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ORIGINAL ARTICLE

Incidence and Risk Factors for Thoracic Spine Pain in the Working Population: The French Pays de la Loire Study

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Objective. **To examine the incidence and risk factors for incident thoracic spine pain (TSP) in workers representative of a French region's working population.**

Methods. **In this prospective study, 3,710 workers were assessed in 2002–2005, and 2,332 (62.9%) of them were reassessed in 2007–2010. TSP was assessed by a self-administered Nordic questionnaire at baseline and at followup. At baseline, all participants completed a self-administered questionnaire on personal factors and work exposure. A total of 1,886 subjects (1,124 men and 762 women) without TSP at baseline were eligible for analysis. Associations between incident TSP and risk factors at baseline were analyzed by multivariate logistic regression.**

Results. **The incidence rate of TSP was 5.2 (95% confidence interval [95% CI] 3.9–6.6) per 100 men and 10.0 (95% CI 7.8–12.1) per 100 women. TSP was often associated with low back pain and neck pain. TSP in men was associated with age (odds ratios [ORs] ranging from 2.6 [95% CI 0.95–7.1] at 30–39 years to 6.0 [95% CI 2.1–17.3] at ≥50 years), being tall (OR 2.2 [95% CI 1.2–3.9]), frequent/sustained trunk bending (OR 3.0 [95% CI 1.5–6.1]), lack of recovery period or change in the task (OR 2.0 [95% CI 1.2–3.6]), and driving vehicles (OR 2.8 [95% CI 1.4–5.5]). Being overweight or obese was associated with lower risk (OR 0.5 [95% CI 0.3–0.96]). TSP in women was associated with high perceived physical workload (OR 1.9 [95% CI 1.1–3.3]), after adjustment for confounding variables.**

Conclusion. **The risk model of TSP combined personal and work-related organizational and physical factors. Trunk bending appeared to be a strong independent predictor of TSP in this working population.**

INTRODUCTION

Back disorders are a major occupational health problem in industrialized countries, with high social and economic implications. Epidemiologic findings mainly concern low back pain (LBP) and neck pain, but information on thoracic spine pain (TSP) in the working population is sparse (1–3). TSP is defined as spinal pain extending from the cervicothoracic hinge (C7–T1) to the thoracolumbar junction (T12–L1).

The literature has focused mainly on the secondary causes of TSP, since it is more likely to be caused by serious disorders than at the cervical and lumbar levels (4,5). Eliminating a specific cause of local or referred TSP is a major issue in medical practice. Nevertheless, the prevalence of such severe disorders is relatively low in young and middle-aged workers (2,6), and information on the incidence of common TSP and its work-related risk factors would be useful for the practitioners.

A systematic literature review on TSP in the work place (1) showed wide variations in the prevalence of TSP in the working population according to the definitions used and the occupational groups considered. The 12-month prev-

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Significance & Innovations

- Thoracic spine pain (TSP) has been less often studied than low back pain or neck pain in the population of working age. This study is one of the first prospective studies of TSP conducted in a large population of workers representative of a region's workforce.
- The incidence rate of TSP is relatively high in the working population.
- TSP was associated with personal and work-related organizational and physical factors, in particular frequent and/or sustained trunk bending at work.
- Work organization and mechanical exposure should be important targets for the prevention of TSP in the working population.

alence of TSP ranged between 3% and 55%, with the highest levels reported among health care professionals, musicians, and manual workers.

Little epidemiologic information is available on the risk factors for TSP in the working population. Several work-related risk factors, such as high physical workload, monotonous work, and specific occupations (e.g., pilots), have been reported in highly exposed workers (1).

The aim of this study was to assess prospectively the effects of individual and work-related factors on the incidence of TSP in a large, representative sample of French workers from various industry sectors and occupations exposed to various levels of work constraints.

MATERIALS AND METHODS

Study population. This prospective study was based on 2 successive surveys conducted in the Pays de la Loire region in France (5.6% of the French working population). Its diversified socioeconomic structure is close to that of France as a whole (7).

First survey. In 2002, all of the region's occupational physicians (OPs; n = 460) were invited to participate in this study, which consisted of selecting a sample of male and female workers ages 20–59 years in any economic sector from those undergoing a mandatory annual health examination (all workers in France are the subject of such medical surveillance, except for the self-employed). A total of 83 OPs volunteered to take part in the study (participation rate 18%) between 2002 and 2005. They were representative of the region's OPs in terms of medical practice, working time, and geographic and economic sectors covered.

Subjects were selected at random, following a 2-stage sampling procedure. First, the research team chose 15–45 half days of scheduled examinations for each OP. Next, using random sampling tables, each OP selected 1 of 10 workers from the schedule on these half days. Fewer than 10% of the selected workers were not included (no shows, refusals, and duplications). Workers completed a self-administered questionnaire about musculoskeletal symptoms in the back and upper extremities, and about personal factors and working conditions just before the medical visit.

A total of 3,710 workers (2,161 men [58.2%], mean ± SD age 38.5 ± 10.4 years and 1,549 women [41.8%], mean ± SD age 38.9 ± 10.3 years) were included between April 2002 and April 2005. Women were slightly underrepresented in the sample (42% versus 47% in the region). Overall, the distribution of occupations in the study sample was close to that of the regional workforce, except for the occupations not surveyed by OPs (e.g., independent workers). Subjects worked mainly in the service industry (58.6%) and manufacturing industry (33.7%) sectors, and more rarely in the construction (5.8%) and agriculture (1.9%) sectors. Men were mainly skilled and unskilled nonprofessional workers (56.0%), associate professionals and technicians (25.0%), and managers and professionals (9.7%). Most women were low-grade professional workers (51.7%), skilled and unskilled nonprofessional workers (24.4%), and associate professionals and technicians (18.7%).

Second survey. In 2007, a followup questionnaire was mailed to all of the subjects included in 2002–2005. In cases of a lack of response, 2 successive reminder letters were sent with a copy of the self-administered questionnaire. If the current address was unknown, the new address was sought by contacting either their OP or the French postal service. For workers who had not returned the self-administered questionnaire in 2007, the OPs were asked to pass on the questionnaire to the workers just before the regular health examination in 2008 and 2009.

Each subject provided written informed consent to participate in this study at baseline, and the study received approval from France's National Committee for Data Protection (Commission Nationale de l'Informatique et des Libertés), first in 2001 and again in 2006.

Outcome. The self-administered questionnaire completed at baseline and at followup comprised a standardized Nordic-style questionnaire asking about the occurrence and duration of pain during the previous 12 months and the occurrence of pain during the previous 7 days. A manikin (rear view) indicated the body zones (8) (Figure 1). Pain intensity was assessed with a visual analog scale (VAS) ranging from 0–10. No physical examination of the back and neck was performed by the OPs. TSP was defined as "experiencing any aching, discomfort, pain, or numbness" in the posterior upper back (shown on the manikin) during the previous 7 days.

Potential risk factors. Self-assessed occupational exposure was considered during a typical workday in the preceding 12-month period. The potential risk factors at baseline and followup were assessed according to 4 groups: individual factors, organizational factors, biomechanical factors, and psychosocial factors.

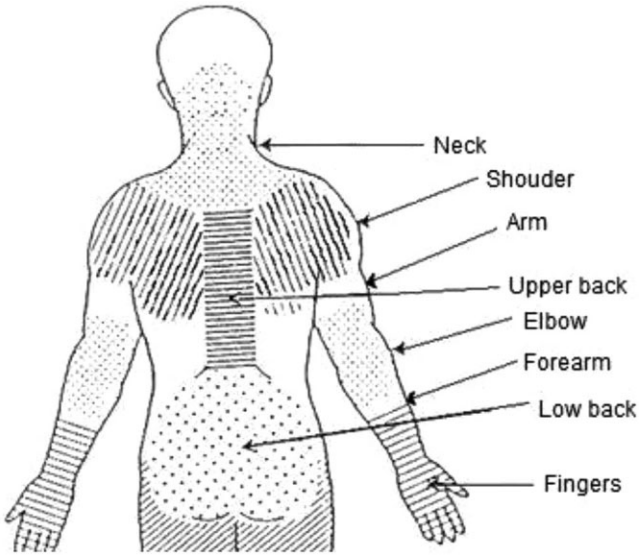

Figure 1. Manikin (rear view) of the Nordic-style questionnaire indicating the body zones.

Individual factors. Individual factors included age, height, and being overweight or obese (body mass index [BMI] $\geq$25 kg/m^2).

Organizational factors. Organizational factors included overtime hours, lack of prior information regarding the workload, job/task rotation between several workstations, variable pay, working with temporary workers, temporary employment, work rate constraints, and lack of possibility to rest or change tasks.

Biomechanical factors. Perceived physical exertion was assessed using the Borg Rating of Perceived Exertion scale, graduated from 6 (very, very light) to 20 (maximum exertion). Scores >15 defined high perceived physical exertion. Two questions focused on the occurrence of frequent/sustained trunk bending, either forward ("during a typical day at work, do you have to lean forward regularly or for a long period?") or sideways ("during a typical day at work, do you have to lean to one side regularly or for a long period?"), and one question focused on the occurrence of frequent/sustained neck flexion movements ("during a typical day at work, do you have to tilt your head forward regularly or for long period?"). Response categories were presented as 4-level Likert-type scales as follows: no or almost never/rarely (<2 hours/day), often (2–4 hours/day), and always or almost always ($\geq$4 hours/day). Similar questions were asked regarding exposure to high levels of repetitive tasks ("during a typical day at work, does your job usually require you to repeatedly perform the same actions more than 2 to 4 times per minute?"), heavy lifting, and driving industrial vehicles (tractors or forklift trucks exposing to whole-body vibrations) or nonindustrial vehicles (cars, buses, or trucks) on the public highway.

Psychosocial work factors. Psychosocial factors included high psychosocial demand, low skill discretion, low decision authority, low supervisor support, and low colleague support assessed according to the validated French version of the Karasek Job Content Questionnaire (9).

Statistical analysis. Analyses were performed separately for men and women to take into account possible differences in exposure to work constraints between sexes (10). The incidence rate of TSP during the 7 preceding days was defined as the frequency of TSP in the second survey in workers free from TSP at baseline. Workers were considered to be free from TSP if they had not experienced TSP for >8 days during the preceding 12 months and/or the 7 days preceding answering the questionnaire at baseline.

The modeling process was based on a 3-step binary logistic model. In the first step, univariate binary logistic regression models were used to estimate the unadjusted links between each potential risk factor and TSP. The factors with a P value less than 0.20 were placed in a multivariable model by groups of variables (individual factors, organizational factors, biomechanical factors, and psychosocial factors). Manual backward multivariate logistic regression models were then applied for each group of variables in order to avoid collinearity between exposure variables in the final model (age was forced into the models). Nonsignificant variables (P value of 0.10 or more) were excluded after this stage. The remaining factors were entered into a final global multivariate logistic regression model, and manual backward selection retained only significant variables with a P value less than 0.05.

Additional analyses were performed for the factors available for both questionnaires to investigate the long- and short-term effects of types of exposure on the incidence of TSP. Types of exposure on the first (baseline) and second (followup) questionnaires were then assessed according to 4 classes: never exposed, exposed only at baseline, exposed only at followup, and exposed during both periods. In addition, multinomial modeling was used to assess the risk factors at baseline for TSP and whether TSP was isolated or associated with neck and/or back pain at followup. Each final multinomial model yielded an odds ratio (OR) associated with isolated TSP and associated TSP for each risk factor. All analyses were performed with the SAS statistical software package, version 9.3.

RESULTS

Study subjects. Between 2007 and 2009, 233 subjects (6.3%) could not be contacted (unknown address [n = 215] or death [n = 18]). Finally, 2,332 subjects (67.1%) filled out the second self-administered questionnaire in 2007: 1,313 were men and 1,019 were women, with most still being at work.

Participation was higher for women (65.8% versus 60.8%) and increased with age until 54 years (from 49.2% at <30 years to 72.8% between 50 and 54 years and 64.6% at >55 years), and increased for length of service at baseline (from 50.5% at <1 year to 68.1% at >10 years) for both sexes. Workers in temporary employment were more often lost to followup (51.6% versus 35.2%). However, the respondents and nonrespondents did not differ regarding the prevalence of TSP at baseline (12.6% versus 12.7%; P = not significant [NS]) and the main biomechanical exposure at baseline: frequent/sustained trunk bending

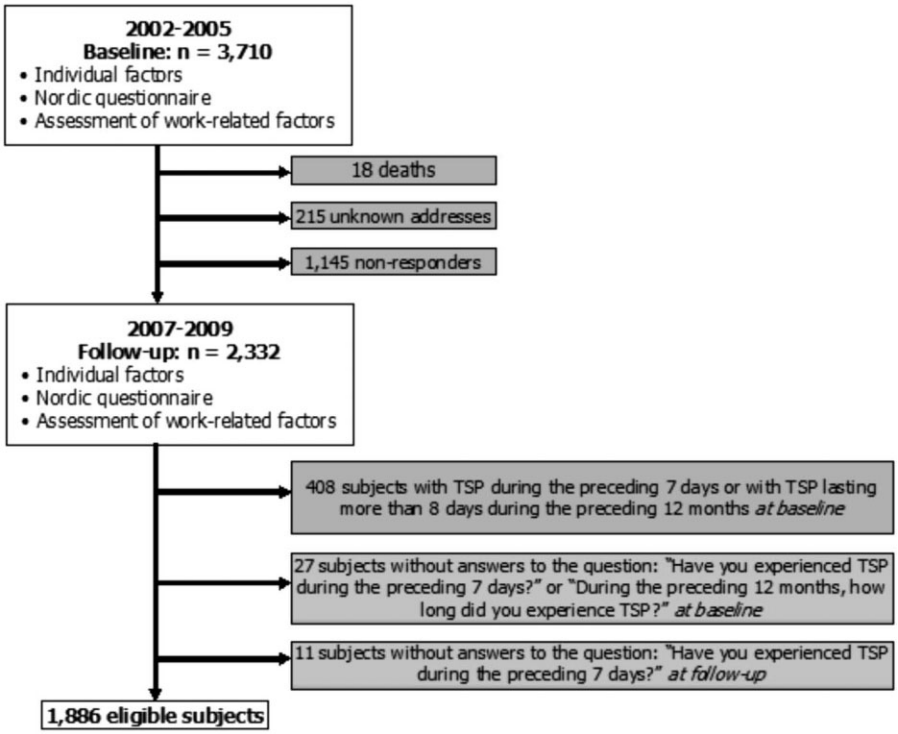

Figure 2. Flow chart of participants: eligibility for analyses of incident thoracic spine pain (TSP).

(61.3% versus 63.9%; P = NS), highly repetitive tasks (62.6% versus 63.1%; P = NS), and high perceived physical exertion (63.1% versus 63.0%; P = NS). No difference was observed according to exposure to the psychosocial factors (high psychosocial demand, low skill discretion, low decision authority, low supervisor support, and low colleague support).

Of the 2,332 subjects, 408 reported TSP during the preceding 7 days at baseline or TSP that lasted >8 days during the preceding 12 months at baseline, and 38 did not answer these questions at baseline or at followup. Finally, 1,886 subjects (1,124 men and 762 women) were eligible for analysis (Figure 2).

Incidence of TSP. The incidence rate of TSP was estimated to be 5.2 (95% confidence interval [95% CI] 3.9–6.6) per 100 workers for men and 10.0 (95% CI 7.8–12.1) per 100 workers for women ($P < 0.001$). The median level of pain intensity (0–10 VAS) was 5 (range 0–10) in men and 4 (range 0–10) in women. As shown in Table 1, TSP was more often associated with both LBP and neck pain (40.7% of cases in men and 36.0% in women) than isolated (18.7% of cases in men and 16.0% in women).

Table 1. Distribution of other spinal pain in cases of incident thoracic spine pain (TSP)

	Men, no. (%)	Women, no. (%)
Isolated TSP	11 (18.7)	12 (16.0)
TSP and neck pain	12 (20.3)	20 (26.7)
TSP and low back pain	12 (20.3)	16 (21.3)
TSP with neck pain and low back pain	24 (40.7)	27 (36.0)
Total	59 (100.0)	75 (100.0)

Risk models for TSP. The final logistic risk models of TSP differed between sexes (Table 2). For men, the risk of TSP increased consistently with age (ORs ranging from 2.6 [95% CI 0.95–7.1] at 30–39 years to 6.0 [95% CI 2.1–17.3] at ≥50 years compared to <30 years). Being tall was associated with an increased risk of TSP (OR 2.2 [95% CI 1.2–3.9]), while being overweight or obese (at baseline) was associated with a lower risk of TSP (OR 0.5 [95% CI 0.3–0.96]). The relationship between TSP and high BMI remained unchanged when adjusting for LBP at baseline. Frequent/sustained trunk bending (for ≥2 hours every day) was the strongest work-related risk factor for TSP, with a higher OR (3.0 [95% CI 1.5–6.1]) for bending both forward and sideways than for bending forward or sideways (OR 2.4 [95% CI 1.3–4.5]). The 2 other work-related risk factors were the lack of recovery period or change in task (not being able or allowed to stop or change the task for 10 minutes every hour; OR 2.0 [95% CI 1.2–3.6]) and driving vehicles, such as cars, buses, or trucks (for ≥4 hours per day; OR 2.8 [95% CI 1.4–5.5]). Temporary employment was a confounding factor and had to be kept in the final model to allow adjustment for the other factors. Young men were more often in temporary employment than older men (25.1% of men ages <30 years, 5.2% at age 30–39 years, 1.8% at age 40–49 years, and 3.5% at age ≥50 years; $P < 0.001$). Investigation of the long- and short-term effects of types of exposure on the incidence of TSP (data not shown) showed that TSP was associated with

Table 2. Final logistic risk models of incident thoracic spine pain in men and women*

Exposure at baseline	Men				Women			
	N	No. (%)	OR (95% CI)	*P*	N	No. (%)	OR (95% CI)	*P*
Age, years				0.007†				0.745
<30	203	6 (3.0)	1		143	18 (12.6)	1	
30–39	328	18 (5.5)	2.6 (0.95–7.1)		217	19 (8.8)	0.7 (0.3–1.4)	
40–49	337	17 (5.0)	3.1 (1.1–8.9)†		252	26 (10.3)	0.8 (0.4–1.5)	
≥50	230	18 (7.8)	6.0 (2.1–17.3)†		138	13 (9.4)	0.7 (0.3–1.6)	
Height, cm				0.01†				
≤179	823	38 (4.6)	1					
>179	275	21 (7.6)	2.2 (1.2–3.9)†					
Overweight or obese (≥25 kg/m^2)				0.037†				
No	616	38 (6.2)	1					
Yes	482	21 (4.4)	0.5 (0.3–0.96)†					
No stop/change of task for 10 minutes/hour				0.014†				
No	743	30 (4.0)	1					
Yes	355	29 (8.2)	2.0 (1.2–3.6)†					
High perceived physical exertion								0.022†
No					618	54 (8.7)	1	
Yes					132	22 (16.7)	1.9 (1.1–3.3)†	
Frequent trunk bending (≥2 hours/day)				0.003†				
No	706	24 (3.4)	1					
Forward or sideways	245	21 (8.6)	2.4 (1.3–4.5)†					
Both	147	14 (9.5)	3.0 (1.5–6.1)†					
Neck flexion and/or repetitiveness of tasks (≥4 hours/day)								0.075
No					393	39 (9.9)	1	
Repetitiveness of tasks					121	11 (9.1)	0.8 (0.4–1.7)	
Neck flexion					128	7 (5.5)	0.5 (0.2–1.2)	
Both					108	19 (17.6)	1.7 (0.9–3.1)	
Driving nonindustrial vehicles (≥4 hours/day)‡				0.003†				
No	977	46 (4.7)	1					
Yes	121	13 (10.7)	2.8 (1.4–5.5)†					
Temporary employment				0.138				
No	1,016	52 (5.1)	1					
Yes	82	7 (8.5)	2.0 (0.8–5.2)					

* OR = odds ratio; 95% CI = 95% confidence interval.
† Significant ($P < 0.05$).
‡ Cars, buses, or trucks.

frequent/sustained trunk bending (forward or/and sideways) for exposure at baseline only (OR 2.3 [95% CI 1.04–5.0]), and above all for exposure during both periods (OR 3.5 [95% CI 1.7–6.9]), but not for exposure at followup only.

TSP in women was not associated with age or height (Table 2). Higher risk of TSP was associated with high perceived physical exertion at work (OR 1.9 [95% CI 1.1–3.3]). The variable combining neck flexion and repetitiveness of tasks was a confounding factor and kept in the model. Workers exposed to both factors more often experienced TSP (17.6% versus 9.9% for unexposed workers, 9.1% for workers exposed to repetitiveness of tasks only, and 5.5% for workers exposed to neck flexion only). Study of the long- and short-term effects of exposure to high perceived physical exertion (data not shown) showed a significant effect only for exposure at baseline (OR 2.3 [95% CI 1.1–4.8]), after adjustment for all significant variables in the final female model.

The comparison of the risk models regarding whether TSP was associated with neck pain and/or LBP or not involved few cases of isolated TSP in either sex (11 men and 12 women), but did show that the only risk factor associated with isolated TSP (OR 18.6 [95% CI 2.3–148.1]) was exposure to frequent/sustained trunk bending at work (in men).

DISCUSSION

This study showed a relatively high incidence of TSP in a large population of workers representative of a French region's workforce and confirmed the role of both personal and work-related risk factors in the development of TSP.

Few prospective studies of TSP in the working (1) and general populations are available in the literature for comparison (2). The relatively high incidence of TSP among workers could be explained by the high sensitivity of the Nordic questionnaire (11), which can pick up not only disabling pain, but also minor aches and pains. The higher incidence of TSP in women during the preceding 7 days confirmed previous cross-sectional studies among Navy sailors, nurses, and students (12–15).

As yet reported (1,16), TSP was most often associated with neck pain and/or LBP, and it was therefore difficult to disentangle the risk factors specifically for TSP from those for neck pain or LBP. This may reflect not only a true association, but also difficulties the respondents had in distinguishing TSP from neck pain and LBP.

Among the potential personal factors studied, aging seemed to play a role in this working population. The increased risk of TSP with age (in men) agreed with previous studies (1,13–15). Tall men are known to be at greater risk of LBP (17), but to our knowledge, such an association has not previously been reported for TSP in the working population. Tall people may be exposed to higher levels of strain on the lower and upper back because of greater mechanical torque in manual handling. The lower risk of TSP associated with being overweight or obese was unexpected and should be confirmed in other populations before drawing any conclusions. This result contradicts findings on LBP (18), and it might be explained by methodological considerations. Indeed, it can be hypothesized that obese workers more often experienced LBP than TSP (at least for biomechanical reasons) and therefore might have underreported pain in the upper back compared to LBP, leading to a low OR in comparison to workers of normal weight taken as a reference.

The main result of this study was the strong effect of frequent trunk bending on the incidence of TSP (in men). This finding is in agreement with the biomechanical understanding of the thoracic spine region (19). Some previous cross-sectional epidemiologic studies reported a nonsignificant increased risk of TSP in cases of frequent trunk bending among nurses (15) and electronic industry workers (20,21). Trunk bending is known to be a risk factor for LBP (18,19), but this factor remained associated with TSP in the multinomial model (in men), regardless of whether TSP was isolated from or associated with neck pain or LBP. Comparison of workers according to whether they were exposed at both periods, only at baseline, or only at followup or never exposed provided information on the effects of duration of exposure on the incidence of TSP (workers exposed only at followup had been exposed for shorter periods than those exposed during both periods). The results reported here are compatible with the hypothesis that the incidence of TSP increases with the duration of exposure.

Several other biomechanical work-related risk factors for TSP were highlighted by this study. High perceived physical exertion was associated with an increased risk of TSP (in women), and this agrees with several epidemiologic surveys (12–15). It should be emphasized that manual handling was not associated with TSP, in contrast to a previous study among nurses exposed to frequent patient handling (13). Women exposed to high perceived workload only at baseline had a greater risk in our study than those exposed only at followup (and even during both periods), suggesting a delayed rather than a short-term effect of the physical workload.

In women, frequent neck flexion combined with highly repetitive tasks was associated with higher risk of TSP, and this confirmed findings for neck pain (22). Frequent or sustained neck flexion may be due to high visual constraints (e.g., computer work) and result in trunk bending or thoracic spine kyphosis. In medical practice, it is known that "referred" neck pain from various origins can cause TSP (4).

Prolonged driving of cars or buses was associated with higher risk of TSP (in men), but not driving industrial vehicles (tractors or forklift trucks). This finding agrees with those of a large survey of bus drivers in San Francisco (23) and the high prevalence of TSP among drivers. In our study, TSP was probably more often related to postural constraints of the upper back than to whole-body vibration, since exposure to whole-body vibrations of sufficient energy to damage the thoracic spine is low in modern cars and buses.

Few factors related to the work organization were associated with TSP, except the lack of ability to take breaks or change the task (every hour). Such inability, which may reflect high time pressure, is often linked to highly repetitive tasks. High time pressure has been associated with TSP (1), but not, to our knowledge, to the lack of ability to take breaks or change tasks regularly. Despite the high prevalence of TSP reported in workers exposed to high psychosocial stress at work (e.g., nurses and pilots) (1), no psychosocial risk factor related to the job strain model was observed in this large working population. This contrasts with the results of the study of LBP in the same sample of the working population (18). It is possible that exposure to job stress plays a higher role in chronic or recurrent TSP rather than in acute TSP, as reported for other types of back pain (24,25).

The prospective design was a major strength of this study, since most data on TSP in workers are derived from a cross-sectional epidemiologic design. The large and representative sample of workers according to activity sectors and occupational categories is another strength (26), as is the diversity of the risk factors studied. It might have been interesting to assess other individual factors (smoking, extraoccupational activities, etc.). Few reports are available for TSP, but a recent review concluded that current and former smokers had a higher prevalence of LBP, although the association was modest (27). The results regarding extraoccupational physical activities are inconsistent in the literature, with most studies showing no association with back disorders and some showing favorable or unfavorable effects, depending on the intensity of physical activity (28). The influence of all of these factors is therefore probably only modest, and their absence from our models is unlikely to have led to major bias in our estimates.

The main limitation of the study was the high percentage of loss to followup. The followup period coincided with a major economic downturn in the region (2008–

2009), during which the regional salaried workforce declined by 3.4% (33.7% in temporary employment agencies). The lowest participation rate was among young workers, workers in temporary employment, and those with a short length of service at baseline. This can be explained by the difficulty of following up with young workers in insecure employment. Workers with a risk factor for upper extremity musculoskeletal disorders (MSDs) at baseline generally less often underwent the second physical examination. We suspect that the economic crisis may have excluded from work the workers most exposed to the risk of MSDs. A study on the impact of loss to followup in epidemiologic studies on upper extremity MSDs found that the differences in the characteristics between participants and those lost to followup did not influence the risk ratios for associations between exposure factors for upper extremity MSDs and upper extremity MSD status (29). Therefore, we believe that there was no major selection bias associated with the quality of the followup. Nevertheless, a selection bias linked to the "healthy worker effect" cannot be excluded, particularly at inclusion.

Another concern in this study was the assumption that, in view of the 5-year period between the 2 assessments, no other event occurred. The incidence of TSP might have been underestimated, since some workers may have developed and recovered from TSP before the second assessment. The use of the term "incidence" is not completely correct, since TSP cases occurring between the data collections and that were negative at followup were not considered as incident cases. In order to avoid a confusion effect from chronic or recurrent TSP, we excluded from analyses workers with coexisting TSP in 2002–2005, as suggested in studying frequent and recurrent disorders (30).

Because of cost and time limitations, direct exposure measurements by observation were not possible. Self-administrated questionnaires were used to assess the work exposure in reference to a typical workday in the preceding 12-month period to limit recall errors (31), and picture forms were used to increase the validity of self-assessment of posture (32).

In conclusion, this study shows that the incidence rate of TSP is relatively high in the working population and confirms that TSP is often linked with neck pain and/or LBP. The risk model associating personal and work-related organizational and physical factors is in line with findings on other MSDs of the back and upper extremities. However, trunk bending appeared to be a strong independent predictor of TSP in this working population. Most personal factors are not modifiable, and therefore work organization and mechanical exposure should be important targets for the prevention of TSP in the working population.

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All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be published. Dr. Roquelaure had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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