


# Self-Reported Smoking Status 10-Months After a Single Session Intervention Including an Education Conference About Smoking Harms and Announcement of Spirometric Lung-Age

Clinical Medicine Insights: Circulatory, Respiratory and Pulmonary Medicine  
Volume 15: 1–11  
© The Author(s) 2021  
Article reuse guidelines:  
sagepub.com/journals-permissions  
DOI: 10.1177/11795484211047041



Khansa Derbel<sup>1</sup>, Chiraz Maatoug<sup>2</sup>, Amira Mchita<sup>2</sup>,  
Khaoula Hadj Mabrouk<sup>2</sup> and Helmi Ben Saad<sup>1,2,3,4</sup> 

<sup>1</sup>Laboratory of Physiology and Functional Explorations, Farhat HACHED Hospital, Sousse, Tunisia.

<sup>2</sup>Occupational Medicine Group of Sousse, Sousse, Tunisia. <sup>3</sup>Heart Failure (LR12SP09) Research Laboratory, Farhat HACHED Hospital, Sousse, Tunisia. <sup>4</sup>Université de Sousse. Faculté de Médecine de Sousse. Laboratoire de Physiologie. Sousse, Tunisie.

## ABSTRACT

**BACKGROUND:** Studies investigating the effects of announcing spirometric lung-age (SLA) on the smokers' self-reported smoking status reported conflicting results.

**MAIN OBJECTIVE:** To evaluate the effects of a single session intervention including an education conference about smoking harms and announcement of SLA on the participants' self-reported smoking status.

**METHODOLOGY:** An interventional study was conducted in a cable factory. The intervention included four steps: PowerPoint presentation about raising smoking hazards awareness; general questionnaire; measurement of the anthropometric and spirometric data, and announcement of SLA; and evaluation of the smokers' self-reported smoking status 10 months later (quitted smoking, decreased consumption; stable consumption, increased consumption).

**RESULTS:** Thirty-six smokers completed the four steps. Ten months after the intervention, 11.1% of smokers quitted smoking, 52.7% decreased their consumption by  $7 \pm 4$  cigarettes/day, 30.5% kept a stable consumption, and 5.5% increased their consumption by  $9 \pm 6$  cigarettes/day.

**CONCLUSION:** Providing an education conference combined with announcing SLA motivated 64% of smokers to quit smoking or to reduce their cigarette consumption.

**KEYWORDS:** Nicotine Dependence, Occupational Medicine, Respiratory Function, Smoking Cessation, Tobacco Smoking

**RECEIVED:** February 16, 2021. **REVISED:** August 7, 2021. **ACCEPTED:** August 31, 2021

**TYPE:** Original Research Article

**FUNDING:** The author(s) received no financial support for the research, authorship, and/or publication of this article.

**CORRESPONDING AUTHOR:** Helmi Ben Saad, Faculty of Medicine of Sousse. Street Mohamed KAROUI. Sousse. Tunisia. Email: helmi.bensaad@rns.tn

## Introduction

In 2015, around a quarter (24.9%) of the global population aged 15 years, were current-users of some form of tobacco.<sup>1</sup> The costs of smoking have been estimated to drain around US\$ 1.4 trillion dollars from the global economy in a single year.<sup>2</sup> Compared to non-smokers, smokers are 10 times more likely to develop chronic lung cancer and chronic obstructive pulmonary disease (COPD), and three times more likely to die due to ischemic heart disease before the age of 65.<sup>3</sup> Therefore, reducing tobacco-use is not only a global health urgency, but also an economic, sustainable development and human rights issue.<sup>1</sup> Smoking prevention and/or cessation are the most effective ways to fight against the increasing epidemic of cigarette smoking.<sup>4</sup> Smoking cessation reverses the aforementioned risks such that a smoker who ceases smoking by the age of 50 has a one-half reduced risk of dying in the next 15 years as compared to a continuing smoker.<sup>3</sup> Among the means usually applied to help smokers quit smoking, are medical

interventions (*eg*, nicotine replacement therapy, pharmacotherapy, counseling), as well as non-medical interventions (*eg*, hypnosis, acupuncture, yoga, homeopathy).<sup>5,6</sup> Compared to “no intervention”, several interventions (*eg*, brief-advice, brief-advice plus self-help material, brief-advice plus self-help material plus nicotine replacement therapy plus specialist clinic, less repeated counselling [RC] and bupropion, and RC and bupropion) result in lower costs, and lead to a reduction in the number of smokers, fewer comorbidities and more quality-adjusted life year.<sup>7</sup> However, the effectivenesses and the costs vary largely from non-medical to medical interventions (respectively, 3% and £11 for the brief-advice, and 31% and £430 for the RC and bupropion).<sup>7</sup> Communicating the chronic risk of smoking on lungs by calculating a theoretical “effective age” could be another non-medical motivational strategy to help smokers quit smoking.<sup>8,9</sup> This intervention consists in announcing accelerated lung deterioration through the estimation of a spirometric lung-age (SLA).<sup>9</sup> The concept



Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (<https://creativecommons.org/licenses/by-nc/4.0/>) which permits non-commercial use, reproduction and distribution of the work without

further permission provided the original work is attributed as specified on the SAGE and Open Access page (<https://us.sagepub.com/en-us/nam/open-access-at-sage>).

of SLA reports spirometric data using the age of an average healthy individual with similar spirometry results (*ie*; “you are 40 years old, nevertheless you have the lungs of a 60-year-old person”).<sup>9,10</sup> An elevated SLA signifies poor lung function as if the lungs have aged beyond the individual’s chronological-age.<sup>11</sup> SLA can provide an easy interpretation of spirometric results and can therefore detect lung function abnormalities.<sup>12</sup> Confronting smokers with their SLA has been used by general practitioners and primary care providers as a tool to encourage them to quit smoking.<sup>13,14</sup>

Interventional studies using SLA as a motivational tool for smoking cessation are scarce, especially in Africa and the underdeveloped countries. To the finest of the authors’ knowledge, only 10 original papers had investigated the effects of confronting smokers with SLA on their smoking attitudes.<sup>10,11,14–21</sup> The aforementioned studies reported conflicting results. While some authors reported that communicating SLA prompts smoking cessation,<sup>11,14–17,21</sup> others highlighted its ineffectiveness.<sup>10,18–20</sup> For example, while Parkes et al.<sup>16</sup> concluded that “telling smokers their SLA promoted successful smoking cessation”, Foulds et al.<sup>18</sup> reported that “baseline SLA feedback did not improve quit rates or compliance at 28-day follow-up in smokers seeking intensive treatment”. These discrepancies could have at least three explanations. On the one hand, some studies<sup>10,14–16,19,20</sup> have applied old SLA norms established more than 35 years ago by Morris and Temple.<sup>22</sup> The use of these old norms to calculate SLA<sup>22</sup> is widely questionable for at least six reasons.<sup>9,23,24</sup> First, the Morris and Temple norms<sup>22</sup> were performed on an unrepresentative sample of a “normal” population with 79% of participants recruited from two churches in rural America. The principles of these churches prohibit the use of tobacco, alcohol and caffeine and promote a vegetarian diet.<sup>9</sup> Second, Morris and Temple used historical data established 50 years ago,<sup>22</sup> and the age distribution of their participants was biased towards younger ages (30% of participants were between 20 and 30 years old).<sup>22</sup> Third, the participants’ height was measured in “inches”, and the conversion from inch to centimeter, as done in some studies,<sup>10,14–16,19</sup> can generate errors.<sup>9,23</sup> Fourth, the spirometric data were collected with a very old equipment and by applying

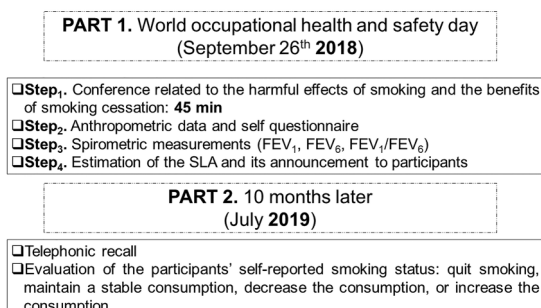
guidelines that differ from those currently recommended by learned societies.<sup>25</sup> Fifth, the statistical method applied to establish the SLA norms is criticized.<sup>9</sup> Indeed, Morris and Temple<sup>22</sup> applied a circular argument and estimated the SLA from the regression equations predicting the spirometric reference values. In summary, using the norms published by Morris and Temple<sup>22</sup> would be a source of over/underestimation of SLA.<sup>9,23</sup> Sixth, till December 2020, at least five additional SLA norms have emerged worldwide (Japan, USA, Australia; North-Africa),<sup>26–30</sup> and some of them<sup>26–29</sup> did not reliably predict chronological-age data in the North-African population.<sup>24</sup> On the other hand, the effects of announcing SLA to smokers may be influenced by multiple factors, including the differences in racial backgrounds and cultural practices, smoking cessation programs, participants’ characteristics (especially age, socioeconomic-level), and so on.<sup>15,17,21,31</sup> Finally, various types of interventions were implemented: announcing SLA only,<sup>11,14–16</sup> announcing SLA associated with other means, such as pharmacotherapy, or RC.<sup>10,17–19–21</sup> Interventions and anti-smoking campaigns aiming at encouraging cessation often debate the damaging health effects of smoking.<sup>32</sup> Nevertheless, numerous participants are unlikely to become interested in quitting without a convincing proof that smoking is damaging their health.<sup>19</sup> To the best of the authors’ knowledge, no previous African study has assessed the self-reported smoking status of factory employees following a single intervention consisting in announcing SLA combined with an education session about the harmful effects of smoking.

In Tunisia, the 2018 “current tobacco-use” rates among people aged <sup>3</sup> 15 years was 25.6%.<sup>1</sup> The direct and indirect economic cost of smoking (*ie*; costs related to healthcare expenditures and to lost productivity due to early mortality and morbidity, respectively) amounts to 1274 million Tunisian dinar.<sup>33</sup> Taking into account all the above considerations, and since the privileged place of occupational physicians in smoking prevention has been documented by many authors,<sup>34,35</sup> the main aim of this interventional study was to evaluate the combined effects of announcing SLA and providing an education session about the smoking harms on the self-reported smoking status of factory employees smokers. The second aim was to determine the profile of participants who quit smoking or decreased their consumption.

## Population and methods

### Study design

This interventional study was conducted in DRÄXLMAIER group in Sousse, Tunisia. The latter is a factory specialized in coating and assembling interior parts of automobiles (n = 587 employees). All the study procedures were in accordance with the Helsinki Declaration. All the employees were invited to an intervention program to raise awareness with respect to the smoking hazards. Approval for the study was obtained



**Figure 1.** Study protocol. FEV<sub>1</sub>: forced expiratory volume in one second. FEV<sub>6</sub>: forced expiratory volume in six seconds. SLA: spirometric lung-age.

from the Farhat HACHED Hospital Ethical Committee (approval number 12092018). Oral consent was obtained from all the participants in the presence of at least one witness. The participants were individually informed about the study proposes, about their right to refuse to participate and/or to withdraw from participating in the study, and they were informed that their data are confidentially protected.

### Sample size

The sample size was estimated using this formula<sup>36</sup>:  $N = [(Z_{\alpha/2})^2 \times P \times (1 - P) \times D] / E^2$ ; where «*E*» was the margin of error, « $Z_{\alpha/2}$ » was the normal deviate for two-tailed alternative hypothesis at a level of significance, «*D*» was the design (= 1 for simple random sampling), and «*P*» was the proportion of the main event of interest (*ie*; percentage of participants who quit smoking). According to a previous local study, one year after informing participants ( $n = 35$ ) about their SLA, eight of them quit smoking ( $p = 0.2285$ ).<sup>15</sup> Assuming a confidence interval of 85% ( $Z_{\alpha/2} = 1.44$ ) and an «*E*» of 0.10, the total sample size was 37 participants. The assumption of 30% for non-response during the 10-month telephonic call gave a revised sample of 52 participants [ $52 = 37 / (1.0 - 0.30)$ ].

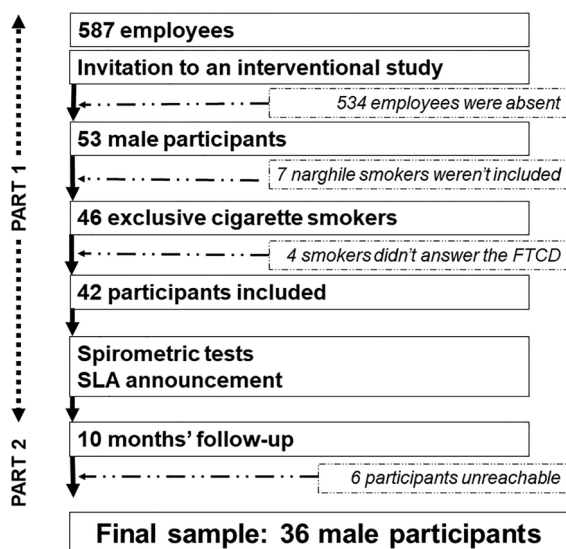
### Population

The target population was the employees who were working the day of the intervention and who volunteered to undergo the study. Only current male exclusive cigarette-smokers were included. In order to assess the “stage of change”, the participants were asked whether they intend to quit smoking in the next year.<sup>37</sup> The integrative model of change introduced by Prochaska and Diclemente, which includes six “stages of

change” (*ie*; pre-contemplation, contemplation, preparation, action, maintenance, and relapse) was used.<sup>37</sup> Only participants in the pre-contemplative stage (answering “no” when asked whether they intend to quit smoking in the next year) were included.<sup>37</sup> The following non-inclusion criteria were applied: narghile smoking,<sup>38</sup> failing to fill the questionnaire or to correctly perform the spirometric test. Participants who did not respond to phone calls (*ie*; at least five times during a week) ten months post-intervention were excluded from the analysis.

### Protocol

The protocol comprised two parts (**Figure 1**). The first part, which coincided with the world occupational health and safety day (September 26<sup>th</sup> 2018), includes four steps. The first step involved an education session. It was a PowerPoint conference lasting 45 min, presented by the project leader (*HBS* in the authors’ list). The conference, presented mainly in Arabic language, addressed the following points: cigarette components, harmful effects of smoking on the different organs, some statistics about smoking-related diseases (mainly COPD and lung cancer), tobacco-induced disabilities and deaths, hospital costs, and benefits of smoking cessation, especially the ones related to the cardiorespiratory system. During the second step, anthropometric data were determined, and the participants completed a self-questionnaire related to their demographic data, smoking habits and physical dependence on nicotine. Chronological-age was determined by collecting the smokers’ date of birth. Height (cm) and weight (kg) were measured, and body mass index (BMI,  $\text{kg}/\text{m}^2$ ) and body surface area ( $\text{m}^2$ ) were calculated. Smoking data (*ie*; number of cigarettes per day [cig/day], number of years of smoking) were collected and cigarette consumption was calculated in pack-years [ $\text{PY} = (\text{cig}/\text{day} \times \text{years of smoking}) / 20$ ]. A validated Arabic version of the Fagerström test for cigarette dependence (FTCD) was used for measuring physical dependence on nicotine.<sup>39</sup> The FTCD is composed of six questions, and according to the answers given, a score of 0 to 10 was obtained. Dependence was considered null if the score was 0 to 2, low if it was 3 or 4, average if it was 5 to 6 and strong if the score was 7 to 10.<sup>39</sup> The third step was reserved for the spirometric tests, which were supervised by a qualified technician (*CM* in the authors’ list). A NEO<sup>®</sup>-6 spirometer [model 4000, Vitalograph, Ennis, Ireland] was used to determine spirometric data [*ie*; forced expiratory volumes in one second ( $\text{FEV}_1$ ) and in six seconds ( $\text{FEV}_6$ ),  $\text{FEV}_1/\text{FEV}_6$ ]. The NEO<sup>®</sup>-6 spirometer was validated and used for the assessment of spirometric data, screening for COPD, and helping smokers quit smoking.<sup>40,41</sup> At least three tests were performed. The one presenting the highest sum “ $\text{FEV}_1 + \text{FEV}_6$ ” was retained for statistical analysis.<sup>15</sup> No information was given to participants with regard to their spirometric data. The last step consisted in calculating SLA, using the following sex specific North African equation<sup>30</sup>:



**Figure 2.** Study flow chart. FTCD: Fagerström test for cigarette dependence. SLA: spirometric lung-age.

**Table 1.** Baseline characteristics of the participants.

		Total Sample (n = 36)	Nondependent group (n = 6)	Dependent group (n = 30)	P-value
Chronological-age (years)		34.29 ± 5.80	33.54 ± 4.99	34.45 ± 6.02	0.730
Spirometric lung-age (years)		38.84 ± 11.35	35.21 ± 14.27	39.56 ± 10.82	0.390
'Change in age' (years)		-4.54 ± 11.89*	-1.68 ± 14.40	-5.11 ± 11.52*	0.520
Height (cm)		174 ± 7	174 ± 8	174 ± 7	0.960
Weight (kg)		76 ± 14	85 ± 17	74 ± 13	0.080
Body mass index (kg/m <sup>2</sup> )		25.0 ± 4.2	28.2 ± 5.8	24.4 ± 3.6	0.043
Fagerstrom score		5.3 ± 1.8	2.7 ± 0.5	5.8 ± 1.4	0.001
Corpulence status	Underweight	2 (5.6)	0 (0)	2 (6.7)	0.510
	Normal weight	20 (55.6)	5 (83.3)	15 (50)	0.130
	Overweight	14 (38.9)	1 (16.7)	13 (43.3)	0.220
Smoking status	Cigarettes/day	18.8 ± 6.2	12.8 ± 4.0	2.0 ± 5.9	0.008
	Pack-years	14 ± 9	8 ± 6	15 ± 9	0.072

'Change in age': difference between the chronological-age and the spirometric lung-age. P: probability. Quantitative and categorical data were expressed as mean ± SD and number (%), respectively. Applied statistical tests for comparison: Between the chronological-age and the spirometric lung-age for the same group: Wilcoxon test (\*p < 0.05). Of categorical data between the 2 groups: Two-sided Chi-square Of quantitative data between the 2 groups: Student test.

SLA (years) = 42.85 - 20.74 × FEV<sub>1</sub> (l) + 47.41 × body surface area (m<sup>2</sup>) - 0.62 × BMI. The "change in age" (= chronological-age minus SLA, years) was calculated, and a negative value is synonym of accelerated lung aging.<sup>9</sup>

The second part of the intervention, with respect to the outcome measures, was carried out 10 months after the intervention (July 2019). The participants were contacted by phone by a trained interviewer (KD in the authors' list) having no prior contact with them in order to evaluate their self-reported smoking status: quit smoking (yes/no), decrease smoking, maintain stable consumption or increase consumption. In the cases involving a decrease or an increase in cigarette consumption, the change in daily consumption (cig/day) was noted.

### Data management

The corpulence status was identified<sup>42</sup>: underweight (BMI < 18.5 kg/m<sup>2</sup>), normal weight (BMI: 18.5 - 24.9 kg/m<sup>2</sup>), overweight (BMI: 25.0 - 29.9 kg/m<sup>2</sup>), and obesity (BMI ≥ 30.0 kg/m<sup>2</sup>). For the cigarette-dependence status, two groups of participants were identified: nondependent (FTCD score ≤ 2) and dependent (FTCD score ≥ 3). For the spirometry test, three spirometric patterns were possible<sup>43</sup>: "no" bronchial obstruction (FEV<sub>1</sub>/FEV<sub>6</sub> ≥ 0.80), "possible" bronchial obstruction (0.70 ≤ FEV<sub>1</sub>/FEV<sub>6</sub> < 0.80) and "most likely" bronchial obstruction (FEV<sub>1</sub>/FEV<sub>6</sub> < 0.70). According to the SLA values, two scenarios arise. If the SLA matched the chronological-age, the physician (KHM in the authors' list)

informed the participant that the test results were normal and that his lungs seemed to be normal at that time. Yet, the physician informed the participant that the risk of having other smoking-related health problems would remain, and that continuing to smoke would lead to having higher SLA in the future.<sup>17</sup> If the SLA was greater than the chronological-age, the physician announced the SLA to the participant and informed him that his SLA is suggestive of a possible harm due to smoking. The participant was also informed that smoking cessation would slow down the worsening rate of his lung function, bringing it to a physiological age-related decline. However, the smoking-related lung harms would not be restored.<sup>17</sup>

Ten months after the intervention, participants were divided into two groups: participants who quit or decrease smoking; and participants who maintain stable or increase consumption.

### Statistical analysis

Categorical data (*ie*; spirometric pattern, corpulence-, smoking-, dependence- and self-reported smoking- status) were expressed as relative frequency. The Shapiro-Wilk test was used to analyze quantitative data (*ie*; chronological-age, SLA, "change in age", anthropometric and spirometric data, Fagerstrom score) distributions. The quantitative data were determined to be distributed normally. Therefore, means and standard deviation (SD) were used as summary statistics. Wilcoxon test was used to compare quantitative data in the same group (*eg*; chronological-age vs SLA). Comparisons of

**Table 2.** Spirometric data of the participants.

	Total sample (n = 36)	Nondependent group (n = 6)	Dependent group (n = 30)	P-value	
FEV <sub>1</sub> (l)	3.80 ± 0.66	4.09 ± 0.92	3.74 ± 0.60	0.240	
FEV <sub>6</sub> (l)	4.37 ± 0.69	4.61 ± 1.11	4.33 ± 0.59	0.360	
FEV <sub>1</sub> /FEV <sub>6</sub> (absolute value)	0.85 ± 0.06	0.89 ± 0.04	0.85 ± 0.06	0.080	
Spirometric pattern	No bronchial obstruction: FEV <sub>1</sub> /FEV <sub>6</sub> ≥ 0.80	28 (77.8)	6 (100)	22 (73.3)	0.150
	Possible bronchial obstruction: 0.70 ≤ FEV <sub>1</sub> /FEV <sub>6</sub> < 0.80	8 (22.2)	0 (0)	8 (26.7)	0.150

FEV<sub>1</sub>: forced expiratory volume in one second. FEV<sub>6</sub>: forced expiratory volume in six seconds. P: probability.

Quantitative and categorical data were expressed as mean ± SD and number (%), respectively.

Applied statistical tests for comparison of:

Categorical data between the 2 groups: Two-sided Chi-square

Quantitative data between the 2 groups: Student test.

quantitative and categorical data between groups (*eg*; dependent vs nondependent groups; quit or decrease smoking vs maintain stable or increase consumption) were performed, respectively, by the Student T-test and the two-sided Chi-square test. Analyses were carried out using the Statistica software (Statistica Kernel version 6; StatSoft, Paris, France). Significance was set at the 0.05 level.

## Results

Fifty-three male participants attended the education session and volunteered to take part in the study. Among these participants, 11 were not included (seven narghile-smokers and four participants did not answer the FTCD). Among the 42 participants who completed the four steps of the intervention protocol, only 36 (86%) answered the phone call 10 months

**Table 3.** Characteristics of the participants 10 months after the intervention (n = 36).

	Quit smoking or decreased consumption (n = 23)	Stable or increased consumption (n = 13)	P-value	
Chronological-age (years)	34.48 ± 5.05	33.96 ± 7.168	0.80	
Spirometric lung-age (years)	42.24 ± 10.95	32.81 ± 9.73	0.010	
'Change in age' (years)	-7.76 ± 10.21	1.15 ± 12.89	0.020	
Height (cm)	175 ± 7	173 ± 6	0.560	
Weight (kg)	79 ± 13	71 ± 14	0.080	
Body mass index (kg/m <sup>2</sup> )	25.8 ± 3.9	23.5 ± 4.6	0.120	
Fagerstrom score	5.22 ± 1.73	5.46 ± 1.94	0.690	
Smoking status	Cigarettes/day	18.4 ± 5.5	19.4 ± 7.6	0.660
	Pack-years	13 ± 7	16 ± 11	0.340
FEV <sub>1</sub> (l)	3.69 ± 0.69	3.98 ± 0.59	0.210	
FEV <sub>6</sub> (l)	4.28 ± 0.71	4.53 ± 0.65	0.300	
FEV <sub>1</sub> /FEV <sub>6</sub> (absolute value)	0.86 ± 0.06	0.84 ± 0.05	0.350	
Dependence status (Yes)	19 (82.6)	11 (84.6)	0.870	
Possible bronchial obstruction (0.70 ≤ FEV <sub>1</sub> /FEV <sub>6</sub> < 0.80)	4 (17.4)	4 (30.8)	0.350	

'Change in age': difference between the chronological-age and the spirometric lung-age. FEV<sub>1</sub>: forced expiratory volume in one second. FEV<sub>6</sub>: forced expiratory volume in six seconds. P: probability. Quantitative and categorical data were expressed as mean ± SD and number (%), respectively.

Applied statistical tests for comparison of:

Categorical data between the 2 groups: Two-sided Chi-square

Quantitative data between the 2 groups: Student test.

later. The six remaining participants were contacted at least five times during a week, but they could not be reached. Therefore, they were excluded from the analysis (**Figure 2**).

Table 1 presents the baseline characteristics of the participants. Thirty (83.33%) and six (16.67%) participants were, respectively, nicotine-dependent and nicotine-nondependent. The dependent and nondependent groups had similar chronological-age and SLA values. Compared to the nondependent group, the dependent one had lower BMI and higher daily cigarettes consumption. The SLAs of the total sample and the dependent group were higher than their chronological-ages by 4.54 ( $p=0.01$ ) and 5.11 ( $p=0.044$ ) years, respectively.

Table 2 presents the participants' spirometric data. All participants had a  $FEV_1/FEV_6$   $\geq 0.70$ . The dependent and nondependent groups had similar spirometric data and included similar percentages of participants with "no" or "possible" bronchial obstruction.

Ten months after the intervention, four (11.1%) and 33 (88.9%) participants reported that they quit smoking and did not quit smoking, respectively. Among the 33 participants who did not quit smoking, 19 (52.7%) decreased their consumption, 11 (30.5%) maintained stable their consumption, and two (5.5%) increased their consumption. In the groups who decreased and increased their consumption, the mean  $\pm$  SD of cig/day were  $7 \pm 4$  and  $9 \pm 6$ , respectively.

Compared to the group who maintain stable or increase its consumption, the group who quit smoking or decrease its consumption had significantly higher SLA by  $\approx 10$  years ( $p=0.010$ ) and higher "change in age" by  $\approx 8$  years ( $p=0.020$ ) (Table 3).

## Discussion

The announcement of SLA combined with an education session about smoking harms had motivated 23 (64%) participants to improve their self-reported smoking status: four participants (11%) quitted smoking and 19 (53%) decreased their consumption by  $7 \pm 4$  cig/day. The profile of participants who quit smoking or decrease cigarette consumption was characterized by a significantly higher SLA and a significantly worse "change in age".

Ceasing and eliminating smoking requires integrated, multi-faceted strategies addressing both physical dependence and social context.<sup>15</sup> These strategies often include prevention measures (*ie*; helping to prevent non-smokers from starting this habit, which is the most important strategy) involving quitting (*ie*; helping quit and avoid relapse, which is vital for an active and healthy lifestyle), and protection (*ie*; protecting from the harmful effects of smoking and from the tobacco industry marketing influences). For smoking cessation, numerous procedures of evidence-based treatments for tobacco-dependence [brief-advice, short information from health specialists, telephone call quit lines, pharmacotherapy] are available in many

countries.<sup>44</sup> While brief-advice is the method having the best cost/efficiency ratio in public health if it is systematically delivered, middle- and low- income countries appear in the penultimate position in the international ranking with regard to the frequency of advice given to smokers.<sup>45</sup> Among the methods used to help smokers quit smoking, is the announcement of SLA. The concept of SLA was initially established as a psychological instrument to show smokers the apparent aging of their lungs.<sup>16,22</sup> SLA is usually appraised from regression equations for the  $FEV_1$  in healthy non-smokers, and constitutes the age at which the  $FEV_1$  measured in an individual equals the predicted value of  $FEV_1$ , taking into account age, height, sex and ethnicity.<sup>9</sup> More details about the conceptual framework for the use of SLA is developed in the Supplementary file 1.

Studies analyzing the effects of announcing SLA as a motivational tool for smoking cessation are scarce and presented conflicting results.<sup>10,11,14–21</sup> The designs and the main results of the studies announcing SLA only<sup>11,14–16</sup> or associated with other methods (*eg*, pharmacotherapy or RC),<sup>10,17–21</sup> are exposed in Supplementary files 2 (Table 1S) and 3 (Table 2S), respectively.

## Discussion of Results

### *Frequencies of participants who changed their smoking attitudes (tables 1s and 2s)*

Our single intervention had motivated 64% of participants to improve their self-reported smoking status. This confirmed the privileged position of occupational physicians in smoking prevention.<sup>34,35</sup> Results of the studies reporting the effects of announcing SLA (alone or in addition to some other interventions) on participants quit smoking are conflicting.<sup>10,11,14–21</sup> First, studies lacking control-groups reported contradictory results.<sup>14,15,19</sup> On the one hand, one study reported no effect of SLA and respiratory symptoms feedback on the desire to quit, although participants were divided into those having a SLA lower or higher than chronological-age.<sup>19</sup> On the other hand, it appears that 22.9% of participants quit smoking,<sup>15</sup> 61.1% increased their motivation to quit,<sup>14</sup> and 48.6% had the intention to quit in the future.<sup>15</sup> Second, some case-control studies reported inconsistent results.<sup>11,16–18,20,21</sup> While two studies identified a significantly higher percentage of cases who quit smoking compared to controls (13.6 vs 6.4%,<sup>16</sup> 22.1 vs 12.0%,<sup>21</sup> respectively), three other studies noted similar percentages of cases and controls who quit smoking (32 vs 24%;<sup>11</sup> 50.8 vs 52.4%;<sup>18</sup> 59.6 vs 41.9%,<sup>17</sup> respectively). In addition, no significant difference was identified between cases and controls even when participants were divided into those having a normal (18 vs 33%, respectively) or a high (39 vs 17%, respectively) SLA.<sup>11</sup> Third, one study including four groups (usual care, SLA, SLA plus contingency management, contingency management) highlighted similar percentages of participants who quit smoking (4%, 0%, 0%, and 14%, respectively).<sup>10</sup> Fourth,

Segnan et al.<sup>20</sup> reported similar frequencies of biologically verified smoking cessation 12 months after four different interventions [minimal intervention (4.8%), RC (5.5%), RC and use of nicotine gum (7.5%), RC and announcement of SLA (6.5%)].

Our conclusions are intermediate with those reported in the literature.<sup>10,11,14–19</sup> First, our frequency of participants quit smoking (*ie*; 11.1%) is lower than the reported frequencies,<sup>14–16,21</sup> which varied between 22.1<sup>21</sup> and 84.6%.<sup>16</sup> Second, our frequency of participants who did not quit smoking (*ie*; 84.6%) was significantly lower than the one observed in controls (90.4%).<sup>16</sup> Third, in participants who did not quit smoking, the means of daily cigarette consumption reported in our study ( $7 \pm 4$  cig/day) was lower than the ones reported in similar studies (**eg**;  $10.9$ ,<sup>14</sup>  $11.7 \pm 9.7$ <sup>16</sup> and  $14.4 \pm 4.8$ .<sup>15</sup>) Fourth, in one case-control study, the mean  $\pm$  SD daily cigarette decrease in cases was significantly lower than the one observed in controls ( $11.7 \pm 9.7$  vs  $13.7 \pm 10.5$ ).<sup>16</sup>

#### *Profile of participants who quit or decrease cigarette smoking (tables 1s and 2s)*

Investigating the profile of participants who quit or decrease cigarette smoking is rarely tackled in the literature. In our study, among all the evaluated data, only high SLA and high “change in age” appear to influence the smoking cessation (Table 3). Conflicting results have been advanced with regard to the factors influencing smoking cessation after telling participants their SLA (alone or in addition to other interventions).<sup>10,11,14–19</sup> On the one hand, some studies reported similar findings to those identified in our study.<sup>14,19,21</sup> First, Lorenzo et al.<sup>14</sup> reported that the presence of an “abnormal” SLA is related to the increased motivation to quit. Second, Lipkus and Prokhorov<sup>19</sup> identified that cases with  $SLA \geq$  chronological-age increase their perceived comparative risk from baseline to follow-up. On the other hand, some studies reported different findings compared to our study. First, Parkes et al.<sup>16</sup> noted that participants with a high SLA are no more likely to quit. Second, Kaminsky et al.<sup>11</sup> reported no significant association between attempts to quit and the interaction of group assignment and SLA. Third, Ojedokun et al.,<sup>21</sup> reported that within the intervention group, smokers with more advanced SLAs were just as likely to stop smoking as those with SLAs closer to their chronological-age. Fourth, Lipkus and Prokhorov<sup>19</sup> reported that increasing SLA is not related to the desire to quit after partialling baseline desire to quit. They also reported that cases and controls (with  $SLA <$  chronological-age) perceive a comparative risk decrease from baseline to the lab follow-up and that increasing SLA in cases is not correlated with any risk or worry outcome although the cases were divided into those having SLA lower or higher than chronological-age. Fourth, no significant difference in the clinical characteristics (SLA, “change in age”, FEV<sub>1</sub>, FEV<sub>1</sub>/FEV<sub>6</sub>, treatment status) was reported between the quit

smoking and non-quit smoking in cases.<sup>17</sup> Finally, additional factors that influence smoking cessation have been advanced: less nicotine dependence, high socioeconomic-level, high schooling-level, Varenicline/nicotine patch, stage on the wheel of change, and age.<sup>11,15,17,21</sup> For example, Tanihara and Momose<sup>46</sup> have reported that “nicotine dependence level of current smokers was negatively associated with cessation attempts during the previous 12 months”, and Ojedokun et al.<sup>21</sup> have reported that “stage on the wheel of change was a strong predictor of smoking cessation, with smokers in the action stage being much more likely to quit than those in pre-contemplation”.

#### *Mechanism by which our intervention attained its effect remains*

The precise mechanism by which our intervention attained its effect remains uncertain. While spirometric results would offer a perfect educational occasion for smokers to notice their lung health status, this method failed to encourage long-term smoking cessation.<sup>17,47</sup> This may be because the lay public usually fails to comprehend the full connotation of spirometry in the context of long-term health and life span.<sup>17</sup> In contrast, the term “SLA”, predictable from some spirometric data seems to be cooler and more suitable for smokers.<sup>17</sup> Announcing SLA may successfully appeal to smokers as it informs them about the risk of developing lung conditions.<sup>17</sup> Helping smokers to recognize their lung health status would, then, encourage them to quit smoking.<sup>17</sup>

#### *What are the reasons for inconsistent results between-studies?*

Three reasons for inconsistent results are exposed in the “Introduction”. Additional reasons related to the study design (**eg**; target population), type of smoking cessation” intervention, characteristics of participants (**eg**; sex, age), and smoking status (**eg**; mean of cigarette consumption, mean FTCD score, Prochaska and Diclemente “stage of change”) can explain a big part of the results’ divergences observed in similar studies. These factors will be detailed in the following paragraphs.

In our study, only males were included. In other related studies, the percentage of males varied between 35%<sup>11</sup> and 100%.<sup>15</sup> In Tunisia, smoking is a taboo subject for working females who often refuse to participate in interventions of this kind. It appears that there is a sex-related beliefs and attitudes about smoking cessation.<sup>48</sup> A recent study reported that females are ambivalent about quitting smoking or not, and males mention not needing professional support.<sup>48</sup> Moreover, one American study reported that “successful smoking quitters” were more likely to be older and male.<sup>49</sup> In this study, similar to another one,<sup>15</sup> the target population was composed of employees working in a factory. This was different from previous studies, where participants were recruited from those referred to a hospital lab,<sup>11</sup> an outpatient clinic<sup>17</sup> or a general

practitioner's medical office.<sup>14,20,21</sup> Other participants were recruited from colleges<sup>19</sup> or from the community.<sup>10,16,18</sup> It is possible that for participants referred to a medical institution<sup>11,14,17,20,21</sup> due to some breathing problems, finding a "normal SLA" may have reduced anxiety, thus leading to a diminished desire to quit.<sup>11</sup> This might not have been the case for participants included in our study as, by virtue of their consent; they might have been more open to health campaign.<sup>11,16,50</sup> However, this study results should be interpreted vigilantly since it is uncertain whether they can be generalized to community and other employee population. The mean age (in years) of our participants ( $34 \pm 6$ ) was higher than the one of Lipkus and Prokhorov<sup>19</sup> ( $21 \pm 2$ ), closer to the one of Ben Mdella et al.<sup>15</sup> ( $36 \pm 7$ ) or Ojedokun et al.<sup>21</sup> ( $38 \pm 15$ ), and lower than those of other related studies ( $46$ ,<sup>14</sup>  $47 \pm 12$ ,<sup>18</sup>  $52 \pm 11$ ,<sup>17</sup>  $53 \pm 12$ <sup>16</sup>). It appears that with increasing age, many heavy smokers eventually stop smoking.<sup>49</sup> The mean of cigarette consumption (in PY) of our participants ( $14 \pm 9$ ) was closer to the one in other studies ( $16 \pm 7$ ,<sup>19</sup>  $16 \pm 16$ <sup>21</sup>), but lower than the ones in other studies ( $26$ ,<sup>14</sup>  $31 \pm 18$ ,<sup>16</sup>  $39 \pm 25$ <sup>17</sup>). The mean of daily cigarette consumption of our participants ( $18.8 \pm 6.2$ ) was higher than those reported in other related studies ( $13.3$ ,<sup>14</sup>  $16 \pm 6$ ,<sup>15</sup>  $16.5 \pm 9.0$ ,<sup>16</sup>  $17.6 \pm 7.8$ <sup>18</sup>). One study had reported that a higher daily cigarette consumption was associated with lower odds of smoking cessation success.<sup>51</sup> In this study, the mean FTCD score was  $5.3 \pm 1.8$ , and 83.3% of participants were nicotine-dependent. In some related studies,<sup>10,14,18</sup> different values were reported. The mean and the median of FTCD score were  $4.6 \pm 1.9$ <sup>18</sup> and 3.5 (2-4) for the SLA group,<sup>10</sup> respectively. In another study, only 36.4% of participants were nicotine-dependent.<sup>14</sup> According a recent study, having a lower nicotine dependence was among the significant predictors of sustained smoking abstinence.<sup>52</sup> In our study, all participants were at a pre-contemplative stage.<sup>37</sup> This was not the case of the participants included in the study of Ojedokun et al.,<sup>21</sup> where 19.7%, 42.5%, and 38.8% of cases were respectively, at the following stages: pre-contemplation, contemplation and preparation. In this study, an education session about the harmful effects of smoking preceded the announcement of SLA. In some related studies, SLA announcement was associated with different other interventions (*eg*; respiratory symptoms feedback, RC, contingency management, exhaled carbon monoxide [CO], smoking cessation sessions and nicotine patch, Varenicline or nicotine patch and education).<sup>10,17-21</sup> However, a Cochrane review of the use of individual biomarkers (*eg*; CO measurements) revealing the damaging effects of smoking concluded "there is little evidence about the effects of biomedical risk assessment as an aid for smoking cessation".<sup>53</sup> In this study, and similar to others,<sup>10,15-18</sup> the main outcomes were related to the participants' self-reported smoking status and their self-reported amount of daily cigarette consumption. Some additional outcomes were verified in other

related studies (*eg*; quit attempts,<sup>10,11</sup> attending smoking cessation counseling,<sup>15,18</sup> intention to quit in the future,<sup>15,19</sup> smoking cessation motivation,<sup>14</sup> exhaled CO,<sup>18</sup> patch-use,<sup>18</sup> changes in FTCD score,<sup>10</sup> total number of visits attended,<sup>10</sup> interim visits,<sup>10</sup> alteration in self-efficacy,<sup>10</sup> desire to repeat SLA test,<sup>19</sup> Prochaska's wheel of change<sup>21</sup>). In this study, among all the collected spirometric data (FEV<sub>1</sub>, FEV<sub>6</sub>, FEV<sub>1</sub>/FEV<sub>6</sub>, spirometric patterns, and SLA), only SLA was announced to participants. When SLA was in the normal range, participants were told that persistent smoking might lead to health problems.<sup>17</sup> This precaution was considered since Kaminsky et al.<sup>11</sup> suggested that participants with "normal" SLA are less likely to make quit attempts if they are informed of their normal lung function. In other related studies, several approaches were applied: announcing SLA alone,<sup>10,15,17,19</sup> or combined with other data (*eg*; FEV<sub>1</sub>,<sup>11,14,18</sup> forced vital capacity,<sup>14</sup> FEV<sub>1</sub>/forced vital capacity,<sup>14</sup> Fletcher and Peto graphic<sup>11,16</sup>). In this study, participants were given enough time (*ie*; 10 months) to try smoking cessation gradually since that it is possible that SLA feedback may have a "sleepier effect" (*ie*; a psychological impact on longer term smoking cessation).<sup>18</sup> On the one hand, evaluating smoking cessation attempts at only one or three months<sup>11,17,18,21</sup> provided a restricted timeframe for evaluating the effect of the intervention.<sup>11</sup> On the other hand, in some related studies, the follow-up period ranged from instantaneously<sup>19</sup> to some months (one,<sup>11,18,21</sup> three,<sup>17</sup> six,<sup>10,20</sup> nine<sup>14</sup> and 12<sup>15-17,20</sup>).

#### Study strength and limitations

One strong point of this study, as done in another one,<sup>17</sup> was the use of local SLA norms.<sup>28</sup> In two previous studies,<sup>11,18,21</sup> the applied SLA norms were unspecified, and in six studies,<sup>10,14-16,19,20</sup> old norms were applied.<sup>20</sup>

This study presents some limitations. The first is related to the study design (before-after trial in a single group) and the lack of a control-group, which makes data interpretation "uncertain". This situation limits the value of our results and restricts their interpretation to only strong trends. The inclusion of a control-group, as done in some studies,<sup>10,11,16-19</sup> would have provided more solid and objective conclusions. The second limitation concerns the nature of the intervention itself (*ie*; combination of SLA announcement and an education session about the smoking harms). It is possible that results could have been different if the two interventions were presented separately. For example, one previous study<sup>54</sup> compared education alone or education plus a supplementary motivational intervention containing instantaneous comment about the participants' exhaled CO, spirometric results, and pulmonary symptoms. The authors reported that 20 versus 7% of participants remained abstinent 12 months later, respectively.<sup>54</sup> The third limitation is related to the description" quality of our



intervention, and therefore its practical replicability. For that reason, in future similar interventional studies aiming to evaluate the impact of announcing SLA on participants' self-reported smoking status; it is preferable to use the template for intervention description and replication checklist and guide.<sup>55</sup> The latter improves the reporting of interventions and make it easier for authors to structure accounts of their interventions, reviewers and editors to assess the descriptions, and readers to use the information.<sup>55</sup> The fourth limitation is related to the ten-month gap between intervention and completing phone interview. During this relatively "long" period, many other potential confounders could have resulted in the participants quitting/not quitting, smoking more/less. Moreover, a simple telephone call probably lacks precision compared to a visual consultation.<sup>14</sup> For that reason, it have been better if there were monthly phone follow-up and/or education session. The fifth limitation is linked to the lack of a biochemical validation for self-reported smoking cessation rates. In this study, as done in some related ones,<sup>11,14,15,21</sup> the smoking attitudes were assessed via a telephonic call and were based on a self-report of the smoking status. In other related studies, more rigorous biological methods were applied (*eg*; cotinine salivary measurements, exhaled CO, plasma cotinine, salivary cotinine).<sup>10,16–18,20</sup> The interest of biochemical validation versus self-report indices of quitting has been studied hitherto.<sup>56–58</sup> On the one hand, a previous review aiming to assess the usefulness of biomarkers has advocated "that in large-population, low-intensity trials, biochemical verification was neither feasible nor necessary".<sup>58</sup> The same review recommended that "while it is probable that quit rates are overestimated when using self-reports, the extent of inflation is small".<sup>58</sup> On the other hand, a large survey has reported commonly high levels of correctness, specificity and sensitivity for self-report.<sup>59</sup> In brief, self-reporting may be a reasonable practical pointer of smoking status among smokers that attend their physicians for routine visits.<sup>21</sup> The sixth limitation concerns the sample size which was calculated using an 85% confidence interval ( $Z_{\alpha/2} = 1.44$ ). Calculation of the "required" sample size is a vital point since determining the sample best size assurances enough power to differentiate statistical significance.<sup>60</sup> On the one hand, our sample size ( $n = 36$ ) was closer to the samples of some related two studies ( $n = 34$ ,<sup>11</sup>  $n = 35$ <sup>15</sup>). On the other hand, it was lower than the samples of other studies ( $n = 48$ ,<sup>10</sup>  $n = 52$ ,<sup>17</sup>  $n = 56$ ,<sup>19</sup>  $n = 74$ ,<sup>14</sup>  $n = 120$ ,<sup>18</sup>  $n = 140$ ,<sup>21</sup>  $n = 280$ ,<sup>16</sup>  $n = 292$ <sup>20</sup>). It was better to choose a confidence interval of 95% ( $Z_{\alpha/2} = 1.96$ ), and therefore a sample size of 68 smokers. The last limitation is related to the calculation of SLA via a small hand-held mini-electronic spirometer (*ie*; NEO<sup>®</sup>-6 spirometer). On the one hand, possibly another type of spirometry equipment could have been advisable and more reliable to use. However, spirometry will screen smokers for chronic lung conditions, nevertheless it is neither practical nor economical to use in occupational care to encourage

smoking quit.<sup>21</sup> Compared to a spirometer, the Vitalograph device is inexpensive, simply reachable and needs no training for use.<sup>21</sup> On the other hand, our method was previously used by some authors<sup>21</sup> who stated that "compared to a spirometer, the Vitalograph is much cheaper, easily accessible and requires no additional training for use".

To conclude, SLA announcement combined with an education session appears to be a practical tool for promoting smoking cessation since 64% of participants quit smoking or reduced their smoking consumption. The profile of participants who quit smoking was characterized by a significantly higher SLA. Even though evaluating SLA does add four to five minutes to the consultation time, this can convert into clinically operative action, which can be simply integrated into routine first consultation lines.<sup>21</sup> In clinical practice, the authors recommend to perform a spirometry (FEV<sub>1</sub>, FEV<sub>6</sub>) on all smokers and to calculate their SLA in the first consultation lines (*eg*; general practitioners, occupational health consultation, and basic health centers).

### Acknowledgments

Authors wish to express their sincere gratitude to all the employees for their cooperation. Authors wish also to thank Professor *Samir BOUKATTAYA* for his invaluable contribution in the improvement of the quality of the writing in the present paper.

### Note

The abstract of the present paper was presented during the European Respiratory Society International Congress, ERS 2020 (Vienna [Austria]: 5-9 September 2020). First author: Helmi BEN SAAD.

### Finding

This research received no specific grant from any funding agency in the public, commercial, or non-profit sectors. There is no restriction on data sharing.

### Establishment Where the Work was Performed

DRÄXLMAIER group in Sousse, Tunisia.

### Conflicts of Interest

**H Ben Saad** reports personal fees from AstraZeneca, Opalia Recordati and Chiesi. The authors have no other relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript apart from those disclosed.

### Research Ethics Section and Patient Consent

Approval for the study was obtained from the Farhat HACHED Hospital Ethical Committee (approval number 12092018)

## Authors' Contributions

**KD:** Concept/design, Contacting participants by phone, Data analysis/interpretation, Drafting article, Critical revision of article, Approval of article, Statistics

**CM:** Concept/design, Supervision of the spirometric tests, Data analysis/interpretation, Drafting article, Approval of article, Data collection

**AM:** Concept/design, Data analysis/interpretation, Drafting article, Approval of article, Data collection

**KHM:** Concept/design, Announcing SLA for participants, Data analysis/interpretation, Drafting article, Critical revision of article, Approval of article, Statistics

**HBS:** Concept/design, Presenting the education session, Data analysis/interpretation, Drafting article, Critical revision of article, Approval of article, Statistics, Data collection

## Data Availability Statement

Data will be available upon request from the corresponding author (helmi.bensaad@rns.tn)


## Ethical Approval

Approval for the study was obtained from the Farhat HACHED Hospital Ethical Committee (approval number 12092018).

## Informed Consent

Oral consent was obtained from all the participants in the presence of at least one witness.

## ORCID iD

Helmi Ben Saad  <https://orcid.org/0000-0002-7477-2965>

## Trial Registration

Not applicable, as no trial was conducted.

## Supplemental material

Supplemental material for this article is available online.

## REFERENCES

- World Health Organisation. global report on trends in prevalence of tobacco use 2000-2025, 3<sup>rd</sup> edition. Geneva: World Health Organization; 2019. Available from this URL: <https://www.who.int/publications/i/item/who-global-report-on-trends-in-prevalence-of-tobacco-use-2000-2025-third-edition> (last visit: August 7<sup>th</sup> 2021).
- Goodchild M, Nargis N, Tursan d'Espaignet E. Global economic cost of smoking-attributable diseases. *Tob Control*. 2018;27(1):58-64.
- Alberg AJ, Shopland DR, Cummings KM. The 2014 surgeon general's Report: commemorating the 50<sup>th</sup> anniversary of the 1964 report of the advisory committee to the US surgeon general and updating the evidence on the health consequences of cigarette smoking. *Am J Epidemiol*. 2014;179(4):403-412.
- World Health Organisation. report on the global tobacco epidemic, 2019. Offer help to quit tobacco use. Available from this URL: <https://apps.who.int/iris/bitstream/handle/10665/326043/9789241516204-eng.pdf?ua=1> (last visit: August 7<sup>th</sup> 2021).
- Abdul-Kader J, Airagnes G, D'Almeida S, Limosin F, Le Faou AL. Interventions for smoking cessation in 2018. *Rev Pneumol Clin*. 2018;74(3):160-169.
- Henningfield JE, Shiffman S, Ferguson SG, Gritz ER. Tobacco dependence and withdrawal: science base, challenges and opportunities for pharmacotherapy. *Pharmacol Ther*. 2009;123(1):1-16.
- Flack S, Taylor M, Trueman P. Cost-effectiveness of interventions for smoking cessation. Final report 2007. Available from this URL: <https://www.nice.org.uk/guidance/ph5/evidence/economic-modelling-report-pdf-65926189> (last visit: August 7<sup>th</sup> 2021).
- Spiegelhalter D. How old are you, really? Communicating chronic risk through 'effective age' of your body and organs. *BMC Med Inform Decis Mak*. 2016;16:104. doi:10.1186/s12911-016-0342-z
- Khelifa MB, Salem HB, Sfaxi R, Chatti S, Rouatbi S, Saad HB. "Spirometric" lung age reference equations: a narrative review. *Respir Physiol Neurobiol*. 2018;247:31-42. doi:10.1016/j.resp.2017.08.018
- Drummond MB, Astemborski J, Lambert AA, et al. A randomized study of contingency management and spirometric lung age for motivating smoking cessation among injection drug users. *BMC Public Health*. 2014;14(761). doi:10.1186/1471-2458-14-761
- Kaminsky DA, Marcy T, Dorwaldt A, et al. Motivating smokers in the hospital pulmonary function laboratory to quit smoking by use of the lung age concept. *Nicotine Tob Res*. 2011;13(11):1161-1166.
- Toda R, Hoshino T, Kawayama T, et al. Validation of "lung age" measured by spirometry and handy electronic FEV<sub>1</sub>/FEV<sub>6</sub> meter in pulmonary diseases. *Intern Med*. 2009;48(7):513-521.
- Parker DR, Eltinge S, Rafferty C, Eaton CB, Clarke JG, Goldman RE. Primary care providers' views on using lung age as an aid to smoking cessation counseling for patients with chronic obstructive pulmonary disease. *Lung*. 2015;193(3):321-327.
- Lorenzo A, Noel F, Lorenzo M, Van Den Broucke J. The role of spirometry in encouraging smoking cessation in general practice. A pilot study using "lung age". *Rev Mal Respir*. 2017;34(7):734-741.
- Ben Mdalla S, Ben Saad H, Ben Mansour N, et al. The announcement of the lung age it is a motivation to quit smoking? *Tunis Med*. 2013;91(8-9):521-526.
- Parkes G, Greenhalgh T, Griffin M, Dent R. Effect on smoking quit rate of telling patients their lung age: the StepQuit randomised controlled trial. *BMJ*. 2008;336(7644):598-600.
- Takagi H, Morio Y, Ishiwata T, et al. Effect of telling patients their "spirometric-lung-age" on smoking cessation in Japanese smokers. *J Thorac Dis*. 2017;9(12):5052-5060.
- Foulds J, Veldheer S, Hrabovsky S, et al. The effect of motivational lung age feedback on short-term quit rates in smokers seeking intensive group treatment: a randomized controlled pilot study. *Drug Alcohol Depend*. 2015;153:271-277. doi:10.1016/j.drugalcdep.2015.05.007
- Lipkus IM, Prokhorov AV. The effects of providing lung age and respiratory symptoms feedback on community college smokers' perceived smoking-related health risks, worries and desire to quit. *Addict Behav*. 2007;32(3):516-532.
- Segnan N, Ponti A, Battista RN, et al. A randomized trial of smoking cessation interventions in general-practice in Italy. *Cancer Causes & Control*. 1991;2(4):239-246.
- Ojedokun J, Keane S, O'Connor K. Lung age bio-feedback using a portable lung age meter with brief advice during routine consultations promote smoking cessation- Know2quit multicenter randomized control trial. *J Gen Pract*. 2013;1(123) doi: 10.4172/2329-9126.1000123.
- Morris JF, Temple W. Spirometric "lung age" estimation for motivating smoking cessation. *Prev Med*. 1985;14(5):655-662.
- Ben Khelifa M, Ben Saad H. Which reference equation should be applied to estimate the lung age? *Rev Mal Respir*. 2018;35(9):997-998.
- Ben Saad H, Elhraiech A, Hadj Mabrouk K, et al. Estimated lung age in healthy north african adults cannot be predicted using reference equations derived from other populations. *Egypt J Chest Dis Tuberc*. 2013;62(4):789-804.
- Miller MR, Hankinson J, Brusasco V, et al. Standardisation of spirometry. *Eur Respir J*. 2005;26(2):319-338.
- Yamaguchi K, Omori H, Onoue A, et al. Novel regression equations predicting lung age from varied spirometric parameters. *Respir Physiol Neurobiol*. 2012;183(2):108-114.
- Ishida Y, Ichikawa YE, Fukakusa M, Kawatsu A, Masuda K. Novel equations better predict lung age: a retrospective analysis using two cohorts of participants with medical check-up examinations in Japan. *NPJ Prim Care Respir Med*. 2015;25:15011. doi:10.1038/nppjcr.2015.11
- Hansen JE, Sun XG, Wasserman K. Calculating gambling odds and lung ages for smokers. *Eur Respir J*. 2010;35(4):776-780.
- Newbury W, Lorimer M, Crockett A. Newer equations better predict lung age in smokers: a retrospective analysis using a cohort of randomly selected participants. *Prim Care Respir J*. 2012;21(1):78-84.
- Saad H B, Selmi H, Hadj Mabrouk K, et al. Spirometric "lung Age" estimation for north african population. *Egypt J Chest Dis Tuberc*. 2014; 63(2):491-503.
- Herzog TA, Pokhrel P. Ethnic differences in smoking rate, nicotine dependence, and cessation-related variables among adult smokers in hawaii. *J Community Health*. 2012;37(6):1226-1233.

32. Beaudoin CE. Exploring antismoking ads: appeals, themes, and consequences. *J Health Commun.* 2002;7(2):123–137.
33. The tobacco atlas (6<sup>th</sup> edition). Tunisia. Available from this URL: <https://files.tobaccoatlas.org/wp-content/uploads/pdf/tunisia-country-facts-en.pdf> (last visit: August 7<sup>th</sup> 2021).
34. Dell'Omo M, Baccolo TP, Marcolina D, Roscelli F, Muzi G, Murgia N. Smoking in the workplace: role of occupational physicians. *G Ital Med Lav Ergon.* 2010 Apr-Jun;32(2):174–181.
35. Lang T, Nicaud V, Slama K, et al. Smoking cessation at the workplace. Results of a randomised controlled intervention study. Worksite physicians from the AIREL group. *J Epidemiol Community Health.* 2000 May;54(5):349–354.
36. Whitley E, Ball J. Statistics review 4: sample size calculations. *Crit Care.* 2002;6(4):335–341.
37. Prochaska JO, DiClemente CC. Stages and processes of self-change of smoking: toward an integrative model of change. *J Consult Clin Psychol.* 1983;51(3):390–395.
38. Ben Saad H, Khemiss M, Bougmiza I, et al. Spirometric profile of narghile smokers. *Rev Mal Respir.* 2009;26(3):299–314.
39. Kassim S, Salam M, Croucher R. Validity and reliability of the fagerstrom test for cigarette dependence in a sample of arabic speaking UK-resident Yemeni khat chewers. *Asian Pac J Cancer Prev.* 2012;13(4):1285–1288.
40. Frith P, Crockett A, Beilby J, et al. Simplified COPD screening: validation of the PiKo-6(R) in primary care. *Prim Care Respir J.* 2011;20(2):190–198.
41. JounEAU S, Pinault M, Gouyet T, et al. AIRBAg study: preliminary results after one year of screening for COPD in dairy farmers. *Rev Mal Respir.* 2015;32(3):240–248.
42. Tsai AG, Wadden TA. In the clinic: obesity. *Ann Intern Med.* 2013;159(5):ITC3–1–ITC3–15.
43. Wang S, Gong W, Tian Y, Zhou J. FEV<sub>1</sub>/FEV<sub>6</sub> in primary care is a reliable and easy method for the diagnosis of COPD. *Respir Care.* 2016;61(3):349–353.
44. Fiore MC, Baker TB. Clinical practice. Treating smokers in the health care setting. *N Engl J Med.* 2011;365(13):1222–1231.
45. Stead LF, Buitrago D, Preciado N, Sanchez G, Hartmann-Boyce J, Lancaster T. Physician advice for smoking cessation. *Cochrane Database Syst Rev.* 2013;2013(5):CD000165.
46. Tanihara S, Momose Y. Reasons for smoking cessation attempts among Japanese male smokers vary by nicotine dependence level: a cross-sectional study after the 2010 tobacco tax increase. *BMJ open.* 2015;5(3):e006658.
47. Bize R, Burnand B, Mueller Y, Cornuz J. Effectiveness of biomedical risk assessment as an aid for smoking cessation: a systematic review. *Tob Control.* 2007;16(3):151–156.
48. Rodríguez-Bolaños R, Caballero M, Ponciano-Rodríguez G, et al. Gender-related beliefs and attitudes about tobacco use and smoking cessation in Mexico. *Health Psychol Behav Med.* 2021;9(1):547–566.
49. Lindsay HG, Wamboldt FS, Holm KE, et al. Impact of a medical diagnosis on decision to stop smoking and successful smoking cessation. *Chronic Obstr Pulm Dis.* 2021;8(3):360–370.
50. Kotz D, Wesseling G, Aveyard P, van Schayck OC. Smoking cessation and development of respiratory health in smokers screened with normal spirometry. *Respir Med.* 2011;105(2):243–249.
51. Garnett C, Shahab L, Raupach T, West R, Brown J. Understanding the association between spontaneous quit attempts and improved smoking cessation success rates: a population survey in England with 6-month follow-up. *Nicotine Tob Res.* 2020;22(9):1460–1467.
52. Hsueh KC, Tang PL, McRobbie H. Effectiveness of varenicline versus combination nicotine replacement therapy for smoking cessation: one-year outcomes in a smoking cessation clinic in Taiwan. *Nicotine Tob Res.* 2021;23(7):1094–1102.
53. Clair C, Mueller Y, Livingstone-Banks J, et al. Biomedical risk assessment as an aid for smoking cessation. *Cochrane Database Syst Rev.* 2019;3(3):CD004705.
54. Risser NL, Belcher DW. Adding spirometry, carbon monoxide, and pulmonary symptom results to smoking cessation counseling: a randomized trial. *J Gen Intern Med.* 1990;5(1):16–22.
55. Hoffmann TC, Glasziou PP, Boutron I, et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *BMJ.* 2014;348:g1687. doi:10.1136/bmj.g1687
56. Velicer WF, Prochaska JO, Rossi JS, Snow MG. Assessing outcome in smoking cessation studies. *Psychol Bull.* 1992 Jan;111(1):23–41.
57. Connor Gorber S, Schofield-Hurwitz S, Hardt J, Levasseur G, Tremblay M. The accuracy of self-reported smoking: a systematic review of the relationship between self-reported and cotinine-assessed smoking status. *Nicotine Tob Res.* 2009 Jan;11(1):12–24.
58. SRNT Subcommittee on Biochemical Verification. Biochemical verification of tobacco use and cessation. *Nicotine Tob Res.* 2002 May;4(2):149–159.
59. Yeager DS, Krosnick JA. The validity of self-reported nicotine product use in the 2001–2008 national health and nutrition examination survey. *Med Care.* 2010 Dec;48(12):1128–1132.
60. Serhier Z, Bendahhou K, Ben Abdelaziz A, Bennani MO. Methodological sheet n degrees 1: how to calculate the size of a sample for an observational study? *Tunis Med.* 2020;98(1):1–7.

#### List of Abbreviations

BMI	body mass index
cig/day	cigarettes per day
CO	carbon monoxide
COPD	chronic obstructive pulmonary disease
FEV <sub>1</sub>	forced expiratory volume in one second
FEV <sub>6</sub>	forced expiratory volume in six seconds
FTCD	Fagerström test for cigarette dependence
PY	pack-years
RC	repeated counselling
SD	standard deviation
SLA	spirometric lung-age