

## Respiratory consequences of light and moderate smoking in young adults in Chile

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### SUMMARY

**OBJECTIVE:** To assess the association between smoking and respiratory symptoms, lung function and bronchial hyperresponsiveness (BHR) in young adults in Chile.

**SETTING:** Selected sample of 1232 subjects aged 22–28 years.

**DESIGN:** In this cross-sectional study, the outcome measures were: respiratory symptoms, forced expiratory volume in one second (FEV<sub>1</sub>), forced vital capacity (FVC), forced expiratory flow between 25% and 75% (FEF<sub>25-75</sub>), FEV<sub>1</sub>/FVC and BHR.

**RESULTS:** Among the 1232 subjects, 67.7% of the men and 49.4% of the women were smokers; the median cigarettes smoked per day was four for men and three for women. Smoking was associated with wheezing, waking up with a cough, breathlessness following exercise and

persistent cough, with odds ratios (OR) between 1.94 (95% CI 1.41–2.66) and 3.12 (95% CI 2.21–4.40) among those smoking  $\geq 5$  cigarettes per day, compared to non-smokers. Smoking  $< 5$  cigarettes was significantly associated with wheezing and waking up with a cough. Smokers had a lower FEV<sub>1</sub>/FVC than non-smokers by approximately 0.8%. Smoking was not associated with FEV<sub>1</sub>, FEF<sub>25-75</sub> or BHR status.

**CONCLUSIONS:** This study highlights the early effects of smoking on respiratory symptoms. It could help governments in Latin America take vigorous action to deter young people from starting smoking.

**KEY WORDS:** smoking; respiratory symptoms; lung function; Chile; young adults

SMOKING IS HIGHLY PREVALENT in South America. In Chile, 48% of men and 37% of women are smokers, and these percentages increase to 60% and 47%, respectively, in young adults (17–24 years).<sup>1</sup> The mean daily consumption of cigarettes among smokers is 8.1 in men and 6.8 in women.<sup>1</sup> Annual cigarette sales are 1240 per capita.<sup>2</sup> In Argentina and Uruguay, the prevalence of smoking is lower, but the annual mean consumption is slightly higher, at 1495 and 1396, respectively.<sup>2</sup> In England and Spain, the prevalence of smoking in 16–24 year olds is lower, between 38% and 42%, and the per capita annual consumption of tobacco is 1748 cigarettes in England compared to 2779 in Spain.<sup>2-5</sup> Thus, smoking in Chile is common, but the amount smoked is relatively low in comparison to high-income countries. The retail price of cigarettes in Chile is low, at less than US\$1.50 for a 20-cigarette pack, and remains cheap even after considering the parity purchasing power in each country.<sup>6</sup>

Many studies have confirmed an association between smoking and respiratory symptoms, especially wheeze, persistent cough and dyspnoea.<sup>7-15</sup> Smoking reduces forced expiratory volume in one second

(FEV<sub>1</sub>), forced expiratory flow between 25% and 75% (FEF<sub>25-75</sub>), forced vital capacity (FVC) and FEV<sub>1</sub>/FVC.<sup>16-18</sup> This evidence is based on all age groups in the adult population, but those aged  $< 30$  years are usually a minority. The European Community Respiratory Health Survey (ECRHS) includes an age range of 20–44 years;<sup>14,15,19</sup> the only relevant information for those aged  $< 30$  years was that the association between smoking and chronic bronchitis was unaffected by the age of the participants.<sup>20</sup> Information on the consequences of moderate or light smoking in young adults is lacking, and it is inappropriate to extrapolate early effects of smoking on the respiratory tract in those aged  $< 30$  years from publications in older age groups. This type of information would be helpful because those aged  $< 30$  years may find information on early consequences of smoking more relevant than information on its long-term consequences.

The aim of the present study was to assess the association between smoking and respiratory symptoms, lung function and bronchial hyperresponsiveness (BHR) in a study conducted in subjects aged 22–28 years. We were especially interested in exploring the effects of mild and moderate smoking levels.

## STUDY POPULATION AND METHODS

A sample of 1232 subjects (569 men and 673 women) was randomly selected from a sampling frame of 3096 births from 1974 to 1978 in Limache, a semi-rural area with a population of 50 000, 120 km from Santiago. Participants were between 22 and 28 years old at the time of the survey. Approximately 21.6% of those in the original selected sample were replaced, using the same sampling frame, because they had migrated from Limache, refused to participate, were serving a custodial sentence or had a learning disability.

Respiratory symptoms were assessed using the ECRHS questionnaire adapted to the Chilean lexicon.<sup>21</sup> We used the ECRHS questionnaire to explore smoking behaviour. Subjects were considered to be smokers if they had smoked at least one cigarette per day over the last 12 months. We first asked those considered as smokers how many cigarettes they smoked per day. We then asked these subjects whether they had ceased to smoke. We classified participants into four groups: never smoked, ex-smokers, <5 cigarettes a day and  $\geq 5$  cigarettes a day. We also estimated pack/years of cigarettes consumption according to the standard formula: daily cigarettes  $\times$  years smoked/20.

The selected respiratory symptoms in the last 12 months were: wheezing, breathlessness following exercise, persistent cough and waking up at night with a cough. These symptoms were chosen for their high prevalence, their relevance in relation to smoking or their relevance as asthma or chronic bronchitis symptoms.<sup>8,14,15</sup> FEV<sub>1</sub>, FVC and FEF<sub>25-75</sub> measurements followed American Thoracic Society (ATS) guidelines,<sup>22</sup> using the Vitalograph 2120 spirometer (Vitalograph Ltd, Maides Moreton, Bucks, UK) and Spirotrac IV software (Vitalograph Ltd). The best baseline FEV<sub>1</sub> measurement was selected out of five attempts. Those who failed to provide a suitable FEV<sub>1</sub> in the first five attempts were asked to provide three further attempts.

Nine participants were unable to carry out the lung function test after eight attempts and were excluded. FVC was measured through a manoeuvre of forced inspiration followed by forced expiration over 6 seconds, in a standing position and with a nasal clip. Expiratory curves without evidence of a variable effort and absence of cough during the manoeuvre were considered appropriate. Spirometer was calibrated on a daily basis using a Vitalograph calibration 1 l syringe (Vitalograph Ltd).

BHR challenge to metacholine was assessed using the tidal breathing method.<sup>23</sup> Increasing concentrations of 0.5, 1.00, 4.00, 8.00 and 16 mg/ml were used with a Hudson nebuliser (Hudson RCI, Temecula, CA, USA) over a 2-min period. A positive BHR was defined as a decrease of 20% in comparison to baseline best FEV<sub>1</sub> at any concentration up to 16 mg/ml. Participants were advised not to smoke for at least 1 h before the test and not to use asthma relievers or preventives for 6 h beforehand. Participants with a history of epilepsy, current pregnancy, breastfeeding or a FEV<sub>1</sub> <70% of expected level were excluded from this assessment.

The tests and measurements were carried out in a health care setting with easy access to medical facilities. The participants signed a consent form after reading and listening to the aims and the procedures of the study. Three university nurses were trained to administer the questionnaire and to carry out the tests. The Ethics Committee of the Faculty of Medicine, University of Chile, approved the study.

Multiple logistic regression analyses were carried out to assess the association between smoking and respiratory symptoms and BHR in separate analysis. Adjustments were made for height, sex, age, body mass index (BMI), birth weight and level of education. Multiple regression analyses were carried out to assess the relationship between smoking and lung func-

**Table 1** Baseline characteristics of the sample by sex

	Men (n = 559)	Women (n = 673)	P value
Age, median (IQR)	25.0 (24–26)	25.0 (23–26)	0.058
Years of education of participants, median (IQR)	12 (10–13)	12 (9–13)	0.171
Age at starting tobacco habit, median (IQR)	16 (14–18)	17 (14–18)	<0.001
Prevalence of current smoking (%)	67.7	49.4	<0.001
Cigarette consumption/day in current smokers, median (IQR)	4 (2–9)	3 (1–5)	<0.001
Pack-years of consumption, median (IQR)	1 (0.01–3)	0.20 (0–1.17)	<0.001
Ex-smokers (%)	8.6	11.7	0.070
Wheeze in the last 12 months (%)	26.5	27.9	0.551
Waking up with cough in the last 12 months (%)	31.7	40.7	0.01
Breathlessness following exercise in the last 12 months (%)	35.3	40.0	0.09
Persistent cough in the last 12 months (%)	28.5	26.8	0.393
Positive BHR ( $\leq 16$ mg/ml) to methacholine (%)	8.0	16.9	<0.001
FEV <sub>1</sub> , l, mean (SD)	4.10 (0.52)	3.08 (0.43)	<0.001
FEF <sub>25-75</sub> , l/sec mean (SD)	4.65 (1.03)	3.73 (0.75)	<0.001
FVC, l, mean (SD)	4.79 (0.62)	3.53 (0.43)	<0.001
FEV <sub>1</sub> /FVC $\times$ 100, mean (SD)	86.12 (4.73)	87.62 (4.63)	<0.001

IQR = interquartile range; BHR = bronchial hyperresponsiveness; FEV<sub>1</sub> = forced expiratory volume in one second; SD = standard deviation; FEF = forced expiratory flow; FVC = forced vital capacity.

**Table 2** Association between smoking, respiratory symptoms and positive BHR after adjustment for sex, age, height, BMI and educational level

	Ex-smokers* (n = 127) OR (95%CI)	<5 cigarettes/day* (n = 362) OR (95%CI)	≥5 cigarettes/day* (n = 284) OR (95%CI)
Wheeze in the last 12 months	1.31 (0.82–2.11)	1.78 (1.28–2.48)	3.12 (2.21–4.40)
Waking up with cough in the last 12 months	1.37 (0.90–2.07)	1.41 (1.05–1.90)	1.99 (1.44–2.74)
Breathlessness with exercise in the last 12 months	1.32 (0.87–2.0)	1.31 (0.97–1.75)	1.94 (1.41–2.66)
Persistent cough in the last 12 months	1.49 (0.95–2.32)	1.23 (0.89–1.72)	2.22 (1.58–3.11)
Positive BHR ≤16 mg/ml	0.88 (0.47–1.66)	1.25 (0.83–1.89)	0.99 (0.61–1.61)

Reference group: never smoked (n = 457).

\* P value for trend &lt;0.01 for each symptom, except for positive BHR.

BHR = bronchial hyperresponsiveness; BMI = body mass index; OR = odds ratio; CI = confidence interval.

**Table 3** Association between total smoking (pack-years) and respiratory symptoms and positive BHR after adjustment for sex, age, height, BMI and educational level

	0.1–2 pack years (n = 386) OR (95%CI)	>2.0 pack years (n = 434) OR (95%CI)	P value for trend
Wheeze in the last 12 months	1.43 (1.01–2.42)	2.96 (2.12–4.12)	<0.001
Waking up with cough in the last 12 months	1.31 (0.98–1.75)	1.59 (1.06–2.05)	0.002
Breathlessness with exercise in the last 12 months	1.54 (1.14–2.08)	1.75 (1.30–2.36)	<0.001
Persistent cough in the last 12 months	1.63 (1.16–2.27)	1.77 (1.27–3.47)	0.001
Positive BHR ≤16 mg/ml	1.38 (0.89–2.13)	1.22 (0.67–1.88)	0.140

Reference group: never smoked (n = 411).

BHR = bronchial hyperresponsiveness; BMI = body mass index; OR = odds ratio; CI = confidence interval.

tion in terms of FEV<sub>1</sub>, FVC, FEF<sub>25-75</sub>, and FEV<sub>1</sub>/FVC, adjusting for the same variables in the logistic analyses.

## RESULTS

Most participants had received at least 12 years of full-time education (Table 1). More than 66% of the men and 50% of the women were active smokers who had started smoking between the ages of 14 and 18 years. Cigarette consumption was moderate or light, as 52.7% of the men and 68.3% of the women smoked <5 cigarettes a day. Ten per cent of the total sample had quit smoking for an average of 4 years. Respiratory symptoms were highly prevalent in both sexes, but waking up with a cough and breathlessness following exercise were more prevalent in women (Table 1). A positive BHR was also more frequent in women than in men. As expected, FEV<sub>1</sub>, FEF<sub>25-75</sub> and FVC were higher in men than women, except for the FEV<sub>1</sub>/FVC ratio (Table 1). Sensitisation to at least one allergen was approximately 25% in both sexes. About 66% of the subjects had had a respiratory event in the first year of life, as recorded in the clinical notes.

There was a marked association between smoking and respiratory symptoms, with an increase in the odds ratio (OR) of symptoms as the number of cigarettes increased (Table 2). There was no association between the number of cigarettes smoked and positive BHR. There was a consistent increase in respiratory symptoms in ex-smokers in comparison to non-smokers, but this did not reach the 5% significance level.

Pack-years of tobacco consumption was also associated with respiratory symptoms; the association was stronger in the group with a higher level of consumption, with the exception of waking with cough in the last 12 months (Table 3). Pack-years was not associated with a positive BHR.

Smoking was not associated with FEV<sub>1</sub> or FEF<sub>25-75</sub>, regardless of the number of cigarettes smoked (Table 4).

**Table 4** Association between smoking and lung function in terms of FEV<sub>1</sub>, FVC and FEV<sub>1</sub>/FVC adjusting for sex, age, height, BMI and education level

Number of cigarettes per day	Coefficient	95%CI	P value
Smoking and FEV <sub>1</sub>			
<5	32 ml	–20–84	0.222
≥5	27 ml	–30–84	0.362
Ex-smokers	33 ml	–41–107	0.380
Smoking and FEF <sub>25-75</sub>			
<5	–27 ml/sec	–152–97	0.67
≥5	–45 ml/sec	–182–92	0.518
Ex-smokers	–68 ml/sec	–241–106	0.446
Smoking and FVC			
<5	76 ml	17–135	0.011
≥5	72 ml	7–136	0.029
Ex-smokers	63 ml	–21–146	0.141
Smoking and FEV <sub>1</sub> /FVC			
<5	–0.792	–1.43–0.146	0.016
≥5	–0.827	–1.53–0.119	0.022
Ex-smokers	–0.428	–1.345–0.488	0.359

Reference group: never smoked (n = 457).

FEV<sub>1</sub> = forced expiratory volume in one second; FVC = forced vital capacity; BMI = body mass index; CI = confidence interval; FEF = forced expiratory flow.

There was a significant but small effect size association, a decrease of approximately 1%, between smoking and FEV<sub>1</sub>/FVC in both moderate and light smokers. There was also a significant positive association between smoking and FVC. The lung function of ex-smokers was similar to that of non-smokers. Tobacco consumption in terms of pack-years was not associated with FEV<sub>1</sub>, FVC and FEF<sub>25-75</sub>, but it was associated with FEV<sub>1</sub>/FVC, regardless of the level of pack-years of consumption.

We did not find any significant interactions between sex and smoking on respiratory symptoms and lung function in terms of FEV<sub>1</sub>, FEF<sub>25-75</sub>, FVC and FEV<sub>1</sub>/FVC.

## DISCUSSION

There was a marked positive association between smoking and respiratory symptoms, which was evident even in those who smoked <5 cigarettes per day. In contrast, there was no evidence of poorer lung function among smokers, except that FEV<sub>1</sub>/FVC was slightly lower in smokers than in non-smokers and there was a small increase in FVC in smokers. This study highlights the early health consequences of smoking among those who smoked <5 cigarettes per day.

This study confirms the high prevalence of smoking in men and women in Chile.<sup>1,24-26</sup> Although the smoking prevalence was high, the number of cigarettes smoked was low, especially in women. Most smokers started to smoke before the age of 18 and 25% started before the age of 15, consistent with official statistics.<sup>27</sup> The low price of tobacco, the lack of legal restrictions on the advertisement of tobacco brands and the lack of concerted efforts in tobacco prevention in Chile may contribute to the early onset and the high prevalence of smoking. Only recently, the Chilean authorities, government and parliament signed the international Framework Convention on Tobacco Control (FCTC) for developing preventive strategies to reduce tobacco consumption.<sup>28</sup>

The strengths of this study are that the prevalence estimates are based on a representative sample of those aged 22–28 years; approximately 21.6% of individuals in the randomly selected sample did not participate in the study, mostly for reasons related to pre-established exclusion criteria such as migration. The same field workers administered the questionnaire to minimise any misunderstanding of the questions, and thus had the opportunity to establish a rapport with the participants. Information bias in relation to smoking should be less of a concern, as individuals in this study were less aware of the deleterious effects of cigarettes in comparison to subjects living in big cities in Chile and in high-income countries. As our analyses were based on respiratory symptoms and objective measures of lung function, the risk of biased reporting associated with diagnostic labels was avoided.

The main independent variable used in the analysis was current smoking, to avoid errors in recall of smoking behaviour over a number of years. However, analysis based on pack-years of tobacco consumption gave similar results. We believe that the cross-sectional characteristic of this analysis does not greatly affect the results in relation to symptoms, as reverse causality is an unlikely mechanism in relation to tobacco and respiratory illness. It is possible that a few smokers would have stopped smoking because of their respiratory symptoms, and this may have contributed to the slight excess in symptoms, albeit statistically non-significant, among the ex-smokers. One weakness of our study is that we could not adjust for possible seasonal effects on respiratory symptoms; however, a seasonal effect would have reduced the associations found.

Our results are important in the context of young adults in Latin America, as the vigorous strategy against smoking in high-income countries may have left lower- and middle-income countries more vulnerable to the marketing strategies of tobacco companies.<sup>29</sup> Many reports have shown an excess of respiratory symptoms in relation to smoking. We could not find many publications in the literature focusing on adults <30 years of age, except that chronic bronchitis was not associated with age in the age range 20–44 years.<sup>20</sup> A Norwegian study showed, in baseline data, that in a broader age range (20–44 years), smokers had a higher prevalence of wheezing, daily coughing, productive coughing and chronic bronchitis in both males and females.<sup>9</sup> In the ECRHS, smoking was associated with cough, regardless of its characteristic (nocturnal, productive or non-productive cough) in the age range 20–44 years,<sup>14</sup> while in Spain, smoking was associated with asthma and chronic bronchitis, although the amount of tobacco smoked was markedly higher than in our study.<sup>15</sup>

Our study unequivocally shows the effects of light smoking on respiratory symptoms in 22–28 year olds. This finding is important for demonstrating immediate health gains in relation to smoking cessation, especially as ex-smokers did not have a statistically significantly higher risk of respiratory symptoms. It is encouraging to observe in our study that respiratory symptoms tended to be similar among those who quit smoking and non-smokers. The mean time to quitting smoking was 4 years, indicating that the time necessary to achieve reversibility could be within this period. In other studies in young populations, smoking cessation reduced episodic respiratory symptoms and normalised the spirometric index.<sup>30,31</sup>

No association was found between smoking and BHR. Willemse et al. reported an inconsistent pattern between positive BHR to histamine or methacholine and smoking status (non-smokers, ex-smokers and smokers).<sup>32</sup> The authors proposed that, in the lung health study, the effect of smoking on BHR could be explained to a great extent by the induced changes in

FEV<sub>1</sub>. In our study, we found no differences in FEV<sub>1</sub> by smoking status and such a lack of association may explain our results with respect to BHR. Britton et al. commented that the relation between smoking and positive BHR is more common in older than in younger smokers, in concordance with our results.<sup>33</sup> A large ECRHS study concluded that smoking is a risk factor for increasing BHR even after adjusting for FEV<sub>1</sub>.<sup>34</sup> Although the magnitude of the decrease in FEV<sub>1</sub>/FVC ratio in smokers was not clinically relevant, it provides an early warning of the future impact of smoking and could be an early manifestation of more serious consequences of smoking, such as chronic obstructive pulmonary disease, in older age groups. A Spanish study found a similar decrease in FEV<sub>1</sub>/FVC in groups of moderate and heavy smokers, but they were also able to find a negative association with smoking and FEV<sub>1</sub>.<sup>15</sup> The decrease in FEV<sub>1</sub>/FVC in smokers was explained not by a decrease in FEV<sub>1</sub> but by an increase in FVC in our study. We speculate that the lack of effects of smoking on FEV<sub>1</sub> may be related to the low rate of tobacco consumption among smokers in our study. Spirometry by itself does not allow us to fully identify the cause of this small increase in FVC detected in the smokers.

## CONCLUSION

This study showed a marked association between smoking and respiratory symptoms, regardless of the level of consumption, and a small decrease in FEV<sub>1</sub>/FVC in 22–28 year olds. As ex-smokers did not have an excess of respiratory symptoms and lung function impairment, preventive action could contribute to health gains in the short term. Our study should provide further ammunition for increasing the pressure on governments and other decision makers in the region to act vigorously to reduce the damaging consequences of smoking, especially among young people.

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## R É S U M É

**OBJECTIF :** Evaluer l'association entre le fait de fumer et les symptômes respiratoires, la fonction pulmonaire et l'hyper-réactivité bronchique (BHR) chez de jeunes adultes chiliens.

**CONTEXTE :** Echantillon sélectionné de 1232 sujets âgés de 22 à 28 ans.

**SCHÉMA :** Etude transversale. Les mesures de résultat ont été : les symptômes respiratoires, le volume expiratoire maximum par seconde (FEV<sub>1</sub>), la capacité vitale forcée (FVC), le débit expiratoire forcé entre 25% et 75% (FEF<sub>25-75</sub>), le rapport FEV<sub>1</sub>/FVC et la BHR.

**RÉSULTATS :** L'échantillon comporte 67,7% d'hommes fumeurs et 49,4% de femmes fumeuses ; le nombre médian de cigarettes consommées par jour est de quatre chez les hommes et de trois chez les femmes. On a noté

une association entre le tabagisme et les sifflements respiratoires, la toux à l'éveil, la dyspnée à l'effort et une toux persistante avec des odds ratios entre 1,94 (IC95% 1,41–2,66) et 3,12 (IC95% 2,21–4,40) respectivement chez ceux fumant  $\geq 5$  cigarettes par jour comparés aux non-fumeurs. Le fait de fumer  $< 5$  cigarettes est associé de manière significative avec le sifflement et la toux à l'éveil. Les fumeurs ont un rapport FEV<sub>1</sub>/FVC plus faible d'environ 0,8% que les non-fumeurs. Le fait de fumer n'est pas associé avec le statut FEV<sub>1</sub>, FEF<sub>25-75</sub> et BHR.

**CONCLUSIONS :** Cette étude souligne les effets précoces du tabagisme sur les symptômes respiratoires. Elle pourrait aider les gouvernements d'Amérique Latine à entreprendre des actions vigoureuses pour empêcher les jeunes de commencer à fumer.

## R E S U M E N

**OBJETIVO :** Evaluar la asociación entre el tabaquismo y los síntomas respiratorios, la función pulmonar y la hiperreactividad bronquial (BHR) en los adultos jóvenes en Chile.

**MARCO DE REFERENCIA :** Muestra poblacional de 1232 individuos entre los 22 y los 28 años de edad.

**MÉTODOS :** Estudio transversal con los siguientes criterios de valoración : síntomas respiratorios, volumen espiratorio forzado en el primer segundo (VEF<sub>1</sub>), capacidad vital forzada (CVF), flujo espiratorio forzado entre el 25% y el 75% de la capacidad vital (FEF<sub>25-75</sub>), cociente entre VEF<sub>1</sub>/CVF y BHR.

**RESULTADOS :** En la muestra, el 67,7% de los hombres y el 49,4% de las mujeres eran fumadores, con una media de 4 y 3 cigarrillos por día, respectivamente. El tabaquismo se asoció con sibilancias, tos al despertar,

disnea de ejercicio y tos persistente con riesgos que oscilaron entre 1,94 (IC 95% 1,41–2,66) y 3,12 (IC95% 2,21–4,40) en aquellos que fumaban  $\geq 5$  cigarrillos al día, al compararlos con los no fumadores. El fumar  $< 5$  cigarrillos al día se asoció en forma significativa con sibilancias y despertar con tos. Los fumadores tuvieron un cociente VEF<sub>1</sub>/CVF cerca de un 0,8% inferior al de los no fumadores. No se observó ninguna asociación significativa entre el tabaquismo y la BHR o modificaciones del VEF<sub>1</sub> o del FEF<sub>25-75</sub>.

**CONCLUSIONES :** Los resultados del presente estudio ponen de manifiesto los efectos precoces del tabaquismo sobre los síntomas respiratorios. Estos datos podrían ser útiles a los gobiernos en América Latina con vistas a tomar iniciativas energéticas para evitar la adopción del hábito del tabaquismo en los jóvenes.