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Long-term effect of telling the lung age on smoking quit rate in undergraduate smokers: a one-year follow-up randomized controlled study

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Abstract

Introduction. To evaluate the effect of telling undergraduate smokers their lung ages on the rate of smoking cessation.

Methods. This randomized controlled study involved 142 eligible volunteer current undergraduate smokers. They were randomly allocated to the study group (group 1; n = 72) and the control group (group 2; n = 70). Participants in group 1 were told their lung age, received a 5-minute motivational interview, and were given raw figures of their pulmonary function, while participants in group 2 received the same intervention except the lung age. Initially (evaluation 1), the subjects' lung ages were estimated through spirometric assessment of forced expiratory volume in 1 second. The number of smoked cigarettes per day was reported and the smoking status was ensured through the assessment of exhaled carbon monoxide at evaluation 1, after 6 months (evaluation 2), and after 12 months (evaluation 3).

Results. At evaluation 2, the overall follow-up rate was 95.07%. There was a significant difference in the smoking quit rate between group 1 (23.61%) and group 2 (10%) (p = 0.03). At evaluation 3, no change existed in the follow-up rate. The smoking quit rate was 19.4% and 4.3% for groups 1 and 2, respectively (p = 0.01).

Conclusions. Telling undergraduate smokers their lung ages can significantly improve the smoking quit rate in a short- and long-term perspective. The long-term partial relapse status arouses the question about other contributing factors out of the scope of this study.

Key words: smoking, spirometry, young adult, smoking cessation

Introduction

Tobacco smoking is a globally alarming problem that usually starts in early adulthood [1]. Hundreds of studies about tobacco smoking-related health hazards are globally available and have made it an easy matter to know the impacts of tobacco smoking on human health [2]. In spite of that, the general awareness of the smoking-related hazards is still much lower than predicted and a large segment of populations worldwide are still underestimating the harmful impact of smoking on their health [3].

It is clear that smoking is the main contributor to increased risk and spread of respiratory disorders [4] and smoking-related cardiovascular disorders that are the leading causes of death worldwide [5]. Additionally, cigarette smoking is the main risk factor for lung cancer, considered among the leading causes of death in men and women worldwide [6], with about 1.8 million deaths attributed to it in 2018 [7]. Starting smoking at an early age seriously impacts on the pulmonary system health [8], retards the pulmonary function, and accelerates the process of premature lung aging [9].

Tobacco smoking caused about 100 million deaths in the 20th century and this number is expected to reach 1 billion victims by the end of the 21st century [10]. Smoking reduces the lifespan by at least 10 years and is associated with a 2–3-fold increase of the risk of early death. Smoking cessation before the age of 40 can reduce this increased risk by about 90% [11, 12], and quitting smoking before the age of 30 maximizes the benefits so that the rates can approach those of the counterparts who never smoked [11].

Smoking cessation is the only practical solution to avoid the continuously increasing smoking-related deaths all over the world [13, 14]. Continuous efforts to incorporate effective strategies enhancing cigarette smoking cessation are critically warranted to assist young adults to quit smoking at early stages [15]. The World Health Organization requested governments to try to achieve a 30% reduction in the smoking prevalence by 2025 [16] to save about 1 billion more than the 200 million lives estimated to die from smoking during the 21st century [5, 17].

Although the number of adult smokers has reached 1.1 billion worldwide [16], a large segment of them have the desire to quit smoking [18]. Lack of adequate support and encouragements to quit smoking negatively influences smokers' decisions and even disturbs the smoking quit process [19]. Increasing the undergraduates' awareness about the harmful impact of smoking on body systems and specifically lung health can encourage them to quit smoking [20]. The aim of the behavioural supportive strategy incorporating the concept of lung age is to clarify the status of the premature aging of the smokers' lungs [21]. This approach proved to be effective in increasing the likelihood of smoking cessation among smokers aged 35 years and older [22], but has not been evaluated yet among young adult and undergraduate smokers. The purpose of this study was to assess the effect of telling undergraduate smokers their lung ages on the rate of smoking cessation.

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Subjects and methods

Research design and subjects

In this randomized controlled study (lasting from August 2017 till August 2019), undergraduate cigarette smokers from the universities of the western region in the Kingdom of Saudi Arabia were the target population. The participants were recruited via face to face friends' invitations and announcements through social media communication programs. All subjects were sedentary, apparently healthy, with no abnormal respiratory manifestations.

A preliminary power analysis (power '1-β error probability' = 0.95, α = 0.05, effect size = 0.62) determined a total participant number of 138 for this study to yield realistic results. Overall, 142 eligible volunteer current undergraduate smokers (109 men and 33 women) aged 18–24 years were involved after their inquiries and questions were fulfilled and answered.

Eligible participants were initially reported by 2 volunteer therapists (who had no other roles in the study) and then were randomly allocated to the study group (group 1; n = 72) and the control group (group 2; n = 70) through computer-generated random numbers with the use of research randomizer software (https://www.randomizer.org).

Outcome measures

Verified smoking quit rates were the primary evaluated variable. Changes in the daily cigarette consumption and the level of exhaled carbon monoxide (CO_{breath}) were the secondary outcome measures.

Each variable was evaluated at 3 time points: at the beginning of the study (evaluation 1), after 6 months (evaluation 2), and after 12 months (evaluation 3).

At these 3 evaluation time points, the smoking status and number of smoked cigarettes were reported; the level of CO_{breath} was measured to objectively monitor and ensure the participant's response and smoking status (continuing or discontinuing smoking).

Assessment

Demographic data and baseline characteristics

All eligible participants underwent a baseline evaluation session, in which demographic data and baseline characteristics (including chronological age [years], weight [kg], height [m], body mass index [kg/m^2], average length of smoking [years], number of smoked cigarettes/day, resting heart rate [beats/min], resting blood pressure [mm Hg], number of previous attempts to quit smoking, number of smoking parents) were evaluated and reported through standard procedures (Table 1).

Pulmonary function and lung age

Pulmonary function indicators, including forced vital capacity (FVC [l]) and forced expiratory volume in 1 second (FEV1 [l]), were evaluated at the beginning of the study (evaluation 1) in accordance with the previously published standard protocol [23] by using a Spiro Analyzer ST-250 device (Japan) that was continuously calibrated. Each participant was instructed to take a deep relaxed inspiration followed by a forceful maximum expiration; the manoeuvre was repeated 3 times and the best result was considered for statistical analysis. Lung age was automatically calculated on the basis of FEV1 in accordance with Morris and Temple estimates [21]:

MEN: Lung age = 2.87 × height (inches)-31.25 × × observed FEV1 (litres) – 39.375

WOMEN: Lung age = 3.56 × height (inches) – – 40 × observed FEV1 (litres) – 77.28

Then, lung age deficits (differences between chronological age and lung age) were calculated.

Exhaled carbon monoxide

The CO_{breath} level was evaluated by using an EC50 piCO+ Smokerlyzer (Bedfont Scientific Ltd., Kent, UK) in accordance with the manufacturer's recommendations and published guidelines [24] to confirm the smoking status at the beginning of the study (evaluation 1), after 6 months (evaluation 2), and after 12 months (evaluation 3). The CO_{breath} level of 11 ppm is the cut-off point between smokers and non-smokers (or smokers who have refrained from smoking). Measuring the CO_{breath} level is a well-established procedure to classify smokers and non-smokers [25].

After holding their breath for 20 seconds, the participant exhaled slowly and fully through the Smokerlyzer device mouthpiece. The CO_{breath} value appeared on the device screen in parts per million (ppm). The device was regularly calibrated prior to each use.

Interventions

For both groups, the intervention package was provided once, at the beginning of the study, after evaluation 1.

In group 1, the intervention included telling the participants their lung age values and the lung age deficits verbally, providing a 5-minute motivational interview (involving evaluation of the participant's intent to stop smoking, simple verbal advice encouraging them to think about smoking cessation, behavioural support through motivating the subject to be smoke-free, written self-help materials to aid smoking cessation) [26], and presenting raw figures (printout charts from the Spiro Analyzer device) of the individuals' pulmonary function. Participants in group 2 received the same intervention as group 1 except the information on lung age and lung age deficit (they only received raw figures of their pulmonary function and 5 minutes of motivational interview).

Statistical analysis

All data were statistically analysed with the SPSS software, version 16.0 (SPSS Inc., Chicago, USA). Descriptive statistical analysis was performed to display means and frequencies. The unpaired t-test was used for continuous data, while chi-square and Fisher's exact tests were applied for categorical data. The significance level was set at the alpha level of < 0.05.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Ethics Committee of the College of Applied Medical Sciences, Umm Al-Qura University (as of August 2, 2017).

Informed consent

Informed consent has been obtained from all individuals included in this study.

Results

A total of 142 current undergraduate smokers participated in this study and underwent the same assessments. At evaluation 2, the overall follow-up rate was 95.07%; the drop-out rate was 4.17% (3 of 72) for group 1 and 5.71% (4 of 70) for group 2. At evaluation 3, the same follow-up and drop-out rates were reported.

Demographic data and baseline characteristics

At evaluation 1, there were non-significant differences between groups 1 and 2 in the demographic data and baseline characteristics. Also, non-significant differences were observed between the 2 groups in the mean values of FVC, FEV1, calculated lung age, lung age deficit, number of smoked cigarettes per day, CO_{breath} level ($p < 0.05$) (Table 1).

Cigarette smoking quit rate

At evaluation 2, a significant difference in the smoking quit rate was revealed between group 1 (23.61%) and group 2 (10%) ($p = 0.03$). At evaluation 3, there was a significant difference in the smoking quit rate between group 1 (19.4%) and group 2 (4.3%) ($p = 0.01$) (Table 2).

Number of smoked cigarettes per day

There were significant differences in the number of smoked cigarettes per day between groups 1 and 2 at evaluation 2 ($p = 0.01$) and at evaluation 3 ($p = 0.01$) (Table 2).

Exhaled carbon monoxide

At evaluation 2

The levels of CO_{breath} in group 1 at evaluation 2 were 12.5 ± 3.03 and 5.00 ± 3.97 ppm for smokers and non-smokers, respectively. There was a significant difference in the CO_{breath} mean value between smokers and non-smokers within group 1 ($t = –8.2$, $p = 0.00$).

The levels of CO_{breath} in group 2 were 13.1 ± 3.1 and 3.86 ± 1.07 ppm for smokers and non-smokers, respectively. There was a significant difference in the CO_{breath} mean value between smokers and non-smokers within group 2 ($t = –7.8$, $p = 0.00$).

At evaluation 3

The levels of CO_{breath} in group 1 at evaluation 3 were 15.00 ± 3.41 and 6.59 ± 5.9 ppm for smokers and non-smokers, respectively. There was a significant difference in the CO_{breath} mean value between smokers and non-smokers within group 1 ($t = –7.3$, $p = 0.00$).

The levels of CO_{breath} in group 2 were 16.49 ± 3.37 and 7.86 ± 5.55 ppm for smokers and non-smokers, respectively. There was a significant difference in the CO_{breath} mean value between smokers and non-smokers within group 2 ($t = –5.96$, $p = 0.00$).

Between-group comparison

Furthermore, there were significant differences between groups 1 and 2 in the mean values of CO_{breath} at evaluation 2 ($p = 0.04$) and evaluation 3 ($p = 0.003$) (Table 2). The tendency to relapse (return to be a smoker after cessation) was 29.41% (5 of 17) in group 1 and 57.14% (4 of 7) in group 2; the overall relapse percentage equalled 37.5% (9 of 24).

Discussion

The objective of this study was to investigate the effect of telling undergraduate smokers their lung ages and lung age deficits on the rate of smoking cessation over short (6 months) and long (12 months) periods. Telling the lung age and lung age deficit augments the concept of the harmful impact of cigarette smoking on lung health and increases the rate of quitting smoking among undergraduate smokers.

Cigarette smoking, with its continuously increasing prevalence, has become an alarming threat to undergraduates' health [27]. The deleterious impacts of cigarette smoking on young adults' health locally and globally cannot be underestimated. Initiating the cigarette smoking habit at an early stage of life makes a life-longer dependant smoker with an increased burden of chronic life-threatening disorders later at life [28].

Youth and young adults are susceptible populations and they have high vulnerability to fall into the danger of cigarette smoking. It has become imperative to implement effective strategies to limit the spread of this adverse habit and alleviate its harm among those populations [29]. The majority of smoking-related mortality can be avoided if smokers successfully stop smoking before the age of 30 years [30].

The observed lung age deficit and premature lung aging can be explained by the fact that the pulmonary function in young adult smokers is negatively affected since cigarette smoking harms the respiratory system function [31], impairs lung growth early at life, and initiates premature lung function deterioration [32], which, in turn, can predispose to the development of chronic pulmonary disorders later at life [33].

Continuous efforts are required to alleviate the impact of cigarette smoking on young adults' health and to increase the rate of smoking cessation at an early stage because beginning smoking at a young age raises the difficulty of giving-up smoking [34] and, unfortunately, early-onset smoking is a potent factor of escalating the dose of cigarette smoking later at life [35]. On the contrary, early smoking cessation is essential for saving smokers a lot of life years: it can increase the life expectancy by about 10 years [11, 30].

Support and motivation to quit smoking is a crucial part of the comprehensive smoking-control strategy. Increasing the smoking quit rate is highly cost-effective and therefore considered among the most important healthcare interventions [36, 37]. Smoking is among the principal causes of pulmonary disorders [38] and starting smoking at a young age constitutes an independent risk factor for lung cancer because of a greater exposure to tobacco carcinogens [39], so smoking cessation is regarded as the biggest single factor in controlling the abnormally increased deaths caused by cardiopulmonary disorders [40].

The lung age motivational intervention was chosen in this study because there is strong evidence concerning the efficacy of motivational interviewing and cognitive-behavioural approaches in increasing the smoking cessation rate among young smokers [41]. The lung age motivational concept was successfully used to promote smoking cessation

Table 1. Demographic characteristics of participants in both groups (mean ± *SD*)

Variables		Study group (group 1)	Control group (group 2)	*p*
Age (years)		21.44 ± 1.41	21.57 ± 1.3	0.58**
Weight (kg)		71.72 ± 11.2	71.92 ± 10.47	0.91**
Height (m)		1.7 ± 0.07	1.71 ± 0.06	0.39**
BMI (kg/m^2)		24.81 ± 3.3	24.64 ± 3.3	0.76**
Length of smoking (years)		5.13 ± 0.9	5.16 ± 1.05	0.85**
Resting heart rate (beats/min)		74.72 ± 5.52	75.27 ± 5.57	0.56**
Resting SBP (mm Hg)		131.44 ± 7.97	130.19 ± 7.91	0.35**
Resting DBP (mm Hg)		75.97 ± 7.41	77.13 ± 6.03	0.31**
Gender (male:female)		55:17	54:16	0.92**
Previous attempts to quit smoking	0	41.7%	51.4%	0.01*
	1	33.3%	35.7%	
	2	20.8%	10%	
	3	4.2%	2.9%	
Parents' smoking status	Parents are non-smokers	26.4%	34.3%	0.23**
	One parent is smoker	56.9%	54.3%	
	Both parents are smokers	16.7%	11.4%	

BMI – body mass index, SBP – systolic blood pressure, DBP – diastolic blood pressure
Level of significance at $p < 0.05$; * significant, ** non-significant

Table 2. Between-group comparison of evaluated variables

Variables		Study group (group 1)	Control group (group 2)	*p*
Smoked cigarettes/day	Evaluation 1	10.64 ± 2.95	9.94 ± 2.97	0.16**
	Evaluation 2	4.84 ± 2.89	6.23 ± 2.78	0.01*
	Evaluation 3	8.12 ± 3.92	9.2 ± 2.86	0.01
CO_{breath} (ppm)	Evaluation 1	15.4 ± 4.33	16.47 ± 3.68	0.1**
	Evaluation 2	10.65 ± 4.6	12.12 ± 4.11	0.04*
	Evaluation 3	12.93 ± 5.5	15.58 ± 4.49	0.003*
FVC (l)	Evaluation 1	4.31 ± 0.36 (91.31% predicted)	4.3 ± 0.39 (89.09% predicted)	0.9**
FEV1 (l)	Evaluation 1	3.63 ± 0.34 (91.27% predicted)	3.61 ± 0.31 (89.13% predicted)	0.78**
FEV1/FVC	Evaluation 1	84.54 ± 5.03 (100.72% predicted)	84.04 ± 1.33 (100.13% predicted)	0.6**
Lung age (years)	Evaluation 1	30.51 ± 5.75	29.19 ± 5.55	0.17**
Lung age deficit (years)	Evaluation 1	9.06 ± 5.64	7.62 ± 0.66	0.13**
Smoking status (evaluation 2)	Smoker	52	59	0.03*
	Non-smoker	17	7	
Smoking status (evaluation 3)	Smoker	55	63	0.01*
	Non-smoker	14	3	

CO_{breath} – exhaled carbon monoxide, FVC – forced vital capacity, FEV1 – forced expiratory volume in 1 second, evaluation 1 – before the study, evaluation 2 – after 6 months, evaluation 3 – after 12 months
Level of significance at $p < 0.05$; * significant, ** non-significant

among difficult-to-treat patients with chronic lung diseases [42]. Achievements in changing smoking behaviour among smokers depend on the way that the smoking-related information is conveyed and understood. Simplifying the information and providing feedback through graphic display and written forms play a vital role in the success of this intervention [43]. Presenting the information related to the impact of cigarette smoking on lung health in an easily understandable way can result in increasing the level of smoking cessation [22]. All these elements were considered and closely adhered to throughout this study.

Young adults usually underestimate the danger of smoking to their health; the majority of them are not aware of being addicted until they try to quit smoking [44]. Young smokers not always accept formal smoking cessation supportive measures and, alternatively, they respond more favourably to behavioural support and others' advice [45]. Although they desire to stop smoking, a large proportion of young adult smokers wrongly perceive smoking cessation as a long-term tiring project rather than a short-term achievable objective [44].

In the present study, telling the lung age and motivational interviewing proved to be effective in increasing the rate of smoking cessation among the undergraduate smokers. These results came in accordance with previous reports which concluded that advice and behavioural support from health professionals could help smokers to stop smoking [46] and that even brief advice from healthcare providers could significantly increase the smoking quit rate in the general population [47]. The raised quit rate, the participants' motivation and decision to quit smoking in response to knowing their lung age may be based on the behavioural belief that the smoking-related health hazards were still within 'the modest zone' and on the fact that the pulmonary function indicators were not seriously deteriorated; these concepts might have positively supported their decision of smoking cessation since it was not too late to stop smoking [22].

The interviewing time in this study was limited to 5 minutes because there was clear evidence that a short time (5 minutes) devoted to advising smokers could provide apparent benefits [46] and was even more advantageous than a longer interview time (more than 10 minutes) [48, 49].

Despite the confirmed harmful effects of cigarette smoking on young adults' health, the modest reduction in the participants' pulmonary function observed in this study can be attributed either to the relatively short overall cigarette smoking duration (5.14 ± 0.97 years) or to the small number of cigarettes smoked per day (10.3 ± 2.97 cigarettes/day) since the magnitude of deterioration in FVC and FEV1 depends on the smoking duration as well as the number of cigarettes smoked per day [50].

Parkes et al. [22] reported that retarded health aspects did not necessarily result in changing subjects' behaviour and decision making. In accordance with this concept, the magnitude of reduction in the pulmonary function and the level of the premature increase in the lung age of the participants in this study might not have been sufficient to motivate all individuals to stop smoking, especially if one considers that they were already underestimating the extent of the smoking-related health risks. Additionally, the relapse status encountered among the participants at the end of the study (evaluation 3) can be explained by the same concept.

The study revealed another important finding that warrants concern with regard to the relapse rate. There was a tendency to return to smoking among subjects who had already stopped smoking (37.5%), so continuous support is essential. It is important to provide advice and motivation at least once a year to maintain smoking quit [26] and to reduce the relapse risk that affects smokers during smoking cessation trials [51]. Regular and continuous education about the possible hazards of smoking as an important behavioural health risk is crucial for smoking prevention and cessation among university students [52].

Additionally, one should remember that no single approach can provide full control over the smoking quit process; it is essential to implement different strategies together in a multi-dimensional comprehensive smoking cessation program [50].

Limitations

Although an important practical message is provided through this study, there are also other contributing factors affecting the decision; hence, the rate of smoking quit should be investigated. Future studies need to be conducted with larger sample sizes and longer follow-up periods.

Conclusions

The concepts of lung age and lung age deficit can serve to motivate young adult smokers to take the decision on quitting cigarette smoking, so these concepts should be implemented in routine evaluation procedures for young adult smokers. Telling undergraduate smokers their lung age significantly increased the cigarette smoking quit rate over short and long runs.

Practical message

Evidence is available regarding the effect of telling smokers older than 35 years their lung age on the rate of smoking cessation [22], but there were no data so far about the efficacy of using the concepts of undergraduate smoker lung age and lung age deficit to increase their smoking quit rate.

Success in raising smoking quit rates can be gained simply by reporting the lung age and lung age deficits via evaluating undergraduate smokers' pulmonary function. Therefore, spirometric examination should be implemented as an essential component of routine youth assessment.

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Conflict of interest

The authors state no conflict of interest.

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