</p> <ul style="list-style-type: none"> • Suicidal plans (e-cigarettes vs non-smoker) among male: OR, 3.22; 95%CI, 2.00-5.18; P < 0.001

					<ul style="list-style-type: none"> • Suicidal plans (e-cigarettes vs smoker) among male: OR, 1.94; 95% CI, 1.22-3.09; P < 0.005 <p><u>Suicidal attempts</u>: 1.1%</p> <ul style="list-style-type: none"> • Suicidal attempts (e-cigarettes vs non-smoker) among male: OR, 4.27; 95% CI, 2.04-8.93; P < 0.001 • Suicidal attempts (e-cigarettes vs smoker) among male: OR, 1.14; 95% CI, 0.57-2.29; P < 0.701
Lee et al.	5,469	19-80	Current	Current user:	<u>Suicidal plans</u> : Non-depressed (1.8%) vs Depressed (8.8%)
2020		50.39 ±	Smoker:18.5%	6.7% (371)	<ul style="list-style-type: none"> • Suicide plans (history of e-cigarette use vs no e-cigarettes use) among men: 1.8%, P = 0.734 • Suicide plans (history of e-cigarette use vs no e-cigarettes use) among women: 2.3%, P = 0.281 <p><u>Suicidal attempts</u>: Non-depressed (0.3%) vs Depressed (2.6%)</p> <ul style="list-style-type: none"> • Suicide plans (history of e-cigarette use vs no e-cigarettes use) among men: 0.3%, P = 0.790 • Suicide plans (history of e-cigarette use vs no e-cigarettes use) among women: 0.0%, P = 0.096
South Korea		16.60			
Kim et al.	1,95,847	12-18	Current smoker:	Current user:	<u>Suicidal ideation</u> : Asthmatic (22.4%) vs Non-Asthmatic (16.9%)
2020		NR	6.5%	2.9% (5,833)	<ul style="list-style-type: none"> • Suicidal ideation (e-cigarettes vs never user): AOR, .28; 95% CI: 1.18-1.43; P < 0.001 <p><u>Suicidal attempts</u>: Asthmatic (10.7%) vs Non-Asthmatic (5.4%)</p> <ul style="list-style-type: none"> • Suicidal attempts (e-cigarettes vs never user): AOR, 2.11; 95% CI: 1.51-2.95; P < 0.001
Korea				Experience of e-cigarette use: 8.3% (16,361)	<u>Suicidal attempts</u> : 2.3% (95% CI: 2.1-2.5)
Pham et al.	53,050	>12	Smoker: 16.3%	Past 30-day user: 2.9% (1,539)	<ul style="list-style-type: none"> • Suicidal attempts (e-cigarettes vs never user) among smoker: 12.6, 95% CI: 7.6-17.5 vs 5.0, 95% CI: 3.7-6.3 • Suicidal attempts (e-cigarettes vs never user) among non-smoker: 6.0, 95% CI: 1.0-11.0 vs 2.1, 95% CI: 1.8-2.5
2020		45.4 ± 0.1	Former Smoker: 35.3%		
Canada			Never Smoked: 48.5%		
Lee et al.	62,276	13-18	Current smoker:	Current user:	<u>Suicidal ideation</u> : 25.2% (current user); 16.3% (lifetime e-cigarette user)
2019		NR	7.5%	0.4% (253)	<ul style="list-style-type: none"> • Suicidal ideation (current e-cigarettes use vs never use): AOR, 2.49; 95% CI: 1.82-3.42 • Suicidal ideation (lifetime e-cigarettes vs never use): AOR, 1.93; 95% CI: 1.54-2.41 <p><u>Suicidal planning</u>: 15.6% (current user) vs 8.8% (lifetime e-cigarette user)</p> <ul style="list-style-type: none"> • Suicidal planning (current e-cigarettes use vs never use): AOR, 4.63; 95% CI: 3.22-6.67
South Korea			Lifetime smoker:4.7%	Lifetime user:1.1% (660)	

					<ul style="list-style-type: none"> • Suicidal planning (lifetime e-cigarettes vs never use): AOR,3.07; 95% CI: 2.30-4.10
					<u>Suicidal attempts</u> : 12.6% (current user) vs 7.6% (lifetime e-cigarette user)
					<ul style="list-style-type: none"> • Suicidal attempts (current e-cigarettes use vs never use): AOR,6.17; 95% CI: 4.13-9.24
					<ul style="list-style-type: none"> • Suicidal attempts (lifetime e-cigarettes vs never use): AOR,4.75; 95% CI: 3.48-6.50
Chadi et al.	26,821	NR	NR	Current user:	<u>Suicidal attempts</u> :20.8%
2019				9.1% (2,431)	<ul style="list-style-type: none"> • Suicidal attempts (e-cigarettes use vs never use): AOR,6.17; 95% CI: 1.03-1.47
USA					

AOR, Adjusted odds ratio; OR Odds ratio; CI, Confidence interval; NR, Not reported

4. Study Outcome

The included studies outcomes had been clarified under the following subheadings:

4.1 Suicidal Ideation/Thoughts

Most of the included studies (5 of 8) (Kim, Jeong, Park, & Jang, 2021; Huh & Cho, 2021; Kim, Kang, Jung, J. W., Jung, S. Y., Park, H. J., Park, J. S., ... Korean Smoking Cessation Study Group, 2021; Kim, C. W., Jeong, Kim, J. Y., Lee, J. S., Lee, J. H., Jo, & Kim, S. H., 2020; Lee, Y. & Lee, K. S., 2019) measured suicidal ideation/thoughts among e-cigarette users based on diverse variables (smoking status, gender, asthmatic condition). Two studies showed an association of suicidal ideation/thoughts between e-cigarette use with smokers (Kim, Jeong, Park, & Jang, 2021) and non-smokers ($P < 0.001$) (Kim, Kang, Jung, J. W., Jung, S. Y., Park, H. J., Park, J. S., ... Korean Smoking Cessation Study Group, 2021). Suicidal ideation/thoughts were also higher among male e-cigarette users than conventional cigarette users (Kim, Jeong, Park, & Jang, 2021) and non-smokers (Kim, Kang, Jung, J. W., Jung, S. Y., Park, H. J., Park, J. S., ... Korean Smoking Cessation Study Group, 2021). Another two studies mentioned a higher odds ratio of suicidal ideation/thoughts among current (Huh & Cho, 2021; Lee, Y. & Lee, K. S., 2019) and lifetime e-cigarette users (Lee, Y. & Lee, K. S., 2019) than never e-cigarette users (Huh & Cho, 2021; Lee, Y. & Lee, K. S., 2019). Suicidal ideation/thoughts were significantly higher among the asthmatic e-cigarette user than never e-cigarette user (AOR, 0.28; 95% CI: 1.18–1.43; $P < 0.001$) (Kim, C. W., Jeong, Kim, J. Y., Lee, J. S., Lee, J. H., Jo, & Kim, S. H., 2020).

4.2 Suicidal Planning

The majority of the included studies (5 of 8) (Kim, Jeong, Park, & Jang, 2021; Huh & Cho, 2021; Kim, Kang, Jung, J. W., Jung, S. Y., Park, H. J., Park, J. S., ... Korean Smoking Cessation Study Group, 2021; Lee, Oh, Kim, Kong, & Moon, 2020; Lee, Y. & Lee, K. S., 2019) measured suicidal planning among e-cigarette users based on diverse variables (smoking status, gender, depressive condition). Two studies showed an association of suicidal planning between e-cigarette use with smokers (Kim, Jeong, Park, & Jang, 2021) and non-smokers ($P < 0.001$) (Kim, Kang, Jung, J. W., Jung, S. Y., Park, H. J., Park,

J. S., ... Korean Smoking Cessation Study Group, 2021). Suicidal planning was also higher among male e-cigarette users than conventional cigarette users (Kim, Jeong, Park, & Jang, 2021) and non-smokers (Kim, Kang, Jung, J. W., Jung, S. Y., Park, H. J., Park, J. S., ... Korean Smoking Cessation Study Group, 2021). Another two studies mentioned a higher odds ratio of suicidal planning among current (Huh & Cho, 2021; Lee, Y. & Lee, K. S., 2019) and lifetime e-cigarette users (Lee, Y. & Lee, K. S., 2019) than never e-cigarette users (Huh & Cho, 2021; Lee, Y. & Lee, K. S., 2019). Suicidal planning was higher among the depressive e-cigarette user than non-depressive e-cigarette users (8.8% vs 1.8% respectively) but was not significantly associated with e-cigarette use status among men ($P = 0.734$) and women ($P = 0.281$) (Lee, Oh, Kim, Kong, & Moon, 2020).

4.3 Suicidal Attempts

All included 8 studies (Kim, Jeong, Park, & Jang, 2021; Huh & Cho, 2021; Kim, Kang, Jung, J. W., Jung, S. Y., Park, H. J., Park, J. S., ... Korean Smoking Cessation Study Group, 2021; Lee, Oh, Kim, Kong, & Moon, 2020; Kim, C. W., Jeong, Kim, J. Y., Lee, J. S., Lee, J. H., Jo, & Kim, S. H., 2020; Pham, Williams, Bhattarai, Dore, Isherwood, & Patten, 2020; Lee, Y. & Lee, K. S., 2019; Chadi, Li, Cerda, & Weitzman, 2019) measured suicidal attempts based on diverse variables (smoking status, gender, asthmatic and depressive condition). Two studies showed an association of suicidal attempts between e-cigarette use with smokers (Kim, Jeong, Park, & Jang, 2021) and non-smokers ($P < 0.001$) (Kim, Kang, Jung, J. W., Jung, S. Y., Park, H. J., Park, J. S., ... Korean Smoking Cessation Study Group, 2021). Another four studies mentioned a higher odds ratio of suicidal attempts among current (Huh & Cho, 2021; Pham, Williams, Bhattarai, Dore, Isherwood, & Patten, 2020; Lee, Y. & Lee, K. S., 2019; Chadi, Li, Cerda, & Weitzman, 2019) and lifetime e-cigarette users (Lee, Y. & Lee, K. S., 2019) than never e-cigarette users. Suicidal attempts were significantly higher (AOR, 2.11; 95% CI: 1.51–2.95; $P < 0.001$) among the asthmatic e-cigarette user than never e-cigarette user (Kim, C. W., Jeong, Kim, J. Y., Lee, J. S., Lee, J. H., Jo, & Kim, S. H., 2020). Suicidal attempts were higher among the depressive e-cigarette user than non-depressive e-cigarette user (2.6% vs 0.3% respectively) but was not significantly associated with e-cigarette use status among men ($P = 0.790$) and women ($P = 0.096$) (Lee, Oh, Kim, Kong, & Moon, 2020).

5. Discussion

We identified eight studies that reported data on suicidal ideation/thoughts, planning and attempts status of e-cigarette users at different population levels. The outcomes varied on smoking status, gender, and medical condition such as asthma and depression. Male, Current smoking status, asthmatic and depression conditions were significantly higher among the e-cigarette user than never e-cigarette users. The associations among smoking, mental illness (especially anxiety and depression), and suicide remain ambiguous, however, a study concluded that the association between smoking and suicide accounted for confounders, such as mental well-being (Hemmingsson & Kriebel, 2003). Additionally, a recent meta-analysis suggests that smoking is associated with suicidal behaviors (Poorolajal & Darvishi,

2016; Li, Yang, Ge, Hao, Wang, Liu, ... Huang, 2012). E-cigarettes are considered as tobacco (heated) product (World Health Organization, 2009) and still controversy exist whether e-cigarettes itself substantiate to reduce harm or induce harm at the individual and the population levels (Balfour, Benowitz, Colby, Hatsukami, Lando, Leischow, ... West, 2021). Therefore, it should be considered as an escalating public health concern whether e-cigarette has a similar impact on suicide as smoking. Hence, our current review provides a baseline platform to design an intervention or helpline services to prevent suicidal behaviour among e-cigarette users.

Similarly, socio-demographic factors, alcohol consumption, drug abuse and depression were they key risk factors for suicide death and attempts among males (Richardson, Robb, & O'Connor, 2021). Prior research also suggests that there is a positive association between suicide and male smokers (Miller, Hemenway, & Rimm, 2000). Additional meta-analysis found that current or former use of e-cigarettes were associated with the prevalence of asthma (Xian & Chen, 2021) and depression (Obisesan, Mirbolouk, Osei, Orimoloye, Uddin, Dzaye, ... Blaha, 2019) who had higher suicidal tendency (Chung, Kim, & Lee, 2016; Hawton, Casañas, Comabella, Haw, & Saunders, 2013). Hence, clinical and psychological conditions among e-cigarettes user particularly male vaper should consider as crucial factors to design any intervention for the prevention of suicidal behaviour.

A potential limitation of this review was that it included only small number of studies. Additionally, for the purposes of the narrative synthesis of the results, all the definitions were grouped under a single broad definition for suicidal outcome. Although the findings were at very diverse context, however, suicidal outcomes were evident at different levels among e-cigarette user which recommend developing intervention program to prevent suicidal impacts worldwide. Yet, more comprehensive longitudinal data collection is needed to understand the consequences of such suicidal tendency in longstanding among the e-cigarette user and to implement and improve effective intervention strategies to prevent suicide.

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