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Assessment of e-cigarette dependence and influencing factors among Palestinian young adults: a cross-sectional study

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E-cigarette use is a growing public health concern, especially because of the potential health risks it poses. This study focuses on assessing e-cigarette dependence and the factors associated with it among Palestinian young adults. A cross-sectional survey was conducted from January to May 2023 among university students in the West Bank. A self-administered questionnaire was used to collect demographic data, knowledge, and attitudes regarding e-cigarettes. E-cigarette dependence was assessed using the Penn State Electronic Cigarette Dependence Index. The study included 386 university students who used e-cigarettes. Many of them started using e-cigarettes at a young age, and 54.7% were dual users of e-cigarettes and traditional tobacco. High levels of dependence were reported in 11.4% of participants, and moderate dependence in 28.8%. Several factors were identified through multivariate linear regression as significantly associated with e-cigarette dependence: a higher monthly allowance ($\beta = 0.116$, 95% CI: 0.128–1.124, $p = .014$), having a father who uses tobacco ($\beta = 0.095$, 95% CI: 0.030–1.638, $p = .042$), having a close friend who smokes traditional cigarettes ($\beta = 0.095$, 95% CI: 0.019–1.667, $p = .045$), using e-cigarettes in areas where traditional smoking is prohibited ($\beta = 0.175$, 95% CI: 0.689–2.330, $p < .001$), using e-cigarettes to quit other forms of tobacco ($\beta = 0.134$, 95% CI: 0.434–2.314, $p = .004$), and a more negative attitude score ($\beta = -0.210$, 95% CI: -0.285 – -0.112 , $p < .001$). The study revealed high levels of e-cigarettes dependence among the participants among young adults, with associated variables such as monthly allowance, attitudes, and age of e-cigarette initiation. Policymakers, educators, and healthcare professionals should collaborate to address e-cigarette dependence among young adults, taking into consideration social, environmental, and socioeconomic factors.

Keywords E-cigarettes, Young adults, dependence, Parental smoking, Dual smoking

Electronic cigarettes (e-cigarettes) have become popular as an alternative to traditional tobacco smoking in recent years. The prevalence of current e-cigarettes use among never-smokers and ex-smokers has increased significantly¹, raising concerns that e-cigarettes may serve as a gateway to tobacco smoking. Some individuals use e-cigarettes as a smoking cessation aid, but the efficacy of this strategy is still debatable.

Peer influence is one of the primary reasons for trying e-cigarettes, in addition to the alluring flavors and marketing strategies aimed at young people^{2,3}. Some individuals use e-cigarettes as a means to quit smoking traditional cigarettes. However, dual-use (using both e-cigarettes and traditional cigarettes) is common¹ and can maintain or exacerbate nicotine dependence, probably riskier for health than using tobacco or e-cigarettes alone⁴. Research suggests that using e-cigarettes as a therapeutic intervention for smoking cessation may lead to permanent nicotine dependence⁵.

The nicotine content of e-cigarettes can vary widely. In certain instances, the plasma nicotine concentration from using e-cigarettes approaches the levels observed after consuming traditional tobacco cigarettes⁶. Numerous studies have investigated this phenomenon, with some indicating that e-cigarettes use increases the likelihood of switching to traditional cigarettes, which inherently poses a greater risk of nicotine dependence^{7,8}. Besides, the

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plasma nicotine concentration following the use of e-cigarettes matches or exceeds the concentration observed in individuals using nicotine replacement therapy⁹. Also, studies have shown that e-cigarettes users frequently exhibit similar usage patterns to traditional cigarette smokers^{1,10}. This includes the frequency and intensity of use and the inhalation of aerosol-containing nicotine. As a result, concerns have arisen regarding their serious potential to lead to e-cigarettes dependence, particularly among adults and non-smokers¹¹.

Young adults are particularly vulnerable to nicotine addiction from e-cigarette use because their developing brains are more susceptible to addiction¹². Some research suggests that e-cigarettes may have less potential than traditional cigarettes to produce dependence, suggesting that individuals who switch from traditional cigarettes to e-cigarettes may reduce their nicotine dependence and health risks^{8,13}. Despite this, few studies have evaluated e-cigarettes dependence, and their results are inconclusive. A recent global systematic review revealed substantial evidence that nicotine e-cigarettes can cause dependence or addiction in non-smokers, as well as solid evidence that young non-smokers who use e-cigarettes are more likely to start smoking and become regular tobacco users than non-users¹⁴.

Public health efforts aim to educate people about the risks of e-cigarettes use, particularly among youth, and the risk of becoming addicted to these products. The prevalence of addiction among e-cigarettes users is the subject of ongoing research which will help provide evidence and resources for those who want to stop using these products. This study aims to investigate the level of e-cigarettes dependence among Palestinian university students who use e-cigarettes and to identify associated variables.

Results

A total of 420 university students who currently use e-cigarettes were recruited, and 386 consented to participate, resulting in a response rate of 91%. Table 1 presents the participants' demographic and lifestyle characteristics. The mean age of the participants is 20.1 ± 1.6 years, with 49.7% being female. The majority of students (56.6%) study humanities, and most (83.9%) live with their families. Their monthly allowances vary, with 37.3% receiving between \$150 and \$300, and 31.3% receiving more than \$300 per month. A significant proportion (46.9%) exercise regularly, while 29.0% maintain a healthy diet. Participants' coffee consumption is notably high, with 37.5% drinking seven or more cups weekly. The majority of participants (90.7%) spend more than two hours daily with friends.

Table 2 provides an overview of e-cigarette usage and smoking habits among the participants. A considerable proportion (24.1%) started using e-cigarettes at the age of 16 or younger, and 54.7% are dual smokers, using both e-cigarettes and other tobacco products. Furthermore, 72.6% of dual smokers have engaged in this behavior for over a year. Nearly two-thirds (62.6%) are willing to quit using e-cigarettes, and out of the 211 dual smokers surveyed, 55.0% expressed their willingness to quit smoking cigarettes and shisha. Regarding parental smoking patterns, 62.5% of the participants reported that their fathers are tobacco users, and 23.4% reported that their mothers are tobacco users. The data also indicate a high prevalence of tobacco use among the participants' peers, with 91.7% having smoking friends and 48.7% having friends who use e-cigarettes.

Table 3 summarizes the participants' attitudes towards, knowledge of, and reasons for using e-cigarettes. It is evident that 55.7% of the participants have a low level of knowledge about e-cigarettes, and a significant majority

Variable	Frequency (%)
Age (mean \pm SD)	20.1 \pm 1.6
Gender	
Male	194(50.3)
Female	192(49.7)
Faculty	
Scientific colleges	167(43.4)
Humanities faculties	218(56.6)
Missing	1
Monthly allowance (\$)	
< 150	121(31.3)
150–300	144(37.3)
More than 300	121(31.3)
Exercising regularly (Yes)	181(46.9)
A healthy diet (Yes)	112(29.0)
Coffee drinking	
No	132 (34.2)
1–6 cups a week	109 (28.3)
\geq 7 cups a week	145 (37.5)
Daily time spent with your friends	
Maximum two hours\day	36 (9.3)
More than two hours\day	350 (90.7)

Table 1. The demographic and lifestyle characteristics of e-cigarette users ($n = 386$).

Variables	Frequency (%)
Age of first use of e-cigarettes	
16 years or less	93 (24.1)
17–20 years	228 (60.5)
More than 20 years	56 (14.9)
Missing	9
Dual smoker (e-cigarettes and other form of tobacco) (Yes)	211 (54.7)
Duration of dual smoking ($n=211$)	
Less than one year	62 (29.4)
More than one year	149 (70.6)
Willing to quit e-cigarettes (Yes)	238 (62.6)
Willing to quit cigarettes and/or shisha smoking ($n=211$) (Yes)	116 (55.0)
Father is a tobacco user* (Yes)	240 (62.5)
Mother is a tobacco user* (Yes)	90 (23.4)
One of your friends is a tobacco user* (Yes)	354 (91.7)
One of your friends is an e-cigarette user (Yes)	188 (48.7)

Table 2. E-cigarette usage and tobacco use habits ($n=386$). *Traditional cigarettes, e-cigarette and/or shisha

Variable	Frequency (%)
Knowledge	
High	171 (44.3)
Low	215 (55.7)
Attitude	
Positive	114 (29.5)
Negative	272 (70.5)
Reasons	
Using e-cigarettes in areas where traditional smoking is prohibited.	226 (58.5)
They cost less than other tobacco products	115 (29.8)
They are less harmful than other forms of tobacco	114 (29.5)
Trying to quit using traditional cigarettes	87 (22.5)
People who are important to me use/used vapor products such as e-cigarette	67 (17.4)
People in the media or other public figures use e-cigarette	46 (11.9)
Others*	53(14.4)

Table 3. Perceptions, knowledge, level, and reasons for e-cigarette usage ($n=386$). *Entertainment, easy to use, does not leave a bad smell, tastes good, decreases level of stress, feeling of freedom and less bothersome to others.

(70.5%) express a negative attitude towards them. The most prevalent reason for using e-cigarettes is the desire to use them in public places where regular cigarettes are prohibited, with 58.5% citing this. Other notable reasons include the belief that e-cigarettes are less expensive than other tobacco products (29.8%), less harmful than traditional tobacco (29.5%), being influenced by important individuals in their lives (17.4%), and attempting to quit using tobacco products (22.5%).

Table 3 presents the frequency of e-cigarette use and the characteristics of e-cigarettes dependence. The majority of e-cigarette users (52.3%) reported using it more than four times daily, and 29.5% reported using it within five minutes of waking up. Regarding nighttime usage, 24.1% admitted to waking up at night to use e-cigarettes.

Concerning the factors contributing to e-cigarette use, 36.5% reported using it because it is challenging to quit, 59.1% reported strong cravings, 45.3% reported having moderate to extremely strong urges to use, and 43% reported that it is difficult to refrain from using it in places where they are not permitted. When unable to use e-cigarettes, more than one-third (36.5%) reported feeling irritable, and nearly half (45.6%) reported feeling nervous, restless, or anxious. The analysis of dependence scores indicated that 28.8% exhibited a moderate level of dependence, while 11.4% had a high level of dependence. The average dependence score was 7.1 ± 4.2 .

Table 4 presents the results of the univariate and multivariate analyses, which examined the relationship between the study variables and e-cigarette dependence scores. Several noteworthy findings emerged from this analysis. There were significant associations found with gender, traditional cigarette smoking, monthly allowance, daily amount of time spent with friends, students' attitude and knowledge, age of first e-cigarette use,

Questions	Frequency (%)
How many times per day do you usually use your e-cigarette	
4 times a day	184(47.6)
5 to 9 times a day	69(17.9)
10 to 14 times a day	41(10.6)
15 to 19 times a day	35(9.1)
20 to 29 times a day	57(14.8)
30 times or more	0(0)
On days that you can use your e-cigarette freely, how soon after you wake up do you first use your electronic cigarette?	
More than 121 min	91(23.6)
61 to 120 min	41(10.6)
31–60 min	41(10.6)
17–30 min	51(13.2)
6–16 min	48(12.4)
Less than 5 min	114(29.5)
Do you sometimes awaken at night to use your e-cigarette? (Yes)	93(24.1)
If yes, how many nights per week do you typically awaken to use your e-cigarette?	
0–1 times a night	330(85.5)
2–3 times a night	36(9.3)
4 or more times a night	20(5.2)
Do you use an e-cigarette now because it is really hard to quit (electronic cigarettes)? (Yes)	141 (36.5)
Do you ever have strong cravings to use an e-cigarette? (Yes)	228 (59.1)
Over the past week, how strong have the urges to use an e-cigarette been?	
None/Slight	211 (54.7)
Moderate/Strong	139 (36.0)
Very Strong/Extremely Strong	36 (9.3)
Is it hard to keep from using an e-cigarette in places where you are not supposed to? (Yes)	166 (43)
Did you feel more irritable because you couldn't use an e-cigarette (Yes)	141 (36.5)
Do you feel nervous, restless, or anxious because you couldn't use an e-cigarette? (Yes)	176 (45.6)
Dependence score(Mean \pm SD)	(7.1 \pm 4.2)
Not dependent	91 (23.6)
Low dependence	140 (36.3)
Medium level	111 (28.8)
High level	44 (11.4)

Table 4. Penn State scale questions about e-cigarette use and characteristics of nicotine dependence ($n=386$).

smoking habits of father and friends, using e-cigarettes in areas where traditional smoking is prohibited, and using e-cigarettes to quit other forms of tobacco (P -value < 0.05).

We conducted a multivariate linear regression analysis to identify variables independently associated with e-cigarette dependence. The results showed that the overall model was statistically significant ($R^2 = 0.20$, $F(20, 361) = 5.3$, $p < .001$). Several variables appeared to be significantly associated with e-cigarette dependence. These include a higher monthly allowance ($\beta = 0.116$, 95% CI: 0.128–1.124, $p = .014$), less daily time spent with friends ($\beta = -0.096$, 95% CI: -2.785– -0.049, $p = .042$), and an earlier age of first e-cigarette use ($\beta = -0.145$, 95% CI: -1.614– -0.349, $p = .002$). Additionally, having a father who uses tobacco ($\beta = 0.095$, 95% CI: 0.030–1.638, $p = .042$) and a close friend who smokes traditional cigarettes ($\beta = 0.095$, 95% CI: 0.019–1.667, $p = .045$) were also significant factors. The analysis further revealed that using e-cigarettes in areas where traditional smoking is prohibited ($\beta = 0.175$, 95% CI: 0.689–2.330, $p < .001$) and using e-cigarettes as a means to quit other forms of tobacco ($\beta = 0.134$, 95% CI: 0.434–2.314, $p = .004$) are associated with higher dependence. Finally, a more negative attitude score also correlated with increased dependence ($\beta = -0.210$, 95% CI: -0.285– -0.112, $p < .001$).

Discussion

The current study examined e-cigarettes dependence among young adults. A significant portion of participants (24.1%) started using e-cigarettes before the age of 16, and more than half (54.7%) were dual smokers, using both traditional cigarettes and e-cigarettes. These findings indicate that early initiation of e-cigarette use and concurrent use of conventional tobacco products are common among young adults, consistent with previous research that has highlighted the high prevalence of dual use among adolescents and young adults^{15,16}. This is con.

	Univariate analysis*		Multivariate linear analysis**	
	Dependence score Mean \pm SD	P-value	Beta (95% CI)	Adjusted P-value
Age in years	7.1 \pm 4.3	.060	---	--
Gender				
Male	7.8 \pm 4.2	.002	---	--
Female	6.5 \pm 4.1			
Faculty type				
Scientific	7.1 \pm 4.3	.195	---	--
Humanitarian	7.1 \pm 4.2			
Monthly allowance (\$)				
<150	6.5 \pm 4.1	.001	.116 (.128- 1.124)	.014
150-300	6.6 \pm 4.1			
More than 300	8.3 \pm 4.3			
Dual smoker				
No	6.8 \pm 4.4	.133	.079 (-.114- 1.464)	.093
Yes	7.4 \pm 4.1			
Exercising regularly				
Yes	6.8 \pm 4.1	.117	-.074 (-1.418- .149)	.112
No	7.5 \pm 4.3			
Healthy diet				
Yes	7.2 \pm 3.9	.960	---	--
No	7.1 \pm 4.4			
Coffee drinker				
No	6.4 \pm 4.4	.067	---	--
1-6 cups a week	7.4 \pm 4.1			
\geq 7 cups a week	7.5 \pm 4.2			
Daily time spent with friends				
Less than 2 hours	8.4 \pm 3.9	.040	-.096 (-2.785- -.049)	.042
More than 2 hours	7.0 \pm 4.3			
Age of first e-cigarette use				
16 years or less	9.2 \pm 3.9	.001	-.145 (-1.614- -.349)	.002
17-20 years	6.4 \pm 4.3			
More than 20 years	6.7 \pm 3.7			
Willing to quit e-cigarette				
Yes	7.2 \pm 4.3	.408	---	--
No	6.9 \pm 4.2			
Father is tobacco user				
Yes	7.4 \pm 4.4	.070	.095 (.030- 1.638)	.042
No	6.6 \pm 4.0			
Mother is tobacco user				
Yes	7.0 \pm 4.5	.780	---	--
No	7.2 \pm 4.2			
One of your close friends is traditional smoker				
Yes	7.6 \pm 4.2	.002	.095 (.019- 1.667)	.045
No	6.2 \pm 4.3			
One of your close friends is waterpipe smoker				
Yes	6.8 \pm 4.2	.111	-.066 (-1.355- .225)	.161
No	7.5 \pm 4.3			
One of your close friends is e-cigarette user				
Yes	7.2 \pm 4.3	.873	---	--
No	7.1 \pm 4.2			
Using e-cigarettes in areas where traditional smoking is prohibited.				
Yes	8.0 \pm 4.2	<.001	.175 (.689- 2.330)	<.001
No	5.8 \pm 3.9			
Using e-cigarettes to quit other form of tobacco				
Yes	8.4 \pm 4.1	.002	.134 (.434- 2.314)	.004
Continued				

	Univariate analysis*		Multivariate linear analysis**	
	Dependence score Mean \pm SD	P-value	Beta (95% CI)	Adjusted P-value
No	6.7 \pm 4.2			
Knowledge score	7.1 \pm 4.3	.005	---	--
Attitude score	7.1 \pm 4.3	<.001	-.210 (-.285- -.112)	<.001

Table 5. Univariate and multivariate linear analysis of factors associated with e-cigarette dependence scores. *Independent t-test and ANOVA and Pearson correlation coefficient. ** All variables listed in this table were included in the multivariate linear regression model. However, the results shown (Beta values, 95% Confidence Intervals, and Adjusted P-values) only represent the variables that remained in the final model.

The multivariate analysis revealing that young adults who begin using e-cigarettes at age 16 or younger show significantly higher dependence scores is concerning. Younger users are more vulnerable to nicotine addiction, as their developing brains are more susceptible to its effects¹². Glantz et al. found that between 2014 and 2021, the age at which adolescents started using e-cigarettes decreased, while their frequency of use and addiction levels increased¹⁷. Early initiation of e-cigarette use has been linked to impulsive behaviors, such as acting without considering long-term consequences, which may heighten the risk of developing long-term dependence¹⁸. These results highlight the need for efforts to prevent early e-cigarette use, especially through stricter regulations on marketing and accessibility to adolescents. Reducing early exposure could be key in combating long-term nicotine addiction and promoting healthier outcomes for future generations.

The study investigated the relationship between parental smoking habits, peer associations and young adults smoking behaviors. The majority of participants reported that their fathers were tobacco users (62.5%), while 23.4% reported that their mothers were tobacco users. Additionally, most of their friends were tobacco users (91.7%) and e-cigarette users (48.7%). Multivariate analysis further revealed that having a father who smoked and a close friend who used traditional cigarettes were significantly associated with higher levels of e-cigarette dependence. This finding aligns with research by Selya et al., which found that adolescents and young adults with a father who smokes are more likely to develop nicotine dependence themselves¹⁹. Family and peer influences have a significant impact on shaping vaping habits²⁰, often making addiction more likely. This underscores the need to address these social factors in efforts to prevent nicotine dependence. Moreover, these social influences highlight the potential protective impact of enforcing strict household rules against e-cigarette use. This aligns with the findings of Buu et al., who concluded that having strict home rules is associated with increased perceived injunctive norms, greater awareness of e-cigarette harm, and reduced likelihood of regular e-cigarette use among youth²¹.

The multivariate analysis showed that young adults with higher monthly allowances are significantly more likely to exhibit increased e-cigarette dependence. This indicates a potential relationship between financial resources and vaping behavior, as higher monthly allowances may lead to more frequent use and, consequently, greater dependence. Interestingly, the literature on this subject is mixed; while most studies link low socioeconomic status to smoking and higher nicotine dependence, our findings suggest the opposite in the context of e-cigarettes^{22,23}. This discrepancy merits further investigation to better understand the role of economic factors in e-cigarette dependence and how financial stability may facilitate easier access to vaping products.

The finding that 58.5% of participants cited the ability to use e-cigarettes in public places where smoking is prohibited as their reason for vaping is concerning, especially considering its strong association with higher levels of e-cigarette dependence in the multivariate analysis. This suggests that being able to use e-cigarettes in smoke-free environments may encourage or worsen dependence. Similar studies, like the one by Yang et al., have shown that young adults, such as university students, are more likely to use e-cigarettes in prohibited areas, reinforcing their dependence²⁴. Allowing e-cigarette use in these spaces normalizes the behavior and downplays the risks of nicotine addiction, particularly among vulnerable populations. These results highlight the need to update current smoke-free policies to explicitly include e-cigarettes, ensuring that public spaces remain truly smoke- and vape-free.

The results indicate that many students have considered quitting smoking: 62.6% of young adults were willing to quit using e-cigarettes, and 55.0% of dual smokers were willing to stop using all forms of tobacco. However, the finding from multivariate analysis showing young adults who use e-cigarettes to quit other forms of tobacco had significantly higher dependence scores, is particularly concerning. Although e-cigarettes are often promoted as a tool for smoking cessation, their use may inadvertently lead to greater dependence on nicotine rather than reducing overall tobacco consumption²⁵. These findings put doubt on the effectiveness of e-cigarettes as a harm-reduction tool, especially for young adults who are more susceptible to addiction. Targeted interventions and policies are needed to both raise awareness about e-cigarette dependence risks and ensure that cessation efforts don't unintentionally lead to continued nicotine addiction.

The study also highlighted certain characteristics of e-cigarettes dependence among e-cigarette users. Factors contributing to e-cigarette use included the difficulty of quitting (36.5%), intense cravings (59.1%), urges to use (45.3%), and difficulty refraining from use in prohibited places (43%). When unable to use e-cigarettes, many users reported feeling irritable (36.5%) and experiencing feelings of nervousness, restlessness, or anxiety (45.6%). These findings emphasize the addictive nature of e-cigarettes and the challenges that some young adults face in controlling their use. A study conducted in Saudi Arabia revealed that e-cigarettes are just as addictive

as traditional cigarettes for users²⁶. Furthermore, a survey in Poland concluded that among young adults, e-cigarettes may have a greater potential for addiction compared to traditional cigarettes²⁷.

A significant proportion of e-cigarette users exhibited heavy usage patterns. Specifically, 52.3% reported using them more than four times a day, 29.5% used them within five minutes of waking up, and 24.1% even woke up at night to use their e-cigarettes. These statistics indicate a substantial dependence on e-cigarettes. Furthermore, our findings show that many users displayed a moderate dependence (28.8%) or high dependence (11.4%). These results are consistent with a recent survey conducted in Malaysia, which revealed that 29.5% of young adult e-cigarette users had moderate e-cigarette dependence and 16.2% had high e-cigarette dependence using the Fagerström Test for Nicotine Dependence (FTND)²⁸.

Our findings align with a qualitative study that highlighted how individuals who use tobacco recognize nicotine as a key factor in their addiction to cigarettes. We found that participants with more negative attitudes toward e-cigarettes were more likely to show significantly higher levels of dependence²⁹. Previous cross-sectional studies have also demonstrated a connection between negative perceptions of e-cigarettes—such as the belief that they are “not addictive” or associated with a “cool” image—and increased use among adolescents^{30,31}. This is a cause for concern, particularly among young individuals, as nicotine use can impair brain development during adolescence. Public health experts can utilize this information to strategize educational programs and regulate the marketing of e-cigarettes by understanding the factors contributing to positive attitudes.

Among the strengths of this study is that it provides valuable insights into the factors of e-cigarette dependence among Palestinian young adults, a critical yet underexplored issue in the region, in addition to the empirical reliability of the Penn State dependence scale, particularly its demonstrated ability to compare dependence across different products. However, this study has a few limitations that should be kept in mind when interpreting the results. First, it's important to note that our research captures a single point in time. To get a clearer picture of how dependence develops and changes, future studies should focus on tracking e-cigarette use over longer periods. Second, due to logistical challenges, we relied on convenience sampling rather than a random sample, which may limit the generalizability of our findings to the broader population. Finally, it's worth noting that floor effects may have influenced the lower dependence ratings in our study. For example, non-daily smokers who scored low might be underreporting dependence-related experiences, making it difficult to accurately measure dependence from both a statistical and psychological perspective.

Conclusion

The study reveals a significant level of e-cigarettes dependence among e-cigarette users. Common experiences include intense cravings, urges to use, and difficulty refraining from use. The addictive nature of e-cigarettes is further emphasized by heavy usage patterns and a substantial proportion of users exhibiting moderate to high dependence levels. The study also highlights the potential relationship between parental tobacco use status and young adults monthly allowance levels and e-cigarette dependence, emphasizing the importance of addressing socioeconomic disparities in tobacco use prevention and cessation efforts.

In light of these findings, policymakers, educators, and healthcare professionals should collaborate to implement evidence-based interventions targeting young adult's e-cigarette use and dependence. Such interventions should address the influence of social factors, environmental factors, and socioeconomic disparities to effectively reduce e-cigarette dependence and its associated health risks. Moreover, ongoing research and surveillance are crucial to stay updated on the evolving landscape of e-cigarette use and dependence among young adults and young adults, ensuring that strategies and policies remain adequate and relevant.

Methodology

Study design and population

A cross-sectional study was conducted between January and May 2023, targeting undergraduate students who use e-cigarettes at six major universities in the West Bank. To determine the initial sample size, the open Epi cross-sectional sample equation (Sample size: $n = \frac{[DEFF * Np(1-p)]}{[(d2/Z21 - \alpha/2 * (N-1) + p * (1-p))]}$) was utilized, taking into account a student population of 75,000, a desired margin of error of 5%, and an expected proportion of 30%³². This calculation resulted in an initial sample size of 322 students. Participants in the study were selected through convenience sampling, as there is no existing registry of young adult e-cigarette users that would allow for a more random and representative sample.

Measurement tool

After providing a description of the study's purpose to students on the university campus, interested participants were directed to a Google form via a QR code scanned with their mobile devices. The Google form contained the study's purpose, consent to participate, and the electronic questionnaire. The research team developed the questionnaire by carefully reviewing relevant literature^{3,33–37}. The questionnaire consisted of three parts. The first part focused on demographic information, including gender, age, location, school, monthly stipend, daily routine (such as tobacco use, exercise, diet, coffee consumption, and social interactions), and exposure to secondhand smoke (including the number of tobacco users in the vicinity and the tobacco use habits of parents and friends). In this part, a traditional cigarette smoker was defined as an individual who had smoked more than 100 cigarettes in their lifetime and was still actively smoking at the time of the study³⁸. A “current e-cigarette user” was identified if a young adult had used an e-cigarette at least once in the 30 days prior to the survey date³⁹.

The second section assessed students' knowledge and attitudes regarding e-cigarettes. This section included statements addressing various aspects, such as the impact of e-cigarettes on general health and the respiratory system, the appropriateness of e-cigarette uses for pregnant women and children, and e-cigarette addiction. An indicative of a positive attitude was a “yes” response to questions related to attitudes toward advocating

for government regulation of e-cigarette use, whether e-cigarettes can be used in restricted areas, their social acceptability, effectiveness and acceptability as smoking cessation tools, and their potential as a replacement for traditional cigarettes. Recommendations to nonsmokers and recreational use were additional examples of a positive perspective. Participants rated their agreement with these statements on a four-point Likert scale, ranging from “strongly agree” to “strongly disagree.” The total attitude score ranged from 0 to 52, while the knowledge score ranged from 0 to 26. Higher scores in both categories reflected more positive attitudes and a greater level of knowledge, respectively. Specifically, an attitude score of 39 or above reflected a positive attitude toward e-cigarette use, while a knowledge score of 20 or higher indicated a high level of knowledge^{3,13,33,40}.

The third part focused on assessing e-cigarette dependence using the Penn State Electronic Cigarette Dependence Index (PSECDI) questionnaire. The PSECDI, initially developed by Dr. J. Foulds in 2011 to evaluate nicotine dependence across all nicotine product types, was updated to specifically measure e-cigarette dependence³⁷. The PSECDI questionnaire consisted of ten items, including two items on the frequency of e-cigarette use, five items on difficulty quitting, experience of craving, and withdrawal symptoms, two items on waking up in the middle of the night to use e-cigarettes, and one item on recent urges to use. Based on their scores, e-cigarette smokers were classified as having high dependence if their score exceeded 13, medium dependence if their score ranged from nine to twelve, low dependence if their score ranged from four to eight, and no dependence if their score was less than four³⁷.

The questionnaire was initially drafted in English and then translated into Arabic. To ensure linguistic accuracy, a native English speaker translated the document back into English. To validate the instrument, three field experts evaluated the questionnaire, which was then pilot-tested on twenty college students. Based on the comments received during the pilot study, modifications were made to the questionnaire. The Cronbach's alpha coefficient for PSEDI items was 0.75, indicating good reliability.

Analysis plan

After collecting information using Google Forms, the data was exported to an Excel spreadsheet where it was filtered and coded. We used SPSS version 23 (IBM Corp., Armonk, NY) to perform statistical analyses. Descriptive analyses included means and standard deviations for continuous variables, and frequencies and percentages for categorical variables. Upon visual examination of the data, it was observed that the distribution closely approximated a normal distribution. Given the assumption that large samples adhere to a normal distribution, parametric tests were used to compare different groups. Specifically, the independent t-test was used to compare two groups, while the ANOVA test was employed for comparisons involving more than two groups. A multivariate linear regression analysis, using the backward elimination approach, was conducted to identify variables associated with e-cigarette dependence scores. The model included variables with P value less than 0.01 in the univariate analysis, as well as other relevant variables suggested by the literature. Collinearity diagnostics showed that all tolerance values were ≥ 0.10 and Variance Inflation Factor (VIF) values were below 10, indicating no issues with multicollinearity among the independent variables. The data were reported as Standardized Coefficients (Beta) with 95% confidence intervals (CI) and corresponding adjusted p-values. In this study, small percentage of missing values were detected during the exploratory data analysis phase; we observed missing values less than 2.5% at most for a few limited variables. Since the missing values occurred at random and represented a very small proportion of the dataset, they were excluded from further analysis. A p-value of less than 0.05 was considered statistically significant.

The Institutional Review Board (IRB) of An-Najah National University approved the study (Med.Jan.2023/1), and participants provided informed consent. The data were treated with strict confidentiality, with personally identifiable information concealed, and each participant was represented numerically. We confirm that all methods were conducted in accordance with the relevant guidelines, regulations, and the Declaration of Helsinki.

Data availability

The data used to support the findings of this study are available from the corresponding author upon request.

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Author contributions

BM and ZN contributed to the study conception, design, data analysis and interpretation. Material preparation and data collection were performed by IA. The first draft of the manuscript was written by ZN and BM. All authors provided feedback on the final draft of the manuscript. All authors read and approved the final manuscript.

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Declarations

Competing interests

The authors declare no competing interests.

Additional information

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