Impact of Cigarettes Smoking on Undergraduates' Lung Health and Functional Performance: Observational Cross-Sectional Study

Abstract

Background: Cigarettes Smoking is a major social and global health problem. Cigarette smoking continues to be a major contributor to deteriorated health status across different age categories. Clarifying the impact of the cigarette smoking on young adults' lungs health and functional aspects can serve eliminating further deterioration in health status and establishing proper management regimens. This study aimed to investigate the impact of cigarette smoking on lung health (age and functions) and functional performance in the university smoker students. **Methods:** One hundred and Thirty eligible volunteer, current smoker students participated in this study to objectively evaluate their pulmonary functions (including forced vital capacity "FVC", forced expiratory volume in one second "FEV1", FEV1/FVC, peak expiratory flow rate "PEFr"), lung age and functional performance (via the 6-minutes' walk test "6MWT") and compare "the observed" with "the predicted normal" mean values. Data were analyzed via SPSS program using the student t-test. **Results:** There were significant differences ($P < 0.05$) between the "observed" and the "predicted normal" FVC, FEV_1, FEV1/FVC, PEFr, lung age, and the 6MWT mean values. The "observed" and the "predicted normal" FVC, FEV_1, FEV1/FVC, PEFr, lung age and the 6MWT mean values were [(4.47 ± 0.53, 4.77 ± 0.5 liter), (3.95 ± 0.42, 4.08 ± 0.4 liter), (88.74 ± 7.17, 85.59 ± 4.91%), (550.75 ± 114.96, 572.72 ± 53.02 liter/minute), (32.77 ± 9.44, 21.55 ± 1.37 year), (387.06 ± 56.47, 466.82 ± 18.45 meter)], respectively. **Conclusions:** Cigarette smoking negatively impacts the lung age, functions, and functional performance of the university smoker students; the concept that can be used to encourage prevention and early smoking cessation.

Keywords: *Cigarette smoking, respiratory function tests, physical functional performance, young adult*

Ashraf Abdelaal Mohamed Abdelaal[1], Gihan Samir Mohamed Mousa[1,2]

[1]Department of Physical Therapy for Cardiovascular/Respiratory Disorder and Geriatrics, Faculty of Physical Therapy, Cairo University, Egypt, [2]Department of Physiotherapy, Faculty of Applied Medical Sciences, Umm Al-Qura University, Saudi Arabia

Introduction

Tobacco smoking is a global public health deteriorus agent that is associated with abnormally elevated death percentage worldwide.[1] Cigarette smoking is a leading cause of preventable death and usually begins at the adolescence phase.[2] Early smoking cessation and prevention is a public health priority.[3]

Cigarette smoking is predicted to cause about ten million deaths per year by 2030 worldwide.[4] Furthermore; cigarette smoking is a strong contributing factor for many health problems[5] especially in areas with high smoking prevalence as the Eastern Mediterranean region.[6]

The smoking-related health risks are strongly associated with the number of smoked cigarettes.[7] Almost all organs in the body are negatively affected by smoking, with majority of cancer deaths and chronic obstructive pulmonary disease (COPD) are caused by cigarette smoking.[1] Youth smoking in particular is associated with deteriorated lung function and other serious systemic pathologies.[8]

The prevalence of cigarette smoking varies according to demographic regions and gender. Algabbani *et al*. reported that the overall prevalence of cigarette smoking among subjects aged 18 years and above was 21.4%; with a 32.5% prevalence among men and 3.9% among women.[9] Cigarette smoking became an increasingly propagating phenomenon among the university students; with the smoking prevalence is higher in men compared to women across many geographic regions.[10-12]

Spirometry is a simple, non-invasive procedure to screen the pulmonary health status,[13] with normal predicted

Address for correspondence:
Dr. Ashraf Abdelaal Mohamed Abdelaal,
Faculty of Physical Therapy, Cairo University, 7 Ahmed Elzaiat St. Ben Elsaryat, EI Dokki-Giza Postal Code: 12612, Egypt.
E-mail: drashraf_pt79@yahoo.com

How to cite this article: Abdelaal AAM, Mousa GS. Impact of cigarettes smoking on undergraduates' lung health and functional performance: Observational cross-sectional study. Int J Prev Med 2022;13:59.

spirometric values depends on the subject's age, gender, height, and body size.[14] The pulmonary function (PF) test can clarify respiratory function variations over time, so further deterioration can be prevented.[15] The forced vital capacity (FVC) and forced expiratory volume in one second (FEV1) are the most commonly utilized measurements of the PF.[13] Lung age is a FEV1-dependent variable that is considered a strong motivator for smoking cessation. The critically altered PF in cigarette smokers is usually manifested in form of abnormally reduced FVC and FEV1.[16]

Knowledge of the cigarette smoking hazards is essential to control smoking.[17] Cigarette smoking accelerates the age-related decline in the PF,[18] so adult or adolescent cigarette smokers are usually characterized by reduced PF compared to their counter partner non-smokers.[19,20]

The cigarette smoking epidemic spreads in a fast manner among university students. Extra-efforts are required to protect young adults from smoking-related hazards, so a smoking prevention and cessation supporting strategies are urgently needed.[21] Although smoking control is a pivot health concern, unfortunately; There is limited understanding of the impact of cigarette smoking on pulmonary health as well as functional performance (FP) among the university students, this is in part due to the limited number of studies conducted to evaluate the PF and FP among smokers youth and university smoker students.[22]

The continuously alarming concept is that the majority of smokers are still underestimating the smoking-related health hazards[23] and even the acknowledgment of the cigarette smoking-adverse effects are not commonly translated into avoidance or stoppage of the smoking habit. There is still a shortage in the health message regarding the smoking hazards on the youth health and physical performance and there is still a shortage in the utilization of the smoking-related health hazards as a motive for smoking cessation.[24] Accurate data about the cigarette smoking-related health risks and the PF alternations are mandatory[22] to correct the alteration in risk perception[25] and motivate younger adult smokers to quit smoking.[26]

Despite the incorporation of the many practical strategies to fight cigarette smoking among young adults; only modest achievements were obtained,[27] more efforts are still needed to alleviate the smoking impact in students' health and more health warnings are required to encourage the process of cigarette smoking control and cessation among youth.[28] Increasing awareness about smoking impacts on health through implementing effective interventions that provides information about the hazards of smoking can augment the intention to stop smoking among the university smoker students.[29]

Providing information about smokers' lung function and lung age can help in increasing motivation to stop smoking,[30] so the aim of this study was to objectively investigate the impact of cigarette smoking on lung age, PF and FP in the university smoker students.

Methods

Research design

Observational cross-sectional study.

Participants

Smoker students from the Saudi Arabia Western region Universities were invited to participate in the study.

Recruitment and sampling

Non-probability, purposive sampling technique was utilized to recruit the smoker students to voluntarily participate in this study. Participants were recruited through face-to-face interviews and web-based announcements. One Hundred and Forty-Two sedentary volunteer, current smoker students were recruited. One Hundred and Thirty participants (105 men and 25 women) fulfilled the inclusion criteria, had no exclusion criteria and were eligible for participation in this study.

This study was conducted in accordance with the principles of the World Medical Association Declaration of Helsinki 1975, revised in Hong Kong 1989 and was approved by the ethics committee of the Faculty of Applied Medical Sciences, Umm Al-Qura University, Saudi Arabia and was conducted between September 2017 and July 2019.

Inclusion and exclusion criteria

Participants were current cigarette smoker university students, from both genders, age ranged from 16-24 years old, 30> body mass index "BMI" > 18.5. Participants were excluded if they refused to sign the written informed consent, had diabetes mellitus, with high resting blood pressure (more than 140/90 mmHg), were underweight or obese subjects ($30 \leq BMI \leq 18.5$), had unstable cardiopulmonary, neuromuscular or musculoskeletal insults that can affect the accuracy of the study outcomes, participated in any regular exercise training within the last four weeks, were unable to perform the six minutes' walk test (6MWT).

The study objectives and procedures were fully explained to each participant who signed a written informed consent form, agreeing for participation and publication of the study results.

Evaluation

All participants underwent similar evaluations that were conducted at the same time of the day (between 8 and 11 am). Outcomes were PF (including FVC, FEV1, FEV1/FVC%, peak expiratory flow rate "PEFr"), lung age and the FP (through the 6MWT).

The pulmonary function and lung age evaluations

Evaluations of the FVC, FEV1, FEV1/FVC, PEFr, and lung age were carried according to previously published guidelines,[31] using (Spiro Analyzer ST 250; Fukuda, Sangyo, Japan) a portable PF testing unit that measures "the observed" PF and estimates "the predicted normal" values. After 10-minutes rest and sufficient explanation about how to perform the test, each participant was directed to perform forced maximal expiration after full inspiration and the procedure was repeated three times for each participant, and the best trial was considered in data analysis.

Functional performance evaluation

Each participant performed the 6MWT according to a previously published protocol.[32] Each participant walked at his/her own maximal steady pace without running between the two ends of a 40-meter straight, flat corridor and the total distance covered in the 6 minutes was then recorded. The "predicted normal" 6MWT values were estimated using the following formula:

$$6MWT = (2.81 \times Height) + (0.79 \times Age) - 28.5 \text{ [33]}$$

Statistical analysis

All data were examined using SPSS version 16.0 (SPSS Inc., Chicago). Descriptive statistics and the student t-test were used to test hypothesis and compare between the "observed" and the "predicted normal" mean values of the evaluated variables. Correlation analysis was done to test the association between the considered variables. Results were reported as means and standard deviations. For all procedures, significance was accepted at the alpha level of <0.05.

Results

One Hundred and forty-two sedentary volunteer smoker students were identified as eligible for enrolment in this study; twelve of them were excluded (three had diabetes, seven were included in an exercise training program at the time of the study, and two refused to sign the written informed consent). Thus, 130 participants were included and completed the study.

Participants' characteristics

Participants' age was 21.55 ± 1.37 years, weight = 72.30 ± 10.72 kg, height = 1.70 ± 0.07 meter, body mass index = 24.90 ± 3.25 Kg/m², resting heart rate = 74.98 ± 5.42 beats/minute, blood pressure = 130.65 ± 7.88/76.30 ± 6.92 mmHg, cigarette number/day = 10.06 ± 3.38 cigarette/day, smoking duration = 5.75 ± 2.36 years [Table 1].

Pulmonary functions

The overall "observed" and the "predicted normal" mean values of FVC, FEV_1, FEV1/FVC, PEFr were [(4.47 ± 0.53, 4.77 ± 0.5 liter), (3.95 ± 0.42, 4.08 ± 0.4 liter), (88.74 ± 7.17, 85.59 ± 4.91%), (550.75 ± 114.96, 576.72 ± 53.02 liter/minute)] respectively. The results revealed that overall "observed values" were significantly lower than the "predicted normal" values for the FVC ($P < 0.001$), FEV1 ($P = 0.01$) and PEFr ($P = 0.02$). Results also revealed that the FVC, FEV_1, PEFr "observed values" were significantly lower than the "predicted normal" values in men ($P < 0.05$), while the "observed values" were non-significantly lower than the "predicted normal" values for the same variables in women. ($P \geq 0.05$) [Table 2].

Lung age

The results revealed that the overall "observed/measured" mean value of the lung age (32.77 ± 9.44 year) was significantly higher than the overall "predicted actual chronological" mean value (21.55 ± 1.37 year) ($P = 0.00$). The results also revealed that the lung age "observed" mean values were significantly higher than the "predicted actual chronological" mean values in both men and women ($P < 0.05$) [Table 3].

Physical functional performance

The results revealed that the overall "observed value" of the 6MWT (387.06 ± 56.47 meter) were significantly lower than the "predicted normal" value (466.82 ± 18.45 meter). The results also revealed that the 6MWT "observed values" were significantly lower than the "predicted normal" values in both men and women ($P < 0.05$) [Table 3].

The results also revealed that there were significant inverse correlations between smoking duration and the observed values of FVC ($r = -0.31$, $P < 0.001$), FEV1 ($r = -0.14$, $P < 0.01$), FEV1/FVC ($r = -0.24$, $P = 0.01$). Also there were significant inverse correlations between the lung age observed values and the observed values of FVC ($r = -0.48$, $P = 0.00$), FEV1 ($r = -0.78$, $P = 0.00$), FEV1/FVC ($r = -0.34$, $P < 0.001$) [Table 4]. The results revealed that the smoking duration and "observed lung age" had significant inverse correlations with the "observed" FVC, FEV1 and FEV1/FVC in both men and women [Table 4].

Discussion

The current study was conducted to evaluate the impact of cigarette smoking on the lung age, function, and functional performance in sedentary university smokers' students. This study aimed to give a conclusion about the harmful effects of smoking on pulmonary system and subject's performance during daily living activities so as to give an encouragement for smokers to stop smoking. This aim was achieved through comparing the "observed" mean values of the PF, lung age, and FP with the "predicted normal" mean values of the same participants.

This study targeted the university students because adolescence and early adulthood are important stages since it is usually the starting point for initiation of smoking

Table 1: Demographic data of all participants (mean±standard deviation); (*n*=130)

Variable	(Men; *n*=104)	(Women; *n*=26)	Total	*t*, *P*
Age (year)	21.55±1.32	21.5±1.5	21.55±1.37	-0.16, 0.87**
Weight (kg)	75.91±8.42	57.56±4.48	72.3±10.72	-10.72, 00*
Height (meter)	1.71±0.06	1.67±0.07	1.7±0.07	-3.06, 0.003*
Body mass index (Kg/m^2)	25.95±2.68	20.72±1.44	24.9±3.25	-9.6, 0.00*
Resting heart rate (beat/minute)	74.84±4.98	75.58±6.7	74.98±5.42	0.62, 0.54**
Systolic blood pressure (mmHg)	130.57±7.75	131.00±8.47	130.65±7.88	0.25, 0.8**
Diastolic blood pressure (mmHg)	76.43±6.89	75.77±7.16	76.3±6.92	-0.44, 0.66**
Cigarette number/day	9.98±3.25	10.39±3.91	10.06±3.38	0.54, 0.59**
Smoking Duration (year)	5.69±2.36	5.96±2.38	5.75±2.36	0.52, 0.6**

**Non-Significant, *Significant, *P*<0.05

Table 2: Comparison between the observed and predicted smokers' undergraduates FVC, EFV1, FEV1/FVC and PEFr (mean±standard deviation); (*n*=130)

Variable		Men (*n*=104)	Women (*n*=26)	Total (Overall)
FVC (liter)	Observed	4.49±0.48	4.39±0.73	4.47±0.53
	Predicted	4.83±0.46	4.57±0.59	4.77±0.5
	t, *P*	6.7, 0.00*	1.26, 0.22**	6.18, 0.00*
FEV1 (liter)	Observed	3.67±0.40	3.87±0.52	3.95±0.42
	Predicted	4.12±0.39	3.92±0.44	4.08±0.4
	t, *P*	3.91, <0.001*	0.59, 0.56**	3.69, 0.00*
FEV1/FVC (%)	Observed	88.74±7.39	88.77±6.39	88.74±7.17
	Predicted	85.47±5.20	86.11±3.53	85.59±4.91
	t, *P*	-4.71, <0.001*	-2.12, 0.05**	-5.18, 0.00*
PEFr (liter/min)	Observed	549.24±115.13	556.8±116.35	550.75±114.96
	Predicted	581.17±51.92	558.89±54.67	576.72±53.02
	t, *P*	3.17, 0.002*	0.95, 0.93**	2.83, 0.02*

FVC: Forced vital capacity, FEV1=forced expiratory volume in one second, FEV1/FVC%, PEFr=peak expiratory flow rate, **Non-significant, *Significant, *P*<0.05

Table 3: Comparison between the observed and predicted smokers' undergraduates lung age and Physical Functional performance (mean±standard deviation); (*n*=130)

Variable		Men (*n*=104)	Women (*n*=26)	Total (Overall)
Lung age (year)	Observed	33.00±9.20	31.81±10.49	32.77±9.44
	Predicted "Chronological"	24.18±2.17	23.68±2.38	21.55±1.37
	t, *P*	9.71, 0.00*	4.36, <0.001*	10.67, 0.00*
6MWT (meter)	Observed	386.89±56.64	387.73±56.85	387.06±56.47
	Predicted	469.22±17.28	457.2±20.17	466.82±18.45
	t, *P*	-14.4, 0.00*	-6.6, <0.001*	-15.83, 0.00*

6MWT=6-min walk test, **Non-significant, *Significant, *P*<0.05

Table 4: Correlations between smokers' undergraduates smoking duration, lung age and evaluated pulmonary function variables (correlation coeffecient "*r*" & *P*)

Variable	Smoking duration			Lung age (Observed)		
	Men (*n*=104)	Women (*n*=26)	Total	Men (*n*=104)	Women (*n*=26)	Total
FVC (Observed)	-0.23, 0.02*	-0.56, 0.03*	-0.31, <0.001*	-0.5, 0.00*	-0.5, 0.01*	-0.48, 0.00*
FEV1 (Observed)	-0.07, 0.02*	-0.4, 0.04*	-0.14, <0.01*	-0.81, 0.00*	-0.76, 0.00*	-0.78, 0.00*
FEV1/FVC (Observed)	-0.2, 0.04*	-0.41, 0.04*	-0.24, 0.01*	-0.34, 0.00*	-0.32, 0.01*	-0.34, <0.001*

r=correlation coeffecient, FVC=Forced vital capacity, FEV1=forced expiratory volume in one second, FEV1/FVC%, *Significant, *P*<0.05

consumption or nicotine addiction[34] Furthermore; youth are more susceptible to smoking-related consequences that can alter both lung functions as well as lung growth.[4] Unfortunately; adolescents and young adult smokers' usually underestimate the obscenity[35] and the harm of the smoking on their health and consider the smoking to be less risky.[26]

Cigarette smoking has a direct deteriorus effect on the lung, producing multiple respiratory disorders, including COPD,

pneumonia, and lung cancer.[36] The smoking-related deterioration in PF can be evaluated through the pulmonary function testing (PFT).[37]

The results of the current study showed that cigarette smoking negatively impacts lung functions of the smokers' undergraduates of both genders (men more than women). This came in accordance with previous studies stated that the FVC and FEV1 are abnormally reduced in smokers adolescent girls and boys[20,38] this can be in part because girls smoke as frequently as boy.[39]

Regarding the smokers' PF; cigarette smoking harms the pulmonary system, both on short and long-term basis. The results of this study came in accordance with that of Bano *et al*. Who reported that PF are usually impaired in smokers.[40] Even the early stages of cigarette smoking can produce obvious respiratory system abnormalities[41] and abnormal deteriorations in the lung functions among youth.[38,41] Cigarette smoking produces acute airways irritation and increases the airways resistance.[42] Cigarette smoking is the most causative agent in the ventilatory impairments.[40] Smoking impairs the normal age-related increase in the FEV1 in children[43] and causes an accelerated FEV1 deterioration in adults.[44]

The results of the current study regarding the correlation between the smoking duration and the PF came in accordance with the results reported by Hariri and Wan Mansor who found significant correlation between the number of cigarettes and smoking duration with the reduction in the smoker's FVC and FEV1,[22] this correlation follows a dose-dependent relationship[20] and the cigarettes smoking dose was the significant predictor of the level of decrease in the FVC and FEV1.[22] Additionally; previous studies reported reduced FVC, FEV1, FEV1/FVC and Forced Expiratory Flow rate among adult smokers[45,46] that indicate affection of the small airways and airways obstruction,[47] with the severity of affection directly depends on the intensity of cigarette smoking.[48]

The observed reduction in smokers' students' PF can be explained on the basis that smoking is negatively impacting the lung growth and thereby lung functions and is usually associated with a variety of pulmonary pathologies.[49] The abnormalities in the lung age and functions are secondary to the harmful, diffuse pathological changes affecting the airways epithelium, lining, and bronchial tree structure[50] since smoking causes a pre-mature lung function deterioration especially when the cigarette smoking starts earlier in the youth's life.[51]

Ambrose and Barua previously reported that the cigarette smoking affects the lung function through reducing the respiratory muscles strength secondary to increasing the free radicals within the smoker's vascular system, that in turn can restrict the blood flow to the respiratory muscles and so impairing its function.[52] This oxidative stress can

fragment the cell nuclei, harms its DNA and even destroy its chromosomes.[53] Impaired respiratory muscles' function and altered PF are negatively impacting the subject's functional performance.[54]

Despite the confirmed harmful effects of cigarette smoking on PF and general health; current study results did not show severe impairments in PF of the smokers' students. This conflict can be clarified when considering the relatively short time and low intensity of smoking that were unlikely to develop intense respiratory or health-related disturbances as those usually encountered in elderly smokers.[41] Despite non-significant differences in cigarette number/ day and smoking duration (year) between men and women; but surprisingly there was non-significant difference "reduction" between observed and predicted women's PF compared with significant difference "reduction" between observed and predicted men's PF. This can be resolved when considering that the deterioration and the accelerated rate of the PF loss are greater in smokers' men than smokers' women.[55,56]

Some points should be mentioned as limitation in this study. This study included a limited age and educational level group. Differences in the demographic and anthropometric characteristics between various geographic areas may limit the generalizability of this study results. The relatively small sample number is another limitation that should be considered when using this study results.

Conclusions

Cigarette smoking proved to have deteriorations impacts on the lung age, functions and the functional performance of the university smokers' students. Such information can be used to encourage youth and university students to avoid and quit cigarette smoking through implementation of this study results in the health education programs targeting the undergraduate smokers to help them stop smoking.

Financial support and sponsorship

Conflicts of interest

There are no conflicts of interest.

References

1. Onor IO, Stirling DL, Williams SR, Bediako D, Borghol A, Harri MB s, *et al*. Clinical effects of cigarette smoking: Epidemiologic impact and review of pharmacotherapy options. Int J Environ Res Public Health 2017;14:1147-63.

2. Selekman J. Vaping: It's all a smokescreen. Pediatric Nursing 2019;45:12-5, 35.

3. Kozlowski LT, Abrams DB. Obsolete tobacco control themes can be hazardous to public health: The need for updating views on absolute product risks and harm reduction. BMC Public Health

2016;16:432-3.

4. National Center for Chronic Disease Prevention and Health Promotion (US). Smoking Cessation: A Report of the Surgeon General. Atlanta (GA): U.S. Department of Health and Human Services, Centers for Disease Control and Prevention (US), Office on Smoking and Health, 2020. Available from: https://www.hhs.gov/surgeongeneral/reports-and-publications/tobacco/index.html. [Last accessed on 2020 Feb 10].

5. Desalu O, Olokoba A, Danburam A, Salawu F, Issa B. Epidemiology of tobacco smoking among adults population in North-East Nigeria. Inter J Epidemiol 2007;6:1-6.

6. Fouad H, Commar A, Hamadeh RR, El-Awa F, Shen Z, Fraser CP. Smoking prevalence in the Eastern Mediterranean Region. East Mediterr Health J 2020;26:94-101.

7. Dawood OT, Rashan MA, Hassali MA, Salem F. Knowledge and perception about health risks of cigarette smoking among Iraqi smokers. J Pharm Bioallied Sci 2016;8:146-51.

8. Qasim H, Alarabi AB, Alzoubi KH, Karim ZA, Alshbool FZ, Khasawneh FT. The effects of hookah/waterpipe smoking on general health and the cardiovascular system. Environ Health Prev Med 2019;24:58-75.

9. Algabbani AM, Almubark RA, Althumiri NA, Alqahtani AS, BinDhim NF. The prevalence of cigarette smoking in Saudi Arabia in 2018: Governmental report. Food Drug Regulatory Sci J 2018;1:1-13.

10. Al-Turki YA. Smoking habits among medical students in central Saudi Arabia. Saudi Med J 2006;27:700-3.

11. Al-Turki YA, Al-Rowais NA. Prevalence of smoking among female medical students in the college of medicine, Riyadh, Saudi Arabia. Saudi Med J 2008;29:311-20.

12. Wali SO. Smoking habits among medical students in Western Saudi Arabia. Saudi Med J 2011;32:843-8.

13. Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A, et al. Standardisation of spirometry. Eur Respir J 2005;26:319-38.

14. Pride NB. Smoking cessation: Effects on symptoms, spirometry and future trends in COPD. Thorax 2001;56:ii7-10.

15. Evans JA, Whitelaw WA. The assessment of maximal respiratory mouth pressures in adults. Respir Care J 2009;54:1348-59.

16. Jerusha J, Santhi V. Comparative study of pulmonary function tests in smokers and non-smokers. Bull Pharm Med Sci 2014;2:2201-8.

17. Nasim A, Khader Y, Blank MD, Cobb CO, Eissenberg T. Trends in alternative tobacco use among light, moderate, and heavy smokers in adolescence, 1999-2009. Addict Behav J 2012;37:866-70.

18. Jaakkola MS, Ernst P, Jaakkola JJ, N'gan'ga LW, Becklake MR. Effect of cigarette smoking on evolution of ventilatory lung function in young adults: An eight year longitudinal study. Thorax 1991;46:907-13.

19. Rawashdeh A, Alnawaiseh N. Effects of cigarette smoking and age on pulmonary function tests in≥40 years old adults in Jordan. Biomed Pharmacol J 2018;11:789-93.

20. Gold, DR, Wang X, Wypij D, Speizer FE, Ware JH, Dockery DW. Effects of cigarette smoke on lung function in adolescent boys and girls. N Engl J Med 1996;335:931-7.

21. Nawafleh HA, Abo Zead SA-S, Al-Maghaireh DF. Pulmonary function test: The value among smokers and nonsmokers. Health Sci J 2012;6:703-13.

22. Hariri A, Wan Mansor WM. Effects of cigarettes smoking on pulmonary function among university students. MATEC Web Conferences 2017; 87:02002 (2017) ENCON 2016, 1-5.

23. Fawibe A, Shittu A. Prevalence and characteristics of cigarette smokers among undergraduates of the University of Ilorin, Nigeria. Niger J Clin Pract 2011;14:201-5.

24. Hussain NA, Akande M, Adebayo ET. Prevalence of cigarette smoking and knowledge of its health implications among Nigerian soldiers. East Afr J Public Health 2010;7:168-70.

25. Morrell HE, Song AV, Halpern-Felsher BL. Predicting adolescent perceptions of the risks and benefits of cigarette smoking: A longitudinal investigation. Health Psychol 2010;29:610-7.

26. Gratziou C. Review of current smoking cessation guidelines. Copyright ERS Journals Ltd. European Respiratory Monograph 2008;42:35-43.

27. Pbert L, Farber H, Horn K, Lando HA, Muramoto M, O'Loughlin J, et al. State-of-the-art office-based interventions to eliminate youth tobacco use: The past decade. Pediatrics 2015;135:734-47.

28. Egbe CO, Petersen I, and Meyer-Weitz A. Knowledge of the negative effects of cigarette smoking on health and well-being among Southern Nigerian Youth. Int J Soc Sci Hum 2016;6:184-90.

29. Al-Zalabani AH, Abdallah AR, Alqabshawi RI. Intention to quit smoking among intermediate and secondary school students in Saudi Arabia. Asian Pac J Cancer Prev 2015;16:6741-7.

30. Trofor A, Miron R, Buculei I, Puiu L, Man MA. "Lung age" - a motivational smoking cessation tool in smokers with chronic obstructive pulmonary disease. Tobacco Induced Dis 2018;16:309.

31. Shah SH, Sonawane P, Nahar P, Vaidya S, Salvi S. Pulmonary function tests in type 2 diabetes mellitus and their association with glycemic control and duration of the disease. Lung India 2013;30:108-112.

32. Abdelaal AA, Taha MM, Bahey El-Deen HA. Effects of positive expiratory pressure breathing on functional outcomes in patients with chronic obstructive pulmonary disease after major abdominal surgeries: Randomized controlled trial. Int J Adv Res 2014;2:784-801.

33. Alameri H, Al-Majed S, Al-Howaikan A. Six-min walk test in a healthy adult Arab population. Respir Med 2009;103:1041-6.

34. Zarallo GR, Chamorro MZ, Luque AG, Condón RM. Prevalence and factors related to tobacco use in adolescent students. Diversity & Equality in Health and Care 2019;16:18-21.

35. 35- Mohammadpoorasl A, Bahari A, Marin S, Hajizadeh M. Obscenity of cigarette and hookah smoking in Iranian adolescents: A longitudinal school-based study. Int J Prev Med 2019;10:47-52.

36. Al-Naggar RA, Al-Dubai SA, Al-Naggar TH, Chen R, Al-Jashamy K. Prevalence and of smoking and associated factors among Malaysian University Students. Asian Pac J Cancer Prev 2011;12:619-24.

37. Macleod J, Robertson R, Copeland L, McKenzie J, Elton R, Reid P. Cannabis, tobacco smoking, and lung function: A cross-sectional observational study in a general practice population. Br J Gen Pract 2015;65:e89-95.

38. Prokhorov AV, Emmons KM, Pallonen UE, Tsoh JY. Respiratory response to cigarette smoking among adolescent smokers: A pilot study. Prev Med 1996;25:633-40.

39. Singh T, Arrazola RA, Corey CG, Husten CG, Neff LJ, Homa DM, et al. Tobacco use among middle and high school students- United States, 2011-2015. MMWR Morb Mortal Wkly Report 2016;65:361-7.

40. Bano R, Ahmad N, Mahagaonkar AM. Study of pulmonary functions in smokers and non-smokers in sugarcane harvesters in rural Maharashtra. Walawalkar Int Med J 2014;1:33-8.

41. Tantisuwat A, Thaveeratitham P. Effects of smoking on chest

expansion, lung function, and respiratory muscle strength of youths. J Phys Ther Sci 2014;26:167-70.

42. Peat JK, Woolcock AJ, Cullen K. Decline of lung function and development of chronic airflow limitation: A longitudinal study of non-smokers and smokers in Busselton, Western Australia. Thorax 1990;45:32-37.

43. Tager IB, Munoz A, Rosner B, Weiss ST, Carey V, Speizer FE. Effect of cigarette smoking on the pulmonary function of children and adolescents. Am Rev Respir Dis 1985;131:752-9.

44. Jawed S, Ejaz S, Rehman R. Influence of smoking on lung functions in young adults. J Pak Med Assoc 2012;62:772-5.

45. Burchfiel CM, Marcus EB, Curb JD, Maclean CJ, Vollmer WM, Johnson LR, *et al*. Effects of smoking and smoking cessation on longitudinal decline in pulmonary function. Am J Respir Crit Care Med 1995;151:1778-85.

46. Urrutia I, Capelastegui A, Quintana JM, Muniozguren N. Smoking habit, respiratory symptoms and lung function in young adults. Eur J Public Health 2005;15:160-5.

47. Zamel N, Altose MD, Speir WA. Statement on spirometry: A report of the section of respiratory pathophysiology of the American College of Chest Physicians. J Asthma 1983;20:307-311.

48. Walter S, Nancy NR, Collier CR. Changes in the force expiratory spirogram in young male smokers. Am Rev Respir Dis 1979;119:717-24.

49. Rehan VK, Asotra K, Torday JS. The effects of smoking on the developing lung: Insights from a biologic model for lung development, homeostasis, and repair. Lung 2009;187:281-9.

50. Hogg JC, Paré PD, Hackett TL. The contribution of small airway obstruction to the pathogenesis of chronic obstructive pulmonary disease. Physiol Rev 2017;97:529-52.

51. Hymowitz N. Cigarette smoking and lung cancer: Pediatric roots. Lung Cancer Int 2012;2012:790841.

52. Ambrose JA, Barua RS. The pathophysiology of cigarette smoking and cardiovascular disease: An update. J Am Coll Cardiol 2004;43:1731-7.

53. Menicagli R, Marotta O, Serra R. Free radical production in the smoking of E-cigarettes and their possible effects in human health. Int J Prev Med 2020;11:53-8.

54. Neder JA, Andreoni S, Lerario MC, Nery LE. Reference values for lung function tests. II. Maximal respiratory pressures and voluntary ventilation. Braz J Med Biol Res 1999;32:719-27.

55. Dockery DW, Speizer FE, Ferris BG Jr, Ware JH, Louis TA, Spiro A. Cumulative and reversible effects of lifetime smoking on simple tests of lung function in adults. Am Rev Respir Dis 1988;137:286-92.

56. Xu X, Dockery DW, Ware JH, Speizer FE, Ferris BG Jr. Effects of cigarette smoking on rate of loss of pulmonary function in adults: A longitudinal assessment. Am Rev Respir Dis 1992;146:1345-8.