

Impact of vaping versus traditional cigarettes on muscle power and respiratory function

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Abstract

English:

Background: Electronic cigarettes (e-cigarettes or vapes), alternative nicotine delivery systems, were initially promoted as safer substitutes for conventional tobacco products. Reduced handgrip strength is frequently associated with diminished respiratory capacity, making it a practical surrogate for assessing respiratory status.

Objective: The current study aimed to evaluate the functional aerobic exercise capacity and upper limbs muscle performance among vape users (VU) compared to combustible cigarette smokers and non-smokers (NS), providing valuable insights into the potential risks of vape smoking.

Methods: This cross-sectional study included 120 apparently healthy male participants, evenly divided into three groups of 40 each: group 1, composed of electronic cigarettes (vapes users), group 2 included combustible cigarette smokers and group 3 included NS. The participants underwent the measurement of handgrip strength, the six-minute walk test (6MWT) and the measurement of dyspnoea utilising the modified Medical Research Council (mMRC) scale. Data were analyzed using one-way ANOVA and Pearson correlation analysis.

Results: NS showed greater performance values for handgrip strength (33.5 ± 1.9 kg), distance achieved during the 6MWT (509.6 ± 46.3 m) and mMRC score (0.8 ± 0.4). VU had intermediate levels of performance for handgrip strength (26.3 ± 1.8 kg), and the distance achieved during the 6MWT (481.5 ± 47.8 m), whereas smokers showed the lowest level of performance for both handgrip strength (22.9 ± 1.7 kg) and the distance achieved during the 6MWT (437.8 ± 51.9 m), compared to the other three groups ($P < 0.001$ for both). VU used their devices for a shorter period of time (10.5 years) compared to smokers (22.8 years), yet they used higher levels of nicotine (45.0 mg/day), compared to the smoking group (28.8 mg/day).

Conclusion: The present study challenges the misconception of vaping as a harmless substitute for combustible cigarettes. It decreases exercise capacity and worsens muscular function, similarly to cigarette smoking.

Keywords

e-cigarettes • vaping • functional capacity • handgrip strength • respiratory health

Abbreviations: 6MWT, six-minute walk test; ANOVA, analysis of variance; e-cigarettes, electronic cigarettes; EVALI, vaping-associated lung injury; GOLD, Global Initiative for Chronic Obstructive Lung Disease; mMRC, modified Medical Research Council; THC, tetrahydrocannabinol; VOCs, volatile organic compounds.

Impactul vapingului comparativ cu fumatul clasic, asupra forței musculare și funcției respiratorii

Rezumat

Romanian:

Introducere: Țigările electronice (e-cigarettes sau vapes), sisteme alternative de livrare a nicotinei, au fost inițial promovate ca substituenți mai siguri ai produselor din tutun convențional. Scăderea forței de prindere a mâinii este frecvent asociată cu diminuarea capacității respiratorii, reprezentând un marker practic al statusului respirator.

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Obiectiv: Studiul și-a propus să evalueze capacitatea funcțională aerobă la efort și performanța musculară a membrilor superioare la utilizatorii de țigări electronice (VU), comparativ cu fumătorii de țigări care ard și nefumătorii (NS), pentru a oferi date relevante privind riscurile potențiale ale vapingului.

Metode: A fost realizat un studiu transversal care a inclus 120 de bărbați aparent sănătoși, împărțiți în trei grupuri egale: utilizatori de țigări electronice, fumători de țigări combustibile și nefumători. Au fost evaluate forța de prindere a mâinii, testul de mers de 6 minute (6MWT) și dispneea utilizând scala mMRC. Analiza statistică a inclus ANOVA unidirecțională și corelații Pearson.

Rezultate: Nefumătorii au prezentat cele mai bune valori ale forței de prindere, distanței parcurse la 6MWT și scorului mMRC. Utilizatorii de țigări electronice au avut valori intermediare, în timp ce fumătorii au înregistrat cele mai scăzute performanțe funcționale ($P < 0,001$). Deși utilizatorii de vaping au avut o durată mai scurtă de expunere, aceștia au utilizat doze zilnice mai mari de nicotină.

Concluzie: Studiul contestă percepția vapingului ca alternativă inofensivă la fumatul clasic, demonstrând scăderea capacității de efort și afectarea funcției musculare, similar fumatului convențional.

Cuvinte-cheie

vaping • țigări electronice • capacitate funcțională • forța de prindere a mâinii • sănătate respiratorie

Background

Electronic cigarettes (e-cigarettes or vapes), introduced in the early 2000s as alternative nicotine delivery systems and initially promoted as safer substitutes for conventional tobacco products (1) Epidemiological data reveal that exclusive e-cigarette users exhibit a 1.3-fold higher risk of developing chronic respiratory disease compared to non-users, whereas conventional cigarette smokers (CS) show a 2.5-fold increase; notably, dual users face an even greater burden, with risk exceeding a threefold elevation in respiratory morbidity (2–4). Handgrip strength, commonly measured using a dynamometer, is a reliable marker of overall muscle health and has been shown to correlate strongly with pulmonary function. Reduced grip strength is frequently associated with diminished respiratory capacity, making it a practical surrogate for assessing respiratory status. Cigarette smoking has been linked to declines in both handgrip and respiratory muscle strength, largely attributable to impaired oxygen transport and chronic systemic inflammation (5, 6). Since most daily activities, such as walking and household chores, are performed at submaximal aerobic levels, evaluation of functional capacity is equally important. Functional capacity reflects the ability to sustain prolonged submaximal exercise without undue fatigue or breathlessness, which are essential indicators of cardiovascular fitness and overall physical health. It captures the integrated responses of multiple physiological systems—including cardiovascular and pulmonary function, systemic and peripheral circulation, blood, neuromuscular units, muscle metabolism and oxygen transport and utilisation within skeletal muscles during exercise (1, 7).

The aerosol generated by vaping contains nicotine, volatile organic compounds (VOCs), heavy metals and various

flavouring agents, which are known to trigger oxidative stress, airway inflammation, epithelial damage and immune dysregulation (2, 7). In more severe cases, exposure has been linked to e-cigarette or vaping-associated lung injury (EVALI), particularly with products containing illicit tetrahydrocannabinol (THC) and vitamin E acetate (3, 4).

Beyond the lungs, traditional cigarette smoking has systemic consequences, including reduced skeletal muscle mass, strength and endurance due to chronic inflammation and oxidative damage. These effects are particularly significant for the respiratory muscles, causing pulmonary dysfunction.

The current study aimed to evaluate the functional aerobic exercise capacity and upper limbs muscle performance among vape users (VU) compared to combustible CS and non-smokers (NS), providing valuable insights into the potential risks of vape smoking.

The functional capacity will be assessed among apparently healthy VU by measuring the six-minute walk test (6MWT) distances, dyspnoea at rest will be assessed by modified Medical Research Council (mMRC) scale and a handheld dynamometer will be used to measure handgrip force and by comparing these parameters among VU to combustible cigarette users and NS. Through achieving the previously mentioned objectives, functional capacity and handgrip force evaluation among VU was accomplished (6).

Methods

Ethics approval and consent to participate

This study was approved by the research ethics committee of the faculty of Physical Therapy, October 6 University (O6U. PT.REC/024/003004). Written informed consent had been taken from all participants.

Study design and participants

The present study was conducted between December 2024 and July 2025. The participants were apparently healthy volunteers who were gathered through a simple random sampling technique. The purpose and procedure of the study were explained to all participants, and the research protocol was approved by the institutional research ethics committee. All participants signed a written informed consent.

The study included 120 male participants randomly selected from the outpatient department of October 6 University between December 2024 and July 2025, during a follow-up visit after acute simple infections. The participants were evenly divided into three groups, with 40 subjects in each. Group 1 consisted exclusively of vape smokers, group 2 consisted exclusively of conventional CS and group 3 was the control group, comprising individuals who had never smoked.

Exclusion criteria

Participants who are dual users of both conventional combustible cigarettes and diagnosed with any systemic comorbidities, musculoskeletal or neurological impairments, or cognitive or psychiatric disorders were excluded; moreover, participation in structured physical training programmes or manual workers, or abnormal spirometry findings.

Data collection

The following data were collected from all eligible participants who underwent a thorough clinical examination, including demographic data (age, smoking history, type of smoking and daily smoking frequency), occupational history and anthropometric measurements. Anthropometric measurements, including body weight and height, were measured using a standardised stadiometer and digital scale, respectively, and body mass index (BMI) was calculated accordingly.

Measurement of handgrip force using a handheld dynamometer and the best value from three attempts using the dominant hand of each participant. The 6MWT

was completed as per the American Thoracic Society guidelines (8). Evaluation of dyspnoea for each subject was performed using the mMRC scale.

Statistical analysis

All data were analysed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Normality of the data was tested via the Shapiro-Wilk test. One-way analysis of variance (ANOVA) was used to compare continuous variables across the three groups, followed by Tukey's post hoc test for pairwise comparisons. The chi-square test was applied to assess differences in categorical variables. Statistical significance was set at $P < 0.05$.

Results

The three groups in this study displayed no significant difference in age and BMI as shown in Table 1. Of note when different smoking habits were analysed between VU and CS are several distinct patterns. CS have used their smoking devices for a significantly longer period of time with a mean duration of 22.8 ± 7.1 years, as opposed to 10.5 ± 2.9 for VU ($P < 0.001$). In addition to this difference in duration of usage, VU have used significantly more in a day with a packs/day equivalent of 1.56 ± 0.15 as opposed to 1.02 ± 0.12 for those smoking cigarettes ($P < 0.001$). Consequently, cumulatively over all those years, VU have had less exposure as evident in a packs-year equivalence of 16.4 ± 4.5 for VU as opposed to 23.3 ± 7.2 for CS ($P < 0.001$). Arguably one of the more astonishing discrepancies is evident when analysing daily dose equivalents with VU exhibiting a substantial increase in 45.0 ± 1.5 mg/day as opposed to 28.8 ± 1.2 mg/day for CS ($P < 0.001$).

On comparison of functional capacity and muscle strength parameters in all three categories of subjects in Table 2, distinct differences were observed. The NS emerged as

Table 1. Descriptive characteristics of study participants

Characteristics	VU (n = 40)	CS (n = 40)	NS (n = 40)	P-value
Demographics				
Age (years)	49.5 ± 6.2	50.2 ± 6.3	49.8 ± 6.1	0.891
BMI (kg/m ²)	24.4 ± 2.7	24.6 ± 2.8	24.3 ± 2.6	0.901
Smoking history				
Duration (years)	10.5 ± 2.9	22.8 ± 7.1	-	<0.001*
Packs/day equivalent	1.56 ± 0.15	1.02 ± 0.12	-	<0.001*
Pack-years equivalent	16.4 ± 4.5	23.3 ± 7.2	-	<0.001*
Nicotine exposure (mg/day)	45.0 ± 1.5	28.8 ± 1.2	-	<0.001*

ANOVA, analysis of variance; BMI, body mass index; CS, cigarette smokers; NS, non-smokers; SD, standard deviation

Data are presented as mean $\pm$ SD. One-way ANOVA for three-group comparisons; Independent *t*-test for two-group comparisons.

* $P < 0.001$ indicates significant difference.

Table 2. Functional capacity and muscle strength outcomes

Outcome measures	VU	CS	NS	P-value
Handgrip strength (kg)	26.3 ± 1.8	22.9 ± 1.7	33.5 ± 1.9	<0.001*
6-minute walk distance (m)	481.5 ± 47.8	437.8 ± 51.9	509.6 ± 46.3	<0.001*
mMRC dyspnoea score (0–4)	1.2 ± 0.5	2.1 ± 0.6	0.8 ± 0.4	<0.001*

ANOVA, analysis of variance; CS, cigarette smokers; mMRC, modified Medical Research Council; NS, non-smokers; SD, standard deviation; VU, vape users.

Data are presented as mean ± SD. One-way ANOVA with Tukey's post hoc test.

* $P < 0.001$ for overall ANOVA.

†All pairwise comparisons significant at $P < 0.05$.

leaders in all parameters with significantly higher handgrip strength of 33.5 ± 1.9 kg. The VU had an intermediate level of performance for handgrip strength of 26.3 ± 1.8 kg. The weakest handgrip strength of 22.9 ± 1.7 kg belonged to CS. Differences were found to be statistically significant ($P < 0.001$). The six-minute walking distance test showed that NS had a significantly greater distance of 509.6 ± 46.3 m. The VU had a distance of 481.5 ± 47.8 m. The minimum distance of 437.8 ± 51.9 m was observed among CS. The differences were found to be statistically significant ($P < 0.001$). Shortness of breath in everyday activity as determined by mMRC Dyspnoea scores, was found to be more in CS (2.1 ± 0.6) than in VU (1.2 ± 0.5) and NS (0.8 ± 0.4) ($P < 0.001$). The difference between all three categories is statistically significant ($P < 0.05$).

The relation between smoking exposure and endpoints in Table 3 has provided valuable information on dose response for smokers. Longer duration of smoking was associated with reduced handgrip strength ($r = -0.58$, $P < 0.01$), walking distance ($r = -0.67$, $P < 0.01$) and increased breathlessness ($r = 0.52$, $P < 0.05$). However, when analysed for cumulative risk in pack-years, correlations tended to emerge more prominently and suggested a very strong association for reduced handgrip strength ($r = -0.62$, $P < 0.01$) and walking distance ($r = -0.71$, $P < 0.01$) and moderate for breathlessness ($r = 0.55$, $P < 0.01$). Daily smoking in packs/day suggested a significant relation for reduced handgrip strength ($r = -0.48$, $P < 0.01$), walking distance ($r = -0.53$, $P < 0.01$) and increased breathlessness ($r = 0.41$, $P < 0.05$). However, a somewhat unexpected finding is that for all endpoints in CS, daily nicotine intake correlated poorly and insignificantly.

In the vape group, in Table 4 there were similar trends but some variations. Use equivalence had a moderate negative correlation with handgrip strength ($r = -0.52$, $P < 0.05$), a strong negative correlation with walking distance ($r = -0.61$, $P < 0.01$) and a moderate positive correlation with dyspnoea ($r = 0.45$, $P < 0.05$). Pack-years equivalence had a moderate to strong negative correlation with handgrip strength ($r = -0.55$, $P < 0.01$) and walking distance ($r = -0.64$, $P < 0.01$) and a moderate positive correlation with dyspnoea ($r = 0.48$, $P < 0.05$). Daily equivalence had similar moderate negative correlations with handgrip strength ($r = -0.44$, $P < 0.01$) and walking distance

($r = -0.49$, $P < 0.01$), and a weak positive correlation with dyspnoea ($r = 0.38$, $P < 0.05$). However, in group II, unlike in group I subjects, nicotine experience had significant negative correlations with handgrip strength ($r = -0.35$, $P < 0.05$) and walking distance ($r = -0.42$, $P < 0.05$); its correlation with dyspnoea remained non-significant ($r = 0.32$).

The level of correlation between different functional in Table 5 measures was remarkably similar for all three categories. Handgrip strength and walking distance were highly positively correlated for those who smoked cigarettes ($r = 0.86$, $P < 0.01$), those who vaped ($r = 0.82$, $P < 0.01$), and for NS ($r = 0.83$, $P < 0.01$), in whom those who had greater handgrip strength walked greater distances. There were similar highly negative correlations between handgrip strength and dyspnoea scores in all three categories: in those that smoked cigarettes ($r = -0.73$, $P < 0.01$), those that vaped ($r = -0.68$, $P < 0.01$) and in NS ($r = -0.65$, $P < 0.01$). The correlation between walking distance and breathlessness was equally as outstanding, as all three categories had a highly negative correlation between walking distance and breathlessness; in those that smoked cigarettes ($r = -0.81$, $P < 0.01$), those that vaped ($r = -0.75$, $P < 0.01$) and in NS ($r = -0.72$, $P < 0.01$).

Analysis of more complex patterns of comprehensive correlations in each group in Table 6 yielded some additional information. In smoking group subjects, there is a very high positive correlation between age and duration of smoking ($r = 0.85$, $P < 0.01$) and total dose of smoking in pack-years ($r = 0.82$, $P < 0.01$); this is natural in a group where age is directly proportional to duration and dose. On top of this, in smoking group subjects, age correlated moderately and negatively with physical function categories of handgrip strength ($r = -0.52$, $P < 0.05$) and walking distance ($r = -0.61$, $P < 0.01$); this is natural in a group where age is inversely proportional to strength and distance. The total dose of smoking in pack-years correlated remarkably positively and highly with breathlessness ($r = 0.55$, $P < 0.01$) and negatively and highly with walking capacity ($r = -0.71$, $P < 0.01$). It is important to note that nicotine is one factor in smoking-related injuriousness and that the total daily dose of nicotine and all physical function categories have a weak and non-significant correlation.

In the VUs' group in Table 7, age remained a strongly correlated factor for duration of vaping ($r = 0.78$, $P < 0.01$)

Table 3. Correlation between smoking exposure and functional outcomes in CS

Variables	Handgrip strength		6MWT distance		Dyspnoea score	
	<i>r</i>	<i>P</i>	<i>r</i>	<i>P</i>	<i>R</i>	<i>P</i>
Duration (years)	-0.58	<0.01	-0.67	<0.01	0.52	<0.05
Pack-years	-0.62	<0.01	-0.71	<0.01	0.55	<0.01
Packs/day	-0.48	<0.01	-0.53	<0.01	0.41	<0.05
Nicotine exposure (mg/day)	-0.21	-0.21	-0.24	-0.24	0.18	0.18

6MWT, six-minute walk test; CS, cigarette smokers.

Table 4. Correlation between vaping exposure and functional outcomes in VU

Variables	Handgrip strength		6MWT distance		Dyspnoea score	
	<i>R</i>	<i>P</i>	<i>r</i>	<i>P</i>	<i>r</i>	<i>P</i>
Duration (years)	-0.52	<0.05	-0.61	<0.01	0.45	<0.05
Pack-years equivalent	-0.55	<0.01	-0.64	<0.01	0.48	<0.05
Packs/day equivalent	-0.44	<0.01	-0.49	<0.01	0.38	<0.05
Nicotine exposure (mg/day)	-0.35	<0.05	-0.42	<0.05	0.32	0.32

6MWT, six-minute walk test; VU, vape users.

Pearson correlation coefficient (*r*).**Table 5.** Correlations between functional outcome measures

Groups	Handgrip versus 6MWT		Handgrip versus dyspnoea		6MWT versus dyspnoea	
	<i>r</i>	<i>P</i>	<i>r</i>	<i>P</i>	<i>R</i>	<i>P</i>
CS (<i>n</i> = 40)	0.86	<0.01	-0.73	<0.01	-0.81	<0.01
VU (<i>n</i> = 40)	0.82	<0.01	-0.68	<0.01	-0.75	<0.01
NS (<i>n</i> = 40)	0.83	<0.01	-0.65	<0.01	-0.72	<0.01

6MWT, six-minute walk test; CS, cigarette smokers; NS, non-smokers.

Pearson correlation coefficient (*r*). All correlations highly significant (*P* < 0.01).

and total exposures ($r = 0.75$, $P < 0.01$), and a moderately correlated factor for handgrip strength ($r = -0.45$, $P < 0.05$) and walking distance ($r = -0.52$, $P < 0.05$). Worth noting here is that in VU rather than in traditional smokers, nicotine concentration appeared to play a relatively more important role as suggested through its significant negative correlations for handgrip strength ($r = -0.35$, $P < 0.05$) and walking distance ($r = -0.42$, $P < 0.05$). Hence, one can hypothesise that in certain aspects, pharmacological needs and formulation in a vaping device might actually have a different physiological effect than that in traditional smoking.

Among NS in our reference group in Table 8, important correlations were apparent between some of the functional tests. Handgrip strength correlated well with walking ability (Correlation Coefficient: 0.83; $P < 0.01$), proving this beyond a doubt independently of smoking status. The known mild correlations between age and physical function were supported for handgrip strength (Correlation Coefficient: -0.28) and walking distance (Correlation Coefficient: -0.35; $P < 0.05$), and body mass index's correlation with physical function suggested that even in normal ranges, body composition is a factor in physical capability.

Statistical note

All analyses used Pearson correlation coefficient (*r*) ranging from -1 (perfect negative) to +1 (perfect positive). Values near 0 indicate weak or no linear relationship.

Interpretation of correlation strength

- $r = 0.80$ – 1.00 : Very strong correlation
- $r = 0.60$ – 0.79 : Strong correlation
- $r = 0.40$ – 0.59 : Moderate correlation
- $r = 0.20$ – 0.39 : Weak correlation
- $r < 0.20$: Very weak/negligible correlation

Discussion

Cigarette packages contain warning labels of death, yet these labels do not appear on e-cigarette packages, as few published studies have provided evidence of the noxious impact of e-cigarette vapour. While most studies regarding smoking as a risk targeted regular combustible tobacco cigarettes, the current study investigated the effect of the newly widespread cigarette use on functional exercise capacity (1, 4).

Table 6. Traditional CS only ($N = 40$)

Variable	Age (years)	BMI (kg/m ²)	Smoking duration	Pack-years	Nicotine level	Dyspnoea score	Hand grip strength	6MWT distance
Age (years)	1.00	0.12	0.85**	0.82**	-0.08	0.45*	-0.52*	-0.61**
BMI (kg/m ²)	0.12	1.00	0.15	0.18	0.22	0.31	-0.28	-0.35*
Smoking duration	0.85**	0.15	1.00	0.95**	-0.12	0.52*	-0.58**	-0.67**
Pack-years	0.82**	0.18	0.95**	1.00	-0.15	0.55**	-0.62**	-0.71**
Nicotine level	-0.08	0.22	-0.12	-0.15	1.00	0.18	-0.21	-0.24
Dyspnoea score	0.45*	0.31	0.52*	0.55**	0.18	1.00	-0.73**	-0.81**
Hand grip strength	-0.52*	-0.28	-0.58**	-0.62**	-0.21	-0.73**	1.00	0.86**
6MWT distance	-0.61**	-0.35*	-0.67**	-0.71**	-0.24	-0.81**	0.86**	1.00

6MWT, six-minute walk test; BMI, body mass index; CS, cigarette smokers.

Strong cumulative exposure effects: Pack-years correlate with dyspnoea ($r = 0.55$) and reduced walking distance ($r = -0.71$). Pearson correlation, * $P < 0.05$, ** $P < 0.01$.

Table 7. E-cigarette (vape) users only ($N = 40$)

Variable	Age (years)	BMI (kg/m ²)	Usage duration	Pack-years	Nicotine level	Dyspnoea score	Hand grip strength	6MWT distance
Age (years)	1.00	0.18	0.78**	0.75**	-0.15	0.38*	-0.45*	-0.52*
BMI	0.18	1.00	0.22	0.25	0.18	0.28	-0.32	-0.41*
Usage duration	0.78**	0.22	1.00	0.92**	-0.08	0.45*	-0.52*	-0.61**
Pack-years	0.75**	0.25	0.92**	1.00	-0.12	0.48*	-0.55**	-0.64**
Nicotine level	-0.15	0.18	-0.08	-0.12	1.00	0.32	-0.35*	-0.42*
Dyspnoea score	0.38*	0.28	0.45*	0.48*	0.32	1.00	-0.68**	-0.75**
Hand grip strength	-0.45*	-0.32	-0.52*	-0.55**	-0.35*	-0.68**	1.00	0.82**
6MWT distance	-0.52*	-0.41*	-0.61**	-0.64**	-0.42*	-0.75**	0.82**	1.00

BMI, body mass index; 6MWT, six-minute walk test.

Nicotine level shows stronger effects in VU ($r = -0.42$ with walking) than traditional smokers. Pearson correlation, * $P < 0.05$, ** $P < 0.01$.

Table 8. NS only ($N = 40$)

Variable	Age (years)	BMI (kg/m ²)	Dyspnoea score	Hand grip strength	6MWT distance
Age (years)	1.00	0.14	0.22	-0.28	-0.35*
BMI (kg/m ²)	0.14	1.00	0.25	-0.30	-0.38*
Dyspnoea score	0.22	0.25	1.00	-0.65**	-0.72**
Hand grip strength	-0.28	-0.30	-0.65**	1.00	0.83**
6MWT distance	-0.35*	-0.38*	-0.72**	0.83**	1.00

6MWT, six-minute walk test; BMI, body mass index; NS, non-smokers.

Even in NS, hand grip strongly predicts walking capacity ($r = 0.83$). Age and BMI show expected mild negative correlations. Pearson correlation, * $P < 0.05$, ** $P < 0.01$.

Our study proved that participants in the group who utilised vaping had significantly shorter distances of 6MWT than the control group, who never smoked, while it was significantly different than the participants in the group who smoked conventional cigarettes, who had a longer duration of smoking. These findings agree with a previous study (9).

Studies have proven that the presence of nicotine and non-nicotinic agents in e-cigarettes includes neurotoxins that affect neurological function (10–13). The results of our study showed a significant difference in the nicotine exposure between participants who utilise vapes and participants who

smoke conventional cigarettes, which we suggest could be minimised by a longer duration of vape smoking.

Regarding functional capacity, mMRC dyspnoea scores were significantly higher among VU and smokers than controls, reflecting increased breathlessness during daily activities and exertion. These outcomes reinforce earlier findings from smoking-related studies and suggest that exposure to e-cigarette vapour may similarly impair respiratory functions and contribute to exertional dyspnoea and may provoke asthma-like respiratory manifestations even among individuals without a prior history of asthma, even though

spirometry measurements are within normal, as proved by other studies (2, 5, 9).

Therefore, despite participants in this study presenting normal spirometry test results at baseline, assessment of functional capacity revealed significant reductions in both (6-minute walk distance) and muscle strength (handgrip strength) among smokers and VU are significantly less than those of the control group, suggesting that early functional impairments may not be adequately captured by standard spirometry alone and measurement of muscle strength using (handgrip strength) as a bed side, easy to use and a reliable marker of overall muscle health correlate strongly with pulmonary function.

Moreover, the significant correlations observed between handgrip strength and 6-minute walk distance in all groups are a convincing indicator of covert respiratory symptoms or measurable declines in lung function tests.

Our results agree with a previous study that has demonstrated that short-term use of 2–5 years of e-cigarettes has been linked with a significant decline in exercise capacity, particularly in young users (14). By considering the recently introduced new category termed pre-COPD, by the Global Initiative for Chronic Obstructive Lung Disease (GOLD) (7, 8). VU may initiate a pathological course similar to combustible CS, falling within this category, especially with a longer duration of exposure (15).

Our study is highlighting the importance of comprehensive functional assessment in smoking-exposed individuals, whether combustible cigarette or vape smokers, for the implementation of targeted structured rehabilitation programmes focusing on muscle strengthening, and chest physiotherapy as part of comprehensive care, such rehabilitation strategies, may represent a valuable preventive strategy to address functional limitations in smoking-exposed populations, even in the absence of diagnosed pulmonary dysfunction, and the development of clinically apparent respiratory disease. Furthermore, to discourage the youth from all forms of smoking and e-cigarettes.

There are some limitations to the present study, which reveal that objective data, including functional tests such as the 6MWT and handgrip strength, provide valuable insights into physical performance; the duration of vaping is not competitive with the duration of combustible cigarette smoking, and smokers of other types of e-cigarettes were not included for assessment in our study.

Conclusion

The present study challenges the misconception of vaping as a harmless substitute for combustible cigarettes. Vaping decreases exercise capacity and worsens muscular function, similar to cigarette smoking.

Author contribution

Authors contributed equally to the study writing manuscript, proof reading, review and revising the manuscript.

Conflict of interest

There are no declared conflicts of interest by the authors.

Ethical approval

At the beginning of study, all patients were informed about the objectives study. Participation was authorised by a written informed consent signed with Legal guardian's acceptance for participation before starting the study procedures. The study protocol was approved by the Ethical Committee of the Faculty of Physical Therapy, October 6 University Egypt with the registration number 2024 (No.P.T.REC/024/003004). All authors had access to the study and have reviewed and approved the final manuscript.

Patient consent

All parents have signed written consent forms at the beginning of the study.

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