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Thoracic spine pain and associated factors among tobacco farmers

Dor na coluna torácica e fatores associados em fumicultores

Abstract

Introduction: thoracic spine pain concerns cumulative trauma involving poor posture, repetitive motion, and long periods of time in the same position. *Objective*: to assess the prevalence of thoracic spine pain and associated factors in tobacco tobacco farmers in southern Brazil. *Methods:* cross-sectional study whose association between the outcome and the sociodemographic and behavioural factors, work activities, workloads and comorbidities were examined using the Wald heterogeneity and linear trend tests. Multivariate analysis was performed using a hierarchical model and Poisson regression with robust variance. *Results*: the study comprised 2,469 individuals of both genders. Prevalence of thoracic spine pain was 21.2%. Cleaning equipments used to apply pesticides, number of episodes of green tobacco sickness, respiratory symptoms and minor psychiatric disorders were positively associated with the outcome in both genders. Smoking and pesticide poisoning were associated factors with the outcome in women, whilst schooling and lifting sticks with tobacco leaves for curing were associated with men. *Conclusions*: ergonomic restructuring, reduction of workload, position switches during work shift and mechanization of work process are important strategies to reduce exposure to nicotine, pesticides, and ergonomic workload.

Keywords: occupational health; spine; tobacco; cumulative trauma disorders; farmers.

Resumo

Introdução*: dor na coluna torácica diz respeito a traumas cumulativos envolvendo posições inadequadas, movimentos repetitivos e longos períodos na mesma posição. Objetivo: avaliar a prevalência de dor na coluna torácica e fatores associados em fumicultores no sul do Brasil.* Métodos*: estudo transversal cuja associação entre o desfecho e fatores sociodemográficos e comportamentais, atividades laborais, cargas de trabalho e comorbidades foram examinadas pelo teste de Wald para heterogeneidade e tendência linear. A análise multivariável foi realizada utilizando um modelo hierárquico e regressão de Poisson com variância robusta.* Resultados*: o estudo envolveu 2.469 indivíduos de ambos os sexos. A prevalência de dor na coluna torácica foi de 21,2%. Limpar equipamento utilizado para aplicação de agrotóxico, número de episódios de Doença da Folha Verde, sintomas respiratórios e transtornos psiquiátricos menores foram positivamente associados ao desfecho em ambos os sexos. Tabagismo e intoxicação por agrotóxicos foram associados ao desfecho entre as mulheres, enquanto escolaridade e passar varas com folhas de tabaco foram associados aos homens.* Conclusões*: reestruturação ergonômica, redução das cargas de trabalho, trocas de posições durante o turno de trabalho e mecanização do processo de trabalho são estratégias importantes para reduzir a exposição à nicotina, agrotóxicos e cargas ergonômicas de trabalho.*

Palavras-chave: *saúde do trabalhador; coluna vertebral; fumo; transtornos traumáticos cumulativos; agricultores.*

Introduction

Brazil stands out as the world's biggest tobacco exporter and second largest tobacco producer. Its southern region accounts for 98% of the country's production and employs more than 150,000 families in tobacco growing, whilst the state of Rio Grande do Sul alone accounts for 49% of the production. In 2016 the sector invoiced around R$ 30 billion regarding income and taxation and generated more than 650,000 direct farming jobs, thus showing the economic importance of this activity for Brazil[1].

Work-related back pain has increased in recent decades, with many studies focusing on low back pain due to its high prevalence and limiting effects on work[2-4]. Population-based studies in Sweden found thoracic spine pain prevalence of 10.2% and 15.0%[5,6].

Another study conducted with Brazilian workers evaluated the association between pain in different body sites and related factors to musculoskeletal pain[7], suggesting that having pain in one body site is associated with pain in another. Among those who reported upper back pain, for example, 50% also reported concurrent low back pain. In addition, being highly exposed to manual material handling and poor posture in the workplace increased the prevalence of pain in more than one body site by 1.5 times. Although epidemiological data on thoracic spine pain in rural populations are scarce, this study[7] encourages to assess thoracic spine pain from concrete literature data about low back pain in workers[2,3,7,8].

Agricultural work involves intense daily practices with susceptibility to climatic conditions and exposure to associated factors such as carrying heavy loads, continuous or repeated bending of the body[9] and repetitive upper limbs movement[10]. All these factors feature in everyday tobacco farming work, as it is basically manual work involving family labor with a clear gender-based division of tasks. Over more than a century of tobacco farming in Brazil many technologies have been enhanced and implemented but even so tobacco farmers still have intense workloads, such as using backpack sprayers for applying pesticide, picking lower leaves and lifting sticks with tobacco leaves for curing, often aggravated by long working days especially in the harvest time[8].

Considering this reality and the relevance of tobacco farming in Brazil, this study aims at identifying the prevalence of thoracic spine pain and its associated factors among tobacco farmers in southern Brazil.

Methods

This is a cross-sectional study with a random sample of tobacco farmers in the municipality of São Lourenço do Sul, state of Rio Grande do Sul, Brazil, during the 2011 harvest (January to March). The Tobacco Farming Project studied 2,469 workers[11] aged over 18 years. To study the prevalence of thoracic spine pain and associated factors in the previous year, the sample was stratified by gender and the study had statistical power of 80% for estimating risks greater than 1.7 for the variables investigated, using a 95% confidence level.

The sample was selected from 3,851 invoices provided by the municipality's Finance Department, referring to tobacco sales and issued in 2009. There were about three workers per farm property and a simple random sample of 1,100 invoices was obtained. Tobacco farmers who worked at least fifteen hours a week were eligible. If selected individuals no longer worked in tobacco farming when the interview took place, they were replaced by the nearest neighbouring tobacco farmers. Workers living in the urban area or no longer living in the municipality being studied, as well as cases in which the invoice had been issued by an individual who did not work with tobacco farming or on whose property no one worked with tobacco growing were ineligible.

Regarding data collection, we used two pre-coded instruments in electronic format with a PDA (personal digital assistant). One instrument assessed aspects of the farm property and was answered by the farm manager. The other focused on individual aspects collecting data on sociodemographic and behavioural issues, work activities, workloads, green tobacco sickness (GTS), pesticide poisoning, respiratory symptoms, minor psychiatric disorders, and spinal column pain. Smokers were workers who smoked one or more cigarettes a day during the last month, while former smokers were those who reported having stopped smoking more than a month ago.

The presence of thoracic spine pain was evaluated by the Nordic Questionnaire for Musculoskeletal Symptoms[12], validated in Brazil[13], and already used in other studies[2,14]. To assess the outcome, each participant was asked about the presence of back pain in the 12 months prior to the interview. If workers reported pain, the interviewer showed them a drawing of the human body in a standing position with the regions of the spinal column (cervical, thoracic, and lumbar) highlighted in different colours. If they pointed to the thoracic region, they were considered to have thoracic spine pain.

Green tobacco sickness in the previous year was defined as the occurrence of dizziness or headache and nausea or vomiting within two days after tobacco harvesting[15]. Minor psychiatric disorders were measured according to the self-reported questionnaire (SRQ-20), a screening test primarily for anxiety and depressive symptoms, using scores ≥ 8 for women and ≥ 6 for men[16].

Data analysis was performed using Stata 12.0®. The frequency of the variables was verified by examining central tendency and proportions measures. Bivariate analysis was then performed, testing the association between the outcome and the independent variables using the Wald Test for Heterogeneity and Linear Trend. Multivariate analysis was performed using Poisson Regression with robust variance and backward selection to estimate the prevalence ratios (PR) and the confidence intervals (95%CI). The significance level adopted for variables selection was 20% to control confounding factors. The multivariate analysis followed a hierarchical model[17] comprising four levels: 1 – socioeconomic, demographic, and behavioural conditions; 2 – work activities and workloads; 3 – comorbidities; 4 – mental health. Interactions between gender, schooling and thoracic spine pain were examined, with gender being an effect modification factor. As the tasks performed are different for men and women, the analysis was stratified by gender. For adjustment quality of the model we used the statistics Mallow's Cp, Adjusted R^2, Bayesian Information Criterion, Akaike Information Criterion and Corrected Akaike Information Criterion.

The study was approved by the Federal University of Pelotas Research Ethics Committee (Opinion No 11/2010) and all study participants signed an Informed Consent form.

Results

The sample comprised 2,469 workers of both genders from 912 farm properties. Losses and refusals accounted for 5.9%. Regarding the population studied, 59% was male and half of them were between 18 and 39 years old; 7.2% of males and 4.8% of females were over 60 years old and 44% of both genders had up to 4 years of schooling (**Table 1**).

Half of the males and 7.6% of females were smokers or former smokers. Around 73% of females lifted sticks with tobacco leaves, whereas lopping trees (62.3%) and cleaning equipment used to apply pesticides (75.7%) were activities predominantly carried out by males. More than half of the sample worked between 9 and 12 hours a day during harvest season and 52% of females worked for long periods of time sitting on the ground. Five percent of females reported pesticide poisoning at some point and 7.6% of females and 2.7% of males had had four or more episodes of GTS in the previous year. Approximately 4% of both genders reported wheezing with dyspnea in the previous year, while 14.3% of females and 10.4% of males had minor psychiatric disorders. Prevalence of thoracic spine pain in the previous year among tobacco farmers was 21.2%, with no difference according to gender (**Table 1**).

We found significant interaction between gender, schooling, and thoracic spine pain, with gender being a modifier effect for this association.

For women, in the adjusted analysis, being smokers or former smokers increased the risk of thoracic spine pain in 70% (95%CI 1.22-2.39), cleaning equipment used to apply pesticides increased the risk in 40% (95%CI 1.09-1.81), having had pesticide poisoning at some point in their lives increased the risk in 82% (95%CI 1.32-2.50). The number of GTS episodes showed positive linear association with thoracic spine pain. Wheezing with dyspnea in the previous year increased the risk of outcome in 61% (95%CI 1.05-2.45), while minor psychiatric disorders increased the risk in 71% (95%CI 1.31-2.22%). Working for 9 to 12 hours a day during harvest and prolonged work while sitting on the ground were associated with reduced risk of thoracic spine pain, with prevalence ratios of 0.62 (95%CI 0.48-0.81) and 0.75 (95%CI 0.59-0.95), respectively (**Table 2**).

Table 1 Description of a stratified sample of 2,469 tobacco farmers by gender. São Lourenço do Sul, Rio Grande do Sul, Brazil, 2011

Variable	Females		Males		p*
	n	% (95%CI)	n	% (95%CI)	
1st level – Socioeconomic, Demographic and Behavioral Conditions					
Age					
18-39 years	522	51.9 (48.8–55.0)	746	51.0 (48.4–53.5)	
40-59 years	435	43.3 (40.2–46.3)	612	41.8 (39.3–44.3)	
60 years or more	48	4.8 (3.4–6.1)	106	7.2 (5.9–8.6)	0.045
Schooling					
0-4 years	442	44.0 (41.0–47.0)	644	44.0 (41.4–46.5)	
5-8 years	473	47.0 (44.0–50.1)	732	50.0 (47.4–52.6)	
9 years or more	90	9.0 (7.2–10.7)	88	6.0 (4.8–7.2)	0.016
Time Working with Tobacco					
Up to 9 years	311	31.0 (28.1–33.9)	457	31.2 (28.9–33.6)	
10-19 years	347	34.6 (31.6–37.5)	455	31.1 (28.7–33.5)	
20 years or more	345	34.4 (31.4–37.3)	551	37.7 (35.2–40.1)	0.136
Amount of tobacco produced (Kg)					
1-5,000Kg	359	36.0 (33.0–38.9)	487	33.5 (31.0–36.0)	
5,001-10,000Kg	438	44.0 (41.0–47.0)	638	43.8 (41.3–46.4)	
10,001-36.000Kg	201	20.0 (17.6–22.6)	330	22.7 (20.5–24.8)	0.242
Smoking					
No	929	92.4 (91.0–94.1)	730	49.9 (47.3–52.4)	
Former smoker	44	4.4 (3.1–5.6)	278	19.0 (17.0–21.0)	
Smoker	32	3.2 (2.1–4.3)	456	31.1 (28.8–33.5)	<0.001
2nd level – Work Activities and Workload					
Lifting sticks with tobacco leaves for curing					
No	270	26.9 (24.1–30.0)	943	64.5 (62.0–67.0)	
Yes	735	73.1 (70.4–75.9)	520	35.5 (33.1–38.0)	<0.001
Tying hands of tobacco					
No / sometimes	135	13.4 (11.3–15.5)	210	14.4 (12.5–16.1)	
Frequently / always	870	86.6 (84.4–88.7)	1.253	85.6 (83.8–87.4)	0.517
Cleaning equipment used to apply pesticides					
No	764	76.3 (73.7–79.0)	356	24.3 (22.1–26.5)	
Yes	237	23.7 (21.0–26.3)	1.108	75.7 (73.5–77.9)	<0.001
Working hours during harvest					
13-18 hours/day	252	25.1 (22.4–27.8)	530	36.3 (33.8–38.8)	
9-12 hours/day	556	55.5 (52.3–58.5)	805	55.2 (52.6–57.7)	
Up to 8 hours/day	195	19.4 (17.0–21.9)	124	8.5 (7.1–9.9)	<0.001
Working at an intense or accelerated pace					
Up to 3 months heavy pace	434	43.3 (40.2–46.4)	600	41.1 (38.6–43.7)	
4-7 months heavy pace	469	46.8 (43.7–49.9)	687	47.2 (44.5–49.7)	
8 months or more	99	9.9 (8.0–11.7)	171	11.7 (10.1–13.4)	0.284
Working in a bending position					
No	78	7.8 (6.1–9.4)	94	6.4 (5.2–7.7)	
Yes	925	92.2 (90.6–93.9)	1.370	93.6 (92.3–94.8)	0.194
Prolonged work while sitting					
No	486	48.4 (45.3–51.5)	770	52.6 (50.0–55.1)	
Yes	518	51.6 (48.5–54.7)	694	47.4 (44.8–50.0)	0.041
3rd level – Comorbidities					
Pesticide poisoning (life)					
No	953	94.9 (93.5–96.3)	1.326	90.6 (89.1–92.1)	
Yes	51	5.1 (3.7–6.4)	138	9.4 (7.9–10.9)	<0.001
Green tobacco sickness episodes (previous year)					
Never	846	85.1 (82.8–87.2)	1.324	91.2 (89.7–92.6)	
Up to 3 times	73	7.3 (5.7–8.9)	88	6.1 (4.8–7.3)	
4 times or more	76	7.6 (6.0–9.3)	40	2.7 (1.9–3.6)	<0.001
Wheezing with dyspnea (previous year)					
No	960	95.6 (94.3–96.9)	1.412	96.5 (95.5–97.4)	
Yes	44	4.4 (3.1–5.6)	52	3.5 (2.6–4.5)	0.297
4th level – Mental Health					
Minor Psychiatric Disorders**					
No	837	85.7 (83.5–87.9)	1.274	89.6 (88.0–91.2)	
Yes	140	14.3 (12.1–16.5)	148	10.4 (8.8–12.0)	0.004
Outcome					
Thoracic spine N pain					
No	792	78.9 (76.3–81.4)	1.151	78.7 (76.6–80.8)	
Yes	212	21.1 (18.6–23.6)	312	21.3 (19.2–23.4)	0.900

95%CI = 95% Confidence Interval
*Chi-square test for heterogeneity
** 70 observations missing

Table 2 Thoracic spine pain in the previous year: prevalence and associated factors among female tobacco farmers. São Lourenço do Sul, Rio Grande do Sul, Brazil, 2011 (n=1,005)

Variable		*Crude*			*Adjusted*		
	%	*PR*	*95%CI*	*p*	*PR*	*95%CI*	*p*
1st level – Socioeconomic, Demographic and Behavioral Conditions							
Smoking							
No	20.0	1	–		1	–	
Smoker / Former smoker	34.2	1.71	1.22 – 2.39	0.002*	1.71	1.22 – 2.39	0.002*
2nd level – Work Activities and Workload							
Tying hands of tobacco							
No / sometimes	15.6	1	–		1	–	
Frequently / always	22.0	1.41	0.93 – 2.13	0.101*	1.37	0.90 – 2.09	0.140*
Cleaning equipment used to apply pesticides							
No	19.2	1	–		1	–	
Yes	27.4	1.42	1.11 – 1.83	0.006*	1.40	1.09 – 1.81	0.009*
Working hours during harvest							
13 – 18 hours/day	29.4	1	–		1	–	
9 – 12 hours/day	17.4	0.59	0.46 – 0.77		0.62	0.48 – 0.81	
Up to 8 hours/day	20.1	0.68	0.49 – 0.96	<0.001*	0.76	0.54 – 1.08	0.002*
Working at an intense or accelerated pace							
Up to 3 months heavy pace	18.9	1	–		1	–	
4-7 months heavy pace	21.5	1.14	0.88 – 1.47	0.035**	1.10	0.84 – 1.43	
8 months or more	29.3	1.55	1.07 – 2.22		1.35	0.94 – 1.94	0.139**
Prolonged work while sitting							
No	23.9	1	–		1	–	
Yes	18.5	0.78	0.61 – 0.99	0.039*	0.75	0.59 – 0.95	0.019*
3rd level – Comorbidities							
Pesticide poisoning (life)							
No	19.9	1	–		1	–	
Yes	43.1	2.16	1.54 – 3.04	<0.001*	1.82	1.32 – 2.50	<0.001*
Green tobacco sickness episodes (previous year)							
Never	19.7	1	–		1	–	
Up to 3 times	23.3	1.18	0.76 – 1.83		1.16	0.75 – 1.78	
4 times or more	35.5	1.80	1.29 – 2.51	0.001**	1.42	1.05 – 1.92	0.024**
Wheezing with dyspnea (previous year)							
No	20.5	1	–		1	–	
Yes	34.1	1.66	1.08 – 2.55	0.021*	1.61	1.05 – 2.45	0.028*
4th level – Mental Healh							
Minor Psychiatric Disorders							
No	18.2	1	–		1	–	
Yes	38.6	2.12	1.65 – 2.74	<0.001*	1.71	1.31 – 2.22	<0.001*

PR = prevalence rate
95%CI = 95% Confidence Interval
*Wald test for heterogeneity
**Wald test for linear trend

For men, in the adjusted analysis, the association between time working and thoracic spine pain presented heterogeneity between categories but no linear trend. Lifting sticks with tobacco leaves for curing increased the risk in 52% (95%CI 1.25-1.84) and cleaning equipment used to apply pesticides increased the risk of thoracic spine pain in 61% (95%CI 1.22-2.13). Having had wheezing with dyspnea in the previous year showed a prevalence ratio of 1.73 (95%CI 1.17-2.54), while having minor psychiatric disorders increased the risk in 52% (95%CI 1.15-2.00). Working for 9 to 12 hours a day during harvest was associated with reduced risk (PR 0.75 – 95%CI 0.61-0.93). Schooling and number of GTS episodes in the previous year showed positive linear association with the outcome (**Table 3**).

Table 3 Thoracic spine pain in the previous year: prevalence and associated factors among male tobacco farmers. São Lourenço do Sul, Rio Grande do Sul, Brazil, 2011 (n=1,464).

Variable	*%*	*Crude*			*Adjusted*		
		PR	*95%CI*	*p*	*PR*	*95%CI*	*p*
1st level – Socioeconomic, Demographic and Behavioral Conditions							
Schooling							
0-4 years	16.6	1	–		1	–	
5-8 years	24.7	1.48	1.20 – 1.84		1.56	1.26 – 1.93	
9 years or more	27.3	1.64	1.12 – 2.40	<0.001**	1.76	1.18 – 2.62	<0.001**
Time working with tobacco							
Up to 9 years	23.2	1	–		1	–	
10-19 years	18.2	0.78	0.61 – 1.01		0.82	0.64 – 1.06	
20 years or more	22.3	0.96	0.76 – 1.21	0.149*	1.13	0.89 – 1.43	0.044*
2nd level – Work Activities and Workload							
Lopping trees							
No / sometimes	17.6	1	–		1	–	
Frequently / always	23.6	1.34	1.08 – 1.66	0.008*	1.19	0.96 – 1.48	0.115*
Lifting sticks with tobacco leaves for curing							
No	18.6	1	–		1	–	
Yes	26.4	1.42	1.17 – 1.73	<0.001*	1.52	1.25 – 1.84	<0.001*
Cleaning equipment used to apply pesticides							
No	14.4	1	–		1	–	
Yes	23.6	1.64	1.24 – 2.16	<0.001*	1.61	1.22 – 2.13	0.001*
Working hours during harvest							
13 – 18 hours/day	24.5	1	–		1	–	
9 – 12 hours/day	18.9	0.77	0.63 – 0.95		0.75	0.61 – 0.93	
Up to 8 hours/day	23.4	0.95	0.67 – 1.35	0.042*	1.08	0.76 – 1.53	0.011*
Working in a bending position							
No	12.8	1	–	0.049*	1	–	
Yes	21.9	1.72	1.00 – 2.94		1.44	0.84 – 2.45	0.184*
3rd level – Comorbidities							
Green tobacco sickness episodes (previous year)							
Never	20.1	1	–		1	–	
Up to 3 times	35.2	1.75	1.29 – 2.37		1.42	1.06 – 1.91	
4 times or more	30.0	1.49	0.92 – 2.42	<0.001*	1.47	0.90 – 2.39	0.013**
Wheezing with dyspnea (previous year)							
No	20.5	1	–		1	–	
Yes	44.2	2.16	1.56 – 2.98	<0.001*	1.73	1.17 – 2.54	0.005*
4th level – Mental Health							
Minor Psychiatric Disorders							
No	19.3	1	–		1	–	
Yes	37.2	1.92	1.52 – 2.44	<0.001*	1.52	1.15 – 2.00	0.003*

PR = prevalence rate
95%CI = 95% Confidence Interval
*Wald test of heterogeneity
**Wald test of linear trend

Discussion

This study shows a high prevalence of thoracic spine pain in the previous year, in this population. Cleaning equipment used to apply pesticides, number of GTS episodes, wheezing with dyspnea and minor psychiatric disorders were positively associated with the outcome for both genders. Smoking and having had pesticide poisoning during their lifetime were associated factors among females; schooling and lifting sticks with tobacco leaves for curing were positively associated with thoracic spine pain among males.

The prevalence of thoracic spine pain in the last year was similar to that found among rural workers in Greece (21%)[18], although it was almost double that found among the general population in Sweden[5,6].

Assessment of pain in other parts of the body in our study indicates that prevalence of thoracic spine pain is greater than prevalence of chronic low back pain (8.4%), but lower than the prevalence of acute low back pain (30.8%) and low back pain in the last month (36.0%)[3,19]. Comparability of prevalence data is compromised because many studies group together distinct segments of the spine[20,21]. Moreover, studies on thoracic spine pain among rural workers are scarce. Musculoskeletal pain in the thoracic spine can either cause total limitation for the work of tobacco growers, or partial limitations leading to the avoidance of certain tasks, having significant impact on quality of life and family financial situation. Nonetheless, we found no studies about work limitations arising from thoracic spine pain.

Age was not associated with the outcome among women or men, suggesting that factors intrinsic to this work[22-24] are more important in determining thoracic spine pain than age inherent degenerative processes. Occupational factors associated with thoracic spine pain are distinct between genders and may be related to the gender-based division of work in tobacco growing. As tobacco growing takes place in a context of family farming, young adults, who in the rural area are precisely those with a higher level of schooling, tend to do more strenuous jobs involving greater intensity and greater risk, which might explain the positive association between schooling and thoracic spine pain in males.

The association between cleaning equipment used to apply pesticides and musculoskeletal pain in the thoracic spine in both genders may be related to prolonged periods spent in a standing position, bending over a wash tank and may be aggravated when the height of the tank is inappropriate, as well as the weight of the equipment to be held during washing. Another activity associated with risk of thoracic spine pain in males is lifting sticks with tobacco leaves for curing. Some workers are sent to work on scaffolding, where they stand on wooden beams, whilst others remain on the ground handling one by one sticks with fastened green tobacco leaves, to be hung in conventional barns for curing[8]. This task requires agility, balance and strength, as well as constant movement of the spine, both for the worker high up on the beams, who leans down to take the sticks, and for those on the ground, who stretch their spines lifting the sticks upwards. The literature suggests that most complaints of musculoskeletal pain relate to work activities performed with poor posture, with overburdening, or even a combination of these factors[24].

The linear increase in thoracic spine pain according to the number of GTS episodes in the previous year, in both genders, may be related to high levels of nicotine being absorbed through the skin and inhaling organic dust, especially tobacco leaf dust to which these workers are exposed, mainly during harvest season[25]. Previous analyses also showed association between GTS and chronic low back pain in this population of tobacco farmers[19]. The chemical effects of nicotine on the human body might affect the musculoskeletal system, given that nicotine affects the circulatory system and impairs the nutrition of the intervertebral discs[26].

Pesticide poisoning in the previous year was an important associated factor for thoracic spine pain among females. Studies show that pesticide poisoning may be associated with musculoskeletal disorders[19,27], as nerve conduction velocity related to pain perception may be altered due to the neurotoxic effects of pesticides[28,29]. Moreover, neonicotinoid pesticides are absorbed through the same route as nicotine and may have similar toxicity[30].

The positive association between wheezing with dyspnea and thoracic spine pain is consistent with studies showing relationship between respiratory dysfunctions and musculoskeletal pain. There is evidence that certain respiratory symptoms affect the region adjacent to the lungs, causing pain in the thoracic muscles due to the effort needed to breathe or loosen secretion[31-34].

Minor psychiatric disorders can cause prolonged muscular tension resulting in musculoskeletal pain, as they alter nociceptive stimuli and thus intensify pain perception[35]. There may however be reverse causality since musculoskeletal problems cause discomfort and restrict the ability to work, which can negatively affect mental health[36-38].

In the farming and livestock sector, an average working day of eight and a half hours was an associated factor for musculoskeletal disorders[39]. In our study, working between 9 and 12 hours a day and prolonged work while sitting on the ground were a protective factor for thoracic spine pain compared with the reference category. These associations may reflect the healthy worker effect, since to be able to do farm work for long periods or to remain sitting on the ground for many hours, the person needs to be in very good health.

This study furthers knowledge about thoracic spine pain in tobacco farmers and discusses the associations between the outcome and ergonomic and chemical exposure, especially to nicotine and pesticides. Our findings indicate that, even among workers labouring in the fields, the prevalence of thoracic spine pain is high. Although this community is very closed, because the interviewers lived in the same region, we obtained a high response rate. The results may be applicable

to other agricultural crop growing with similar characteristics to tobacco growing.

Future studies should provide a more in-depth understanding of the association between chemical exposure and musculoskeletal outcomes, enhancing the characterization of types of chemicals, forms of exposure, use of protective equipment and assessing biomarkers of such exposure. Considering the high prevalence of thoracic spine pain and that tobacco growing is a family activity, the degree of work limitation due to thoracic spine pain also needs to be assessed.

Health professionals, especially those working in rural areas, should be aware of the occupational risks to which tobacco farmers are exposed to provide appropriate health education. They should know that aside ergonomic factors related to thoracic spine pain, chemical factors might also play an important role in the outcome. Tobacco farmers need to develop healthier habits. From an ergonomic point of view, it is important to implement regular breaks during the day, stretching and adjusting postural aspects, to minimize the impact of work on health. Regarding chemical exposure, it is important to reduce pesticide use, to ergonomically restructure job activities, particularly tying hands of tobacco, or mechanize work processes to avoid exposure to pesticides and nicotine. These actions shall improve the tobacco farmers' quality of life and health.

Authors contribution

The authors contributed equally to the research and paper writing, which included the design, data collection and analysis, manuscript writing and revision, and approval of the final published version, taking full responsibility for the study and the published article content.

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