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Neck pain among tobacco farm workers in Southern Brazil

Dolor cervical entre agricultores que producen tabaco en el sur de Brasil

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ABSTRACT This study aims to assess neck pain prevalence and associated factors among tobacco farm workers. This is a cross-sectional study of 2,469 tobacco farm workers in southern Brazil. An adapted version of the Nordic Questionnaire of Musculoskeletal Symptoms was used to characterize neck pain. Multivariate analysis was performed using Poisson regression, following a hierarchical theoretical model. Neck pain prevalence in the last year among the population studied was 7.4%. Worker age, tobacco smoking, tobacco bundling, use of heavy chainsaws, working at an intense or accelerated pace and green tobacco sickness were variables associated with neck pain in females. Among males, age, use of heavy chainsaws, working in a sitting position on the ground, pesticide poisoning, and green tobacco sickness were associated with the outcome. The study reinforces the importance of ergonomic and physiological workloads in the determination of neck pain. Future studies are needed to understand the role of pesticides and nicotine exposures on musculoskeletal problems. The mechanization of tobacco harvesting could reduce ergonomic and chemical exposure, thereby improving farmers' health.

KEY WORDS Cervical Pain; Occupational Health; Agriculture; Tobacco; Rural Health; Brazil.

RESUMEN Este estudio tiene como objetivo evaluar la prevalencia del dolor cervical y los factores asociados entre agricultores que producen tabaco. Se realizó un estudio transversal en el que participaron 2.469 agricultores que producen tabaco en el sur de Brasil. Para la caracterización del dolor cervical se utilizó una adaptación del cuestionario nórdico para síntomas musculoesqueléticos. El análisis multivariante se realizó mediante la regresión de Poisson, siguiendo un modelo teórico jerárquico. La prevalencia del dolor cervical en el año previo entre la población estudiada fue del 7,4%. Las variables que se asociaron con el dolor cervical entre las mujeres trabajadoras fueron la edad, el consumo de tabaco, el enfardado del tabaco, el uso de motosierras pesadas, trabajar en un ritmo intenso o acelerado y la enfermedad del tabaco verde, mientras que, entre los varones, fueron la edad, el uso de motosierras pesadas, el trabajo sentado en el suelo, la intoxicación por plaguicidas y la enfermedad del tabaco verde. El estudio refuerza la importancia de las cargas de trabajo ergonómicas y fisiológicas en la determinación del dolor cervical. Se necesitan estudios futuros para comprender el papel de la exposición a los plaguicidas y a la nicotina en los problemas musculoesqueléticos. La mecanización de la cosecha del tabaco podría reducir la exposición ergonómica y química, mejorando así la salud de los agricultores.

PALABRAS CLAVES Dolor Cervical; Salud Laboral; Agricultura; Tabaco; Salud Rural; Brasil.

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BACKGROUND

Although the global tobacco sector is facing a reduction in consumption and production, owing to restrictive legislation and adverse climate conditions, China and Brazil harvest per annum, the equivalent of 2,685,983 tonnes of tobacco leaves. Tobacco growing plays an important role in the Brazilian economy, with the country standing out as the world's largest exporter and second largest producer of tobacco, generating approximately 640,000 direct farming jobs.[1] Accounting for 98% of the Brazilian harvest during 2017/2018, the country's southern region produced the equivalent of 685,983 tonnes of tobacco, with the state of Rio Grande do Sul alone producing 46.5% of the region's output.[1]

Studies indicate that neck pain is highly prevalent in farming and cattle raising and can restrict the ability to work. It was found to affect 33% of women cow milkers[2] and 26% of rural workers.[3] The occupational factors associated with painful symptoms in the shoulders/neck and lower back region include manual labour, exposure to vibrations, repetitive motions and poor working conditions.[4,5,6,7]

In Brazil, tobacco production occurs through the integrated tobacco cultivation system, which is a commercial partnership between family farmers and companies that provides technical assistance, financial support and guarantee the purchase of production.[8] Tobacco growing takes place all year round following five stages, production of seedlings and preparation of the ground, seedling transplantation, cultivation and harvesting, curing and pre-classification.

Harvesting is the most intensive stage, requiring the entire workforce available on the farm and long working days. It is a manual process, that occurs in steps, starting from the removal of the leaves closest to the ground, to the leaves of the top. The leaves are taken to the barn where, sitting on the ground, the workers tie hands of tobacco, arrange them on sticks, lift them up to be hanged in the barn for drying, and then bundle them.[9] These workers are exposed to physical exertion, working in awkward posture and chemicals, particularly nicotine, and other workloads which may be related to musculoskeletal symptoms.[9] Despite this, other studies regarding musculoskeletal symptoms among tobacco farm workers, have not been reported in the literature. The few studies conducted on this population address green tobacco sickness which is the nicotine poisoning that occurs due to dermal contact with the green tobacco leaf.[10,11]

This study is part of a larger project – Green tobacco sickness among tobacco farm workers – that evaluated mental health, wheezing, green tobacco sickness, chronic low back pain and other health outcomes among tobacco farm workers. Considering the economic importance of tobacco growing in Brazil, the number of family farm workers exposed, and the fact that tobacco harvesting involves intensive manual labour, this study assessed neck pain prevalence and associated factors among tobacco farm workers in southern Brazil.

METHODS

A cross-sectional study was conducted with tobacco farm workers in the municipality of São Lourenço do Sul, Rio Grande do Sul, Brazil. Data were collected between January and March 2011, during the harvest period.

The study consisted of a sample of 2,469 tobacco farm workers[10] aged 18 years old or over. This sample estimated 7% of neck pain prevalence with a precision of $\pm$ 2 percentage points and a confidence level of 95%, conferring statistical power of 80% to identify prevalence ratios around 2.0 to investigate associated factors for most of the examined associations, except for working in a bending position and pesticide poisoning in the last year.

The sample of workers was based on 3,852 invoices of tobacco sales issued in 2009, made available to the study by the São Lourenço do Sul Municipal Finances Department. Considering the desired sample size and estimating approximately three workers per

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farm property, 1,100 invoices were randomly sampled. With the aid of key informants, the properties' locations were identified.

Following the criteria established by the Brazilian Institute of Geography and Statistics to consider someone a rural worker in its surveys, individuals working in tobacco growing at the time of the study for at least fifteen hours per week were eligible for the study.[12,13] In cases in which the individual had been a tobacco farm worker in 2009 but was no longer working as such at the time of the interview, the property was replaced by the closest tobacco farm. A property was considered ineligible for inclusion in the study when the invoice had been issued by an individual who did not undertake tobacco growing or on whose property there was no one working with tobacco growing, or when the individual was living in the urban area of the municipality or had moved to another municipality. When the location of the farm was not identified, it was considered a loss of 2.7 individuals per property. This number was added to the number of individuals who were not found in the properties and those who did not consent to participate, in order to evaluate the response rate.

Two instruments were used to collect data – one for individual farmers and the other for family farm properties. Both were pre-coded in electronic format for use with personal digital assistants (PDA). The farm properties instrument investigated socioeconomic factors of the farm which were answered by the main administrator at each property, who was a member of the tobacco farmer family. The instrument used to assess individual farmers addressed socioeconomic and demographic factors (age; level of schooling; time working with tobacco; tobacco production), behavioural issues (tobacco smoking; alcohol abuse), work activities (using heavy chainsaws; bundling and transporting tobacco leaves; preparing beds for planting tobacco; working into the curing barn; applicating pesticides and/or herbicides; tying hands of tobacco; harvesting bottom leaves; climbing high into the curing barn; lifting sticks with tobacco leaves to the barns), workloads (work at an intense or accelerated pace; hours worked during harvest; average weight loaded at work; strenuous work; work in a bending position; work sitting on the ground), comorbidities (green tobacco sickness; pesticide poisoning) and pain in the vertebral column.

Smokers were considered those who smoked one or more cigarettes a day for at least one month prior to the interview, whilst former smokers were considered those who reported having stopped smoking more than a month ago. For the purposes of analysis, the tobacco smoking variable was dichotomized into non-smokers and smokers/former smokers. Work that was intense, strenuous, or that was at an accelerated pace was self-referenced. Pesticide poisoning was determined with the question "Have you ever had pesticide poisoning in your life?"[14] Green tobacco sickness (GTS) was defined as the occurrence of dizziness or headache and nausea or vomiting within two days after tobacco harvesting in the last year.[15]

An adapted version of the Nordic Questionnaire for the Analysis of Musculoskeletal Symptoms[16] was used to characterize neck pain. This version has been validated in Brazil[17] and used in other studies in this country.[18,19] In order to assess neck pain, tobacco farm workers were asked if they had back pain in the 12 months prior to the interview. For those who reported pain, the interviewer showed a figure in an upright position, with the cervical, dorsal and lumbar regions highlighted in different colours; those who pointed to the cervical region were considered to have neck pain.

The analyses were performed using Stata 12.0®. Initially the frequency of each of the variables being studied was verified, examining measures of central tendency and proportions, as well as the chi-square test for heterogeneity to evaluate the differences by sex in each variable. Bivariate analysis was then performed, testing the association between the independent variables and the outcome of interest using the Wald Test for heterogeneity and the Wald Test for linear trend. Multivariate analysis was conducted using Poisson regression with robust variance

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and backward selection in order to estimate prevalence ratios (PR) and confidence intervals (95% CI). Variables having a *p*-value less than or equal to 0.20 were kept in the model to control confounding factors. Association was considered significant when the *p*-value was less than or equal to 0.05. The multivariate analysis followed the hierarchical model[20] comprising five levels: 1) socioeconomic and demographic factors; 2) behavioural issues; 3) work activities; 4) workloads; 5) comorbidities (Figure 1).

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

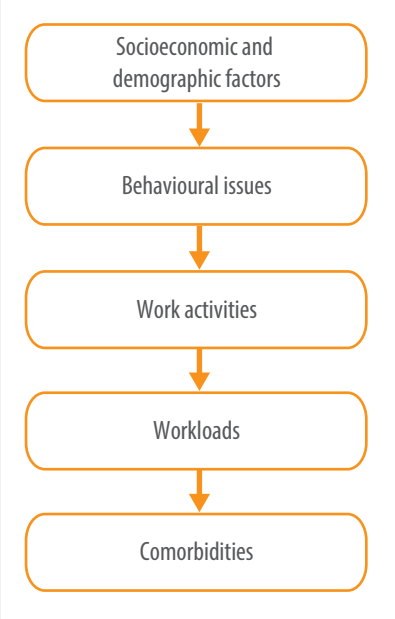

Figure 1. Hierarchical model for the multivariable analysis.

Source: Own elaboration.

RESULTS

The sample was comprised of 2,469 individuals working on 912 properties. The response rate was 94.1%. In the population studied, 59.3% were male and half of them were aged 18-39 years, while 4.8% of females and 7.2% of males were aged 60 years or over. The proportion of individuals with up to 4 years of schooling (44%) was similar in both sexes, over 60% had been working for at least 10 years in tobacco growing, and 44% worked at properties producing between 5,001 kg and 10,000 kg of tobacco per annum (Table 1).

Among females, 7.6% were smokers or former smokers, while half the males had this form of exposure. Tobacco leaf bundling was a work activity undertaken by a considerable number of workers of both sexes (70.6% of females and 87.2% of males). Passing tobacco leaves sticks to hang into the curing barns was predominant among females (73.1%); while using heavy chainsaws (45.4%) and preparing beds for planting tobacco (83.3%) were activities predominating among males. Over half the tobacco farm workers of both sexes worked between 9 and 12 hours a day during the harvest and over half reported working for 4 months or more per year at an intense or accelerated pace. Among males, 60% were exposed to strenuous labour, compared to 48% of females. Over 92% of both sexes worked in a bending position, while 50% worked sitting on the ground. In relation to comorbidities, in the year prior to the interview, pesticide poisoning prevalence was 0.3% in females and 0.5% in males, while prevalence of 4 or more episodes of green tobacco sickness was 7.6% in females and 2.7% in males (Table 1).

Neck pain prevalence in the last year among the population studied was 7.4%, with a significant difference between sexes ($p = 0.008$): 9.1% in females and 6.2% in males.

The adjusted analysis for females showed that the prevalence ratio of neck pain was 1.7 for women aged 40-59 years in relation to their younger counterparts, and approximately double for smokers/former smokers (PR = 2.00) and for women who worked bundling tobacco leaves (PR = 2.05) or using heavy chainsaws (PR = 2.05). The amount of time spent working at an intense or accelerated pace and the number of green tobacco sickness episodes were positively associated with neck pain (Table 2).

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Table 1. Number and percent distributions (95% confidence intervals) of socioeconomic and demographic factors, behavioural issues, work activities, workloads, comorbidities, and neck pain by sex in farm workers that produce tobacco. City of São Lourenço do Sul, Rio Grande do Sul, Brazil, 2011. (n=2,469).

Variable	Females			Males			*p*-value*
	n	%	95% CI	n	%	95% CI	
Socioeconomic and demographic factors							
Age							
18-39 years	522	51.9	48.8-55.0	746	51.0	48.4-53.5	0.045
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	
Level of schooling							
0-4 years	442	44.0	41.0-47.0	644	44.0	41.4-46.5	0.016
5-8 years	473	47.1	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	
Time working with tobacco							
Up to 9 years	311	31.0	28.1-33.9	457	31.2	28.9-33.6	0.136
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	
Tobacco production							
1-5,000 kg	359	36.0	33.0-38.9	487	33.5	31.0-35.9	0.242
5,001-10,000 kg	438	44.0	33.0-38.9	638	43.8	41.3-46.4	
10,001-36,000 kg	201	20.1	17.6-22.6	330	22.7	20.5-24.8	
Behavioural issues							
Tobacco smoking							
Non-smoker	929	92.4	90.8-94.1	730	49.9	47.3-52.4	<0.001
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	
Work activities							
Bundling tobacco leaves							
No / Sometimes	295	29.4	26.6-32.3	187	12.8	11.1-14.5	<0.001
Frequently / Always	707	70.6	67.7-73.4	1,275	87.2	85.5-89.0	
Preparing beds for planting tobacco							
No / sometimes	464	46.2	43.1-49.2	244	16.7	14.8-18.6	<0.001
Frequently / always	541	53.8	50.7-56.9	1,219	83.3	81.4-85.2	
Using heavy chainsaws							
No	923	95.6	94.3-96.9	793	54.6	52.0-57.1	<0.001
Yes	42	4.3	3.1-5.6	660	45.4	42.9-48.0	
Passing tobacco leaves sticks							
No	270	26.9	24.1-29.6	943	64.5	62.0-66.9	<0.001
Yes	735	73.1	70.4-75.9	520	35.5	33.1-38.0	
Hours worked during harvest							
Up to 8 hours	195	19.4	17.0-21.9	124	8.5	7.1-9.9	<0.001
9-12 hours	556	55.4	52.3-58.5	805	55.2	52.6-57.7	
13-18 hours	252	25.1	22.4-27.8	530	36.3	33.8-38.8	
Workloads							
Work 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	0.284
4-7 months heavy pace	469	46.8	43.7-49.9	687	47.1	44.5-49.7	
8 months or more	99	9.9	8.0-11.7	171	11.7	10.1-13.4	
Work in a bending position							
No	78	7.8	6.1-9.4	94	6.4	5.2-7.7	0.194
Yes	925	92.2	90.6-93.9	1,370	93.6	92.3-94.8	
Strenuous work							
No	520	51.8	48.7-54.9	581	39.7	37.2-42.2	<0.001
Yes	484	48.2	45.1-51.3	883	60.3	57.8-62.8	
Work sitting on the ground							
No	486	48.4	45.3-51.5	770	52.6	50.0-55.1	0.041
Yes	518	51.6	48.5-54.7	694	47.4	44.8-50.0	
Comorbidities							
Pesticide poisoning in the last year							
No	1,001	99.7	99.4-100.0	1,456	99.4	99.1-99.8	0.364
Yes	3	0.3	0.0-0.6	8	0.5	0.2-0.9	
Green tobacco sickness in the last year							
Never	846	85.0	82.8-87.2	1,324	91.2	89.7-92.6	<0.001
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	
Outcome							
Neck pain							
No	913	90.9	89.1-92.7	1,372	93.8	92.5-95.0	0.008
Yes	91	9.1	7.3-10.8	91	6.2	5.0-7.4	

Source: Own elaboration.
Note: Independent variables are structured with a hierarchical model comprising five levels 1) socioeconomic and demographic factors; 2) behavioural issues; 3) work activities; 4) workloads; 5) comorbidities.
CI 95% = Confidence interval of 95%.
*Chi-square heterogeneity test

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The adjusted analysis for males showed that work sitting on the ground was a protection factor (PR = 0.66), while using heavy chainsaws increased prevalence ratio of neck pain to 1.7 and having had pesticide poisoning in the last year resulted in a 3.8 times higher prevalence ratio of reporting neck pain. Age and number of green tobacco sickness episodes showed positive linear association with the outcome (Table 3).

Table 2. Crude and adjusted prevalence ratios (95% confidence intervals) using Poisson regression, with a model that includes socioeconomic and demographic factors, behavioural issues, work activities, workloads, comorbidities, and neck pain in female farm workers that produce tobacco. City of São Lourenço do Sul, Rio Grande do Sul, Brazil, 2011. (n=1,005).

Variable	%	Crude prevalence ratio			Adjusted prevalence ratio		
		PR	95% CI	*p*-value	PR	95% CI	*p*-value
Socioeconomic and demographic factors							
Age							
18-39 years[1]	6.9	1.00	-		1.00	-	
40-59 years	11.9	1.73	1.15-2.60	0.023*	1.73	1.15-2.60	0.023*
60 years or more	6.4	0.92	0.30-2.89		0.92	0.30-2.89	
Behavioural issues							
Tobacco smoking							
Non-smoker[1]	8.4	1.00	-	0.010*	1.00	-	0.011*
Smoker / Former smoker	17.1	2.03	1.19-3.49		2.00	1.17-3.41	
Work activities							
Bundling tobacco leaves							
No / sometimess[1]	5.1	1.00	-	0.006*	1.00	-	0.010*
Frequently / always	10.8	2.12	1.24-3.62		2.05	1.19-3.52	
Using heavy chainsaws							
No[1]	8.5	1.00	-	0.003*	1.00	-	0.027*
Yes	21.4	2.53	1.37-4.69		2.05	1.08-3.86	
Workloads							
Work at an intense or accelerated pace							
Up to 3 months heavy pace[1]	6.0	1.00	-		1.00	-	
4-7 months heavy pace	10.7	1.77	1.12-2.80	0.001**	1.54	0.97-2.42	0.033**
8 months or more	15.1	2.52	1.39-4.58		1.77	0.93-3.38	
Work in a bending position							
No[1]	2.6	1.00	-	0.061*	1.00	-	0.109*
Yes	9.6	3.75	0.94-14.96		3.27	0.77-13.91	
Comorbidities							
Green tobacco sickness in the last year							
Never[1]	7.9	1.00	-		1.00	-	
Up to 3 times	11.0	1.38	0.69-2.77	0.002**	1.41	0.70-2.83	0.005**
4 times or more	18.4	2.33	1.37-3.94		2.15	1.25-3.70	

Source: Own elaboration.
Note: Independent variables are structured with a hierarchical model comprising five levels 1) socioeconomic and demographic factors; 2) behavioural issues; 3) work activities; 4) workloads; 5) comorbidities
CI 95%= Confidence interval of 95%. PR = Prevalence ratio.
[1]Reference value.
*Wald test for heterogeneity.
**Wald test for linear trend.

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Table 3. Crude and adjusted prevalence ratios (95% confidence intervals) using Poisson regression, with a model that includes socioeconomic and demographic factors, behavioural issues, work activities, workloads, comorbidities, and neck pain in male farm workers that produce tobacco. City of São Lourenço do Sul, Rio Grande do Sul, Brazil, 2011. (n=1,464).

Variable	%	Crude prevalence ratio			Adjusted prevalence ratio		
		PR	95% CI	*p*-value	PR	95% CI	*p*-value
Socioeconomic and demographic factors							
Age							
18-39 years[1]	4.4	1.00	-		1.00	-	
40-59 years	7.0	1.59	1.02-2.47	<0.001**	1.59	1.02-2.47	<0.001**
60 years or more	14.1	3.20	1.80-5.69		3.20	1.80-5.69	
Behavioural issues							
Tobacco smoking							
Non-smoker[1]	4.5	1.00	-	0.008*	1.00	-	0.063*
Smoker / former smoker	7.9	1.75	1.15-2.65		1.49	0.98-2.28	
Work activities							
Prepared beds for planting tobacco							
No / sometimes[1]	9.4	1.00	-	0.023*	1.00	-	0.062*
Frequently / always	5.6	0.59	0.38-0.93		0.63	0.39-1.02	
Used heavy chainsaws							
No[1]	5.2	1.00	-	0.079*	1.00	-	0.009*
Yes	7.4	1.43	0.96-2.14		1.68	1.13-2.49	
Pass tobacco leaves sticks							
No[1]	5.3	1.00	-	0.050*	1.00	-	0.183*
Yes	7.9	1.49	1.00-2.22		1.31	0.88-1.95	
Workloads							
Work at an intense or accelerated pace							
Up to 3 months heavy pace[1]	4.7	1.00	-		1.00	-	
4-7 months heavy pace	7.1	1.53	0.97-2.40	0.031**	1.49	0.93-2.37	0.085**
8 months or more	8.2	1.75	0.94-3.26		1.56	0.83-2.94	
Work sitting on the ground							
No[1]	7.3	1.00	-	0.081*	1.00	-	0.047*
Yes	5.0	0.69	0.46-1.05		0.66	0,44-0,99	
Strenuous work							
No[1]	5.0	1.00	-	0.120*	1.00	-	0.067*
Yes	7.0	1.40	0.91-2.15		1.50	0.97-2.32	
Comorbidities							
Pesticide poisoning in the last year							
No[1]	6.1	1.00	-	0.023*	1.00	-	0.042*
Yes	25.0	4.09	1.21-13.81		3.85	1.05-14.14	
Green tobacco sickness in the last year							
Never[1]	5.6	1.00	-		1.00	-	
Up to 3 times	11.4	2.03	1.09-3.79	0.001**	2.07	1.08-3.95	0.005**
4 times or more	15.0	2.68	1.24-5.79		2.21	1.05-4.65	

Source: Own elaboration.
Note: Independent variables are structured with a hierarchical model comprising five levels 1) socioeconomic and demographic factors; 2) behavioural issues; 3) work activities; 4) workloads; 5) comorbidities.
CI 95%= Confidence interval of 95%. PR = Prevalence ratio.
[1]Reference value.
*Wald test for heterogeneity.
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DISCUSSION

This study found significantly higher prevalence of neck pain in the last year among females compared to males. Using heavy chainsaws and having green tobacco sickness in the last year were variables positively associated with neck pain in both sexes. The habit of smoking, bundling tobacco leaves and working at an intense or accelerated pace were factors that showed positive association among women; while being older and having had pesticide poisoning in the last year were positively associated with neck pain among men.

In studies with farm workers in South Korea and the United States, neck pain prevalence in the last year varied considerably – 21.8% and 8.9%, respectively,[21,22] while our study found a prevalence of 7.4%, however, these studies evaluated other crops making it difficult to compare.

Tobacco growing is mainly manual, labour-intensive and heavily based on the family production, with a sharp division of labour between the sexes.[23] Gender construction has a historical characteristic, marked by long-standing cultural factors relating rurality and masculinity, and emphasized by the strenuous physical work required in same agricultural production tasks.[24,25] Some epidemiological studies[26,27] indicate that physiological, hormonal, psychosocial factors or even factors relating to the different activities carried out by men and women can be related to increased presence of neck pain. Moreover, females usually have better memory recall of their health problems than men and seek medical assistance more frequently.[28] Our findings support other studies conducted with rural workers in Sweden and the United States,[2,22] which also reported higher neck pain prevalence in the last year among females.

The positive association between age and neck pain is consistent with a study that assessed chronic musculoskeletal pain in Latino farm workers of both sexes and up to 55 years of age.[22] It is known that degeneration in the spine occurs as intervertebral discs become worn, worsens in the presence of osteoporosis, arthrosis and osteophytosis, and may result in diverse morbidities. There was a small number of female workers over age 60. Although this must be corroborated with further research, it is possible that these women replaced farm work with domestic chores, especially if they have presented health problems. As such, the healthy worker effect may justify the absence of a linear association between age and neck pain among women, with those aged 40 to 59 years being at greater prevalence ratio. Among males, the linear trend between age and the outcome suggests that they continue to work as tobacco growers despite the presence of morbidity.

This study shows that, although tobacco leaf bundling was widely carried out by both men and women, it was only associated with neck pain in females. This job requires physical exertion and repetitive motions when piling bundles of tobacco leaves, which may affect women more than men if the weight handled is greater than the size and body capacity supported by females, which have a physiological structure less prepared for greater efforts. Other studies also point to positive associations between repetitive motions and physical exertion and neck pain in women.[6,29]

Working in a sitting position on the ground was a protection factor against neck pain in males. This may be related to the healthy worker effect, since neck pain in males may be a limiting factor for tasks that require this position.

Positive association between use of heavy chainsaws and neck pain in both sexes may be related to the weight and intense vibration of this equipment. These factors are recognized as harmful to joints and musculature,[30] given that they provoke repeated muscle contractions and consequent tissue fatigue, compression of nerves and tendons, as well as headaches in many cases. Studies reveal that exposure to physical working conditions that involve strenuous physical effort is a relevant risk factor for musculoskeletal symptoms in the neck and shoulder region.[31,32]

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A positive linear association between time spent working at an intense or accelerated pace and neck pain in females was consistent with the findings of previous literature. Working for many hours over long periods,[33] especially with exposure to physical workloads such as repetitive motions, vigorous physical exertion, poor posture, vibration or even a combination of these and other forms of exposure,[29,34] results in muscle,[35] mental and psychomotor fatigue.[36] The persistence of these exposures could lead to chronic fatigue that may be associated with fibromyalgia.[37]

Tobacco farm workers are subjected to diverse forms of nicotine exposure, whether through the skin during harvesting or by inhaling nicotine suspended in the air inside tobacco storage barns and in areas close to tobacco plantations.[38] This exposure to occupational nicotine combines with active and passive cigarette smoking, resulting in massive exposure to nicotine. Biologically speaking, it is known that the presence of nicotine in the bloodstream reduces the amount of pro-inflammatory cytokines in the circulation, as well as reducing intervertebral disc nutrition, outcomes which may promote disc degeneration.[39] Tobacco smoking was only strongly associated with neck pain among women, suggesting that susceptibility to nicotine may differ between sexes. On the other hand, the number of green tobacco sickness episodes in the last year showed a linear increase in positive association with neck pain in both sexes, suggesting that the harm caused to the body by nicotine poisoning could also be prejudicial to the musculoskeletal system.

Pesticide poisoning in the last year was positively associated with neck pain in males. The tobacco farm workers, particularly young adult males handle the pesticides themselves. The relationship between pesticides and musculoskeletal symptoms has been little described thus far in the literature; however, neonicotinoid pesticides[40] have the same absorption route as nicotine present in tobacco, thus suggesting similar toxicity to that of nicotine in the body. Furthermore, some studies indicate that pesticide poisoning might be associated with musculoskeletal disorders,[41,42] given that the neurotoxic effects of pesticides alter nerve conduction velocity,[43] which may accentuate the perception of pain.[44]

CONCLUSIONS

Studies on neck pain in rural workers are scarce in the literature. This study points to the important prevalence of neck pain in tobacco growers, especially in women, and strengthens the occupational effects associated with this outcome. The stratified analysis allows us to observe that the factors associated with neck pain have specificities according to sex.

This article brings to the surface a subject that is little disseminated in the literature, namely the association between pesticides and nicotine exposure with neck pain. These findings highlight the pertinence of future studies that allow a deep understanding about the role of chemical exposures on musculoskeletal problems. The study reinforces the importance of ergonomic and physiological workloads in the determination of neck pain, indicating the association between the use of heavy chainsaws in both sexes, as well as, between bundling tobacco leaves and intense or accelerated work among women with neck pain.

However, the assessment of the association between occupational exposures and neck pain is limited by the low statistical power to examine exposures reaching a large number of tobacco growers, such as work in a bending position, and by the healthy worker effect, a selection bias that may occur in cross-sectional studies. Future studies with larger samples, studies with longitudinal designs or even the evaluation of some exposures such as height, body mass and previous self-reported accidents, are important to overcome the identified limitations.

Policies should address the need to mechanize the tobacco harvesting process in order to reduce ergonomic and chemical workloads which might have negative impact on health. Policies should seek to

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promote gender equity, addressing activities mainly performed by women, which often are monotonous and repetitive, and overlap with housework. In addition, it is important to promote crop diversification policies, with an agro-ecological model, as a way of guaranteeing healthy jobs in family agriculture, especially in a context of reducing world consumption of tobacco. In this perspective, it is essential to develop policies and projects to promote and monitor the health of rural populations.[45]

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