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Exercise Interventions for Reducing Nicotine Dependence and Craving in E-Cigarette Users: A Narrative Review

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Abstract

Background. Electronic cigarette (e-cigarette) use has increased considerably, particularly among adolescents and young adults, raising concerns regarding nicotine dependence and difficulties associated with vaping cessation. Craving and withdrawal symptoms may contribute to continued nicotine use and complicate abstinence attempts.
Aim. This review aimed to evaluate current evidence regarding the relationship between exercise and nicotine dependence associated with e-cigarette use and to examine the potential applicability of physical activity within vaping cessation approaches.
Material and Methods. A narrative review was conducted using literature identified through PubMed, PubMed Central (PMC), and Google Scholar in April 2026. Publications related to e-cigarette use, nicotine dependence, exercise interventions, biological mechanisms, and vaping cessation were screened and synthesized. The final review included 43 publications representing different study designs and evidence types.

Results. Exercise interventions were most frequently associated with reductions in craving and withdrawal-related symptoms during temporary nicotine abstinence. Additional findings suggested favorable effects involving emotional regulation, stress responses, and behavioral factors associated with nicotine use. Emerging evidence also indicated biological alterations related to vaping exposure, including endothelial dysfunction, oxidative stress, and inflammatory responses.
Conclusions. Exercise may represent a complementary component within vaping cessation strategies. Potential benefits may extend beyond craving reduction and involve broader psychological and behavioral factors associated with nicotine dependence. However, further investigations among exclusive e-cigarette users remain necessary.
Keywords: electronic cigarettes; vaping cessation; exercise interventions; nicotine dependence; nicotine withdrawal; physical activity

1. Introduction

Electronic cigarette (e-cigarette) use has become increasingly common in recent years, particularly among adolescents and young adults, representing an important public health concern worldwide (13). Initially introduced as an alternative to conventional combustible tobacco products, e-cigarettes gained popularity due to their accessibility, wide range of flavor options, and extensive promotion through digital and social media environments (33). Although frequently perceived as less harmful than traditional cigarettes, accumulating evidence indicates that e-cigarette use may still be associated with adverse respiratory and cardiovascular effects (14). Emerging findings suggest that consequences associated with vaping may extend beyond nicotine dependence alone and involve endothelial, inflammatory, and respiratory alterations (14, 43). Chronic e-cigarette exposure has additionally been associated with impaired endothelial function, alterations in nitric oxide signaling, increased endothelial permeability, and reduced flow-mediated dilation, indicating potential vascular consequences related to long-term vaping (43). Nicotine dependence remains one of the principal concerns associated with e-cigarette use, particularly among adolescents and young adults (15). Symptoms characteristic of nicotine addiction, including craving, impaired control over nicotine intake, and withdrawal manifestations during abstinence, have been reported among e-cigarette users (17). The increasing popularity of pod-based devices with high nicotine concentrations may further facilitate the development and maintenance of nicotine dependence (16). Continued vaping behaviors may additionally be influenced by psychological and behavioral factors such as stress, emotional regulation difficulties, sleep disturbances, and social influences (18, 20, 39).

Several approaches supporting vaping cessation, including text message–based interventions, digital platforms, and quitline-assisted programs, have become increasingly available; however, evidence regarding their long-term effectiveness remains limited (12). Consequently, attention has expanded toward non-pharmacological approaches that may help alleviate craving and withdrawal symptoms associated with nicotine abstinence.

Findings derived from smoking cessation and substance use research suggest that exercise interventions may temporarily reduce nicotine craving, improve emotional functioning, and alleviate withdrawal symptoms through both physiological and psychological mechanisms (2, 3, 25). Exercise has additionally been associated with improvements in mood regulation, stress responses, and psychological well-being during nicotine abstinence (26, 30). Such effects may support coping strategies during nicotine abstinence. Proposed mechanisms include stress

regulation, distraction from craving-related cues, and modulation of pathways involved in addictive behaviors (26, 30).

This narrative review aims to provide an evidence-based overview of the role of exercise interventions in reducing nicotine craving and nicotine dependence related to e-cigarette use (2, 3, 25). The review additionally examines biological, physiological, and psychological mechanisms potentially associated with exercise and evaluates the applicability of exercise-based strategies within vaping cessation approaches (12, 41).

2. Material and Methods

For this narrative review, data were obtained from publicly available sources. Electronic searches were performed in April 2026 using PubMed, PubMed Central (PMC), and Google Scholar. The search strategy included combinations of the following terms: “e-cigarettes”, “vaping”, “nicotine dependence”, “exercise interventions”, “physical activity”, “nicotine craving”, “withdrawal symptoms”, and “vaping cessation”.

Only publications written in English were considered eligible, without restrictions related to publication year. Priority was given to studies addressing e-cigarette use, nicotine dependence, exercise-related interventions, biological mechanisms, and vaping cessation approaches.

The review included systematic reviews, meta-analyses, randomized controlled trials, observational studies, and mechanistic investigations. Conference abstracts, editorials, and publications not directly related to the review topic were excluded. Reference lists of eligible articles were additionally screened to identify further relevant publications.

A total of 43 articles were included in the final analysis. The selected literature comprised studies related to e-cigarette use and nicotine dependence together with investigations evaluating exercise interventions, withdrawal symptoms, biological mechanisms, and vaping cessation approaches.

Data extraction focused on patterns of e-cigarette use, characteristics of nicotine dependence, exercise intervention protocols, craving and withdrawal outcomes, biological mechanisms, and currently available vaping cessation strategies.

3. Results

The findings identified in the reviewed literature were organized into thematic areas concerning nicotine dependence associated with e-cigarette use, exercise-related effects, biological consequences of vaping exposure, mechanisms of exercise action, and cessation strategies with long-term evidence.

3.1 Nicotine Dependence

Nicotine dependence remains an important concern associated with e-cigarette use and represents a relevant target for intervention strategies. Vogel et al. reported that adolescent e-cigarette users frequently exhibited symptoms associated with nicotine addiction, including craving, impaired control over nicotine intake, and withdrawal manifestations during abstinence periods (15). Dependence-related symptoms may contribute to prolonged nicotine exposure and persistence of vaping behaviors (17, 35).

Craving and withdrawal symptoms have been identified as important barriers limiting the effectiveness of vaping cessation interventions (11, 12). Morean et al. additionally suggested

that the increasing popularity of pod-based devices may be associated with higher levels of nicotine dependence because of their enhanced nicotine delivery capacity (16, 34).

Product-related and environmental factors may additionally influence nicotine use patterns among younger populations. Flavored products, high-nicotine formulations, and extensive exposure through social media environments have been associated with greater experimentation and more frequent e-cigarette use among adolescents and young adults (13, 33, 38). These characteristics may prolong nicotine exposure and increase susceptibility to dependence development among vulnerable users (14, 36).

Available findings additionally suggest that nicotine dependence severity may vary according to device characteristics, frequency of use, and individual vaping patterns (19). Reed et al. observed differences in craving intensity between daily and non-daily users, indicating that nicotine consumption patterns may influence dependence-related outcomes (31).

Dependence severity may additionally differ according to vaping frequency and habitual patterns of use. Individuals using e-cigarettes daily are exposed to nicotine more regularly and may therefore experience stronger craving and more pronounced withdrawal symptoms than non-daily users (31). Earlier initiation of vaping may further contribute to continued nicotine use and increase susceptibility to dependence-related behaviors (15, 36).

Stress, emotional regulation difficulties, sleep disturbances, and psychosocial factors may additionally contribute to the persistence of vaping behaviors and continued nicotine use (18, 20, 32).

3.2 Exercise Effects

3.2.1 Acute Effects on Craving and Withdrawal

Available evidence suggests that exercise interventions may alleviate nicotine craving and withdrawal symptoms during temporary abstinence, supporting their potential role in nicotine dependence management (2, 3, 25). Taylor et al. summarized findings from 14 studies evaluating acute exercise during smoking abstinence and reported that 12 interventions were associated with significant reductions in craving intensity and withdrawal symptoms compared with passive control conditions. Several investigations additionally reported delayed smoking behavior following exercise participation (2).

Further support was provided by Haasova et al., who conducted an individual participant data meta-analysis including 15 primary studies assessing Strength of Desire (SoD) outcomes and 17 studies evaluating Desire to Smoke (DtS). Significant reductions in carving were observed following physical activity, with standardized mean differences of -1.91 for Strength of Desire (SoD) ($p < 0.001$) and -2,03 for Desire to Smoke (DtS) ($p < 0.001$) compared with control conditions (3).

Individual intervention studies also supported these findings. Janse van Rensburg et al. demonstrated that moderate-intensity walking performed by temporarily abstinent smokers ($n = 23$) significantly reduced cigarette craving after exercise ($p < 0.05$) (5). Comparable observations were reported in studies evaluating mild-to-moderate exercise interventions among abstinent smokers, where exercise participation was associated with improvements in withdrawal-related outcomes.

Beneficial effects were observed across several exercise modalities, including walking, cycling, yoga, handgrip, and isometric exercise interventions (4, 6, 28). Moderate-intensity exercise appeared to produce more consistent improvements than vigorous exercise, which occasionally showed less favorable affective responses.

Collectively, available findings indicate that exercise may contribute to short-term management of craving and withdrawal symptoms during nicotine abstinence.

3.2.2 Psychological and Affective Responses

Beyond its effects on nicotine-related symptoms, physical activity may additionally influence psychological factors associated with nicotine dependence and continued vaping behaviors. Psychological distress, negative affect, sleep disturbances, and difficulties related to emotional regulation have previously been associated with continued nicotine use and increased relapse vulnerability among e-cigarette users (18, 20). Such factors may increase susceptibility to persistent vaping and relapse-related outcomes.

Evidence derived from substance use research demonstrated favorable psychological outcomes related to exercise participation. Wang et al. conducted a meta-analysis including 22 randomized controlled trials and reported significant improvements in abstinence-related outcomes following exercise interventions (OR = 1.69, $p < 0.001$). Reductions in anxiety ($p < 0.001$) and depressive symptoms ($p < 0.01$) were also observed across substance-dependent populations (10).

Greenwood et al. proposed that exercise-related adaptations involving serotonergic pathways may contribute to improved emotional regulation and stress resilience (30). Improvements in emotional well-being and stress responses may therefore indirectly influence nicotine dependence management, particularly among individuals using nicotine in response to psychological stressors (25, 26).

Psychological motives may additionally contribute to continued vaping in some users. E-cigarettes are frequently used in situations involving emotional discomfort, stress, boredom, or negative mood states (18, 20). Since exercise has been associated with improvements in mood and stress regulation, physical activity may provide an alternative behavioral response during craving episodes or nicotine withdrawal (25, 30).

Collectively, these findings indicate that exercise may influence nicotine-related behaviors not only through craving reduction but also by affecting emotional and psychological functioning. Consequently, exercise-based approaches may provide additional value within vaping cessation strategies by addressing affective determinants associated with nicotine use (41).

3.3 Biological Effects Associated with Nicotine Exposure and Vaping

Emerging evidence suggests that consequences associated with e-cigarette use extend beyond nicotine dependence alone. Exposure to nicotine and vaping aerosols has been associated with endothelial dysfunction, oxidative stress responses, inflammatory alterations, and respiratory effects involving airway tissues (14, 43). Chronic e-cigarette use has additionally been linked with impaired endothelial function, reduced flow-mediated dilation, alterations in nitric oxide signaling, and increased endothelial permeability, indicating potential vascular consequences related to long-term vaping (43). Such changes may contribute to cardiovascular and pulmonary effects observed among e-cigarette users.

Nicotine dependence additionally involves neurobiological mechanisms associated with dopaminergic reward pathways, stress-related responses, and neurotransmitter alterations contributing to reinforcement and maintenance of nicotine use behaviors (40). Exercise-related effects on craving reduction, emotional regulation, and stress responses may therefore interact with selected pathways implicated in nicotine addiction (26, 30).

Exercise-related mechanisms may additionally involve physiological adaptations associated with stress regulation and systemic homeostasis (26, 30). Such effects may have relevance in the context of vaping-related biological alterations; however, direct evidence among exclusive e-cigarette users remains limited.

3.4 Mechanisms of Exercise Action

Experimental findings suggested that exercise may influence cognitive processes associated with nicotine-related behaviors. Janse van Rensburg et al. demonstrated that a 15-min walking intervention among temporarily abstinent smokers ($n = 23$) significantly reduced cigarette craving after exercise ($p < 0.05$) and was accompanied by changes in attentional responses toward smoking-related cues (5).

Changes in attentional processing may partly explain these observations. Previous investigations suggested that physical activity can temporarily reduce attention directed toward smoking-related stimuli and modify responses associated with reward processing (5, 29). Such effects may contribute to the transient reductions in craving frequently observed after exercise sessions.

Behavioral and neurobiological mechanisms may jointly contribute to exercise-related effects observed during nicotine abstinence. Modulation of reward processing, stress responses, and cue-related attention may influence craving intensity and coping responses during abstinence periods (1, 8, 26, 29, 30).

These mechanisms may also have relevance for e-cigarette users because craving control and responses to vaping-related cues may influence nicotine dependence and persistence of vaping behaviors (17, 39).

3.5 Cessation Strategies with Long-Term Evidence

Although acute exercise interventions repeatedly demonstrated beneficial short-term outcomes, their influence on long-term abstinence remains uncertain. Ussher et al. conducted a Cochrane review including 24 randomized controlled trials with 7279 participants and did not observe significant improvements in long-term smoking cessation outcomes following exercise interventions compared with standard cessation support ($RR = 1.08$, $p > 0.05$) (1). Nevertheless, exercise interventions remained associated with favorable short-term outcomes involving craving reduction, withdrawal symptoms, and attentional responses related to smoking cues (1).

Comparable observations were reported in later meta-analytic studies. While exercise interventions consistently demonstrated beneficial effects on acute nicotine-related outcomes, evidence supporting sustained abstinence remained limited (25).

Existing vaping cessation studies have predominantly evaluated digital interventions, text-message programs, quitline-supported approaches, and clinical guidance frameworks rather than exercise-based strategies (11, 12, 21, 24, 42). Randomized studies among adolescents demonstrated improved vaping abstinence following text-message interventions, whereas digital cessation programs evaluated among adult e-cigarette users were associated with reductions in nicotine dependence and increased motivation to quit (21, 24).

Differences between user groups may additionally influence intervention preferences and cessation outcomes. Graham et al. reported higher abstinence rates among adolescents participating in a text message–based intervention compared with controls after 7 months (37.8% vs. 28.0%; $RR = 1.35$, $p < 0.001$) (21). Digital cessation programs evaluated among adult e-cigarette users were additionally associated with reductions in nicotine dependence and

increased motivation to quit (24). These observations indicate that intervention engagement and support preferences may vary according to age group and vaping-related behaviors (23, 37).

Maintaining participation throughout vaping cessation programs may remain challenging, particularly among younger users despite their frequent use of mobile-based interventions (23, 24). Reduced engagement over time may influence intervention effectiveness and long-term outcomes. Exercise may therefore be better considered as an adjunctive approach for craving management and vaping cessation support rather than as an isolated intervention targeting abstinence maintenance.

4. Discussion

4.1 Interpretation of Main Findings

Available evidence indicates that exercise may have an adjunctive role in addressing nicotine dependence associated with e-cigarette use. The most consistent findings concerned reductions in craving and withdrawal symptoms following physical activity, particularly during short periods of nicotine abstinence (2, 3, 25). These effects may be relevant in vaping cessation because craving and withdrawal manifestations frequently contribute to continued nicotine use and difficulties during abstinence attempts (11, 12).

Differences were also observed between short-term and long-term outcomes. Favorable effects were reported more consistently for immediate nicotine-related symptoms, whereas evidence supporting sustained abstinence remained less clear (1, 10, 25). Exercise may therefore be better viewed as a complementary component within cessation strategies rather than an independent intervention aimed at maintaining long-term abstinence.

Interpretation of current findings should remain cautious because vaping-specific exercise evidence is still limited (21, 22).

4.2 Interpretation of Potential Mechanisms in E-Cigarette Users

Changes in responses to nicotine-related stimuli may partly explain the observed effects of exercise (5, 26, 27, 29). However, vaping behaviors involve additional factors including device characteristics, nicotine delivery patterns, and flavor preferences, which may influence these mechanisms among e-cigarette users (16, 19).

Psychological factors may additionally contribute to this relationship. Stress, emotional discomfort, and negative mood states have previously been associated with continued vaping behaviors (18, 20). Since exercise has been linked with improvements in mood regulation and stress responses, these factors may partly explain its favorable effects during nicotine abstinence (25, 30).

Beyond dependence-related mechanisms, e-cigarette exposure has also been associated with endothelial dysfunction and inflammatory alterations, indicating that vaping-related consequences extend beyond behavioral aspects of nicotine use (43).

4.3 Clinical Relevance of Exercise in Vaping Cessation

From a clinical perspective, exercise appears more suitable as an additional component within vaping cessation strategies than as an isolated intervention, which remains consistent with broader observations regarding exercise-based approaches in substance use disorders (7,

9). Physical activity may provide value during periods when craving and withdrawal symptoms are most pronounced.

Differences in age, vaping behaviors, and preferred support modalities may additionally influence intervention effectiveness. Younger users frequently engage with digital and mobile-based programs, whereas adult users may benefit from more individualized cessation approaches (23, 24, 37). Integration of exercise with behavioral or digital support strategies may therefore improve applicability within future vaping cessation programs.

Evidence evaluating combined exercise-based interventions among exclusive e-cigarette users remains limited.

4.4 Future Research Directions

Current literature remains dominated by studies involving conventional cigarette smokers, whereas vaping-specific investigations are still limited (21, 22). Future studies should clarify the applicability of exercise interventions among exclusive e-cigarette users and determine optimal intervention characteristics, including exercise intensity, duration, and adherence.

Further investigations should additionally evaluate exercise within combined vaping cessation approaches.

5. Limitations

Several limitations should be acknowledged. First, evidence evaluating exercise interventions specifically among exclusive e-cigarette users remains limited, and part of the interpretation relied on findings derived from studies involving conventional cigarette smokers. Consequently, direct extrapolation of current observations to vaping populations should be approached cautiously.

Second, heterogeneity was observed across the included studies regarding intervention design, exercise characteristics, outcome assessment, and participant populations. These differences limited direct comparisons and complicated interpretation of the available evidence.

Finally, only studies published in English were included, which may have resulted in omission of relevant findings reported in other languages.

6. Conclusion

The available literature suggests that exercise may have an adjunctive role in the management of nicotine dependence associated with e-cigarette use. The most consistent findings concerned reductions in craving and withdrawal-related symptoms, particularly during short periods of nicotine abstinence. Exercise may additionally influence psychological and behavioral factors linked with nicotine use, including emotional regulation, stress-related responses, and coping processes during abstinence.

Current evidence also indicates that exercise may extend beyond short-term symptom management by potentially supporting broader vaping cessation efforts. In parallel, emerging evidence suggests that vaping-related consequences extend beyond dependence alone and may involve biological alterations associated with endothelial function, oxidative stress, and inflammatory responses (43).

Nevertheless, evidence specific to exclusive e-cigarette users remains limited, restricting direct extrapolation of current findings to vaping populations.

Exercise may therefore be better considered as a complementary component within vaping cessation strategies rather than as an isolated intervention targeting long-term abstinence.

Integration of exercise with behavioral or digital support approaches may represent a relevant direction for future vaping cessation programs.

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