Knee Pain and Driving Duration: A Secondary Analysis of the Taxi Drivers' Health Study

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Objectives. We explored a postulated association between daily driving time and knee pain.

Methods. We used data from the Taxi Drivers' Health Study to estimate 1-year prevalence of knee pain as assessed by the Nordic musculoskeletal questionnaire.

Results. Among 1242 drivers, the prevalence of knee pain, stratified by duration of daily driving (≤6, >6 through 8, >8 through 10, and >10 hours), was 11%, 17%, 19%, and 22%, respectively. Compared with driving 6 or fewer hours per day, the odds ratio of knee pain prevalence for driving more than 6 hours per day was 2.52 (95% confidence interval=1.36, 4.65) after we adjusted for socioeconomic, work-related, and personal factors in the multiple logistic regression.

Conclusions. The dose-related association between driving duration and knee pain raises concerns about work-related knee joint disorders among professional drivers. (*Am J Public Health.* 2004;94:575–581)

Knee pain is a common health problem worldwide. Data from the First National Health and Nutrition Examination Survey (NHANES I) suggest that in the 1970s, it was the second most common musculoskeletal symptom, affecting 13.3% of people aged 25 to 74 years.[1] Results of NHANES III (1988–1994) revealed that 18.1% of US men and 23.5% of US women aged 60 years or older suffered from significant knee pain.[2] During the same period surveyed by NHANES III, the estimated 1-year prevalence of persistent knee pain in England was 25% among those aged 55 years and older.[3] Similar statistics showing that knee pain is a prevailing public health problem can be derived from studies conducted in Europe.[4–7] Other research findings demonstrate that people who live in the nonindustrialized world are not exempt from this endemic problem, because estimates of knee pain prevalence from nonindustrialized countries either were comparable to those in industrialized countries[8–11] or were even higher,[12] partially because of the greater prevalence of heavy physical activities in nonindustrialized countries.

Knee pain is very likely a health problem with tremendous health care costs, despite the lack of direct cost estimates. In 1996–1997, more than 6 million Americans sought medical care for knee problems,[13] about 5 million of whom visited offices of orthopedic surgeons and 1.4 million of whom went to a hospital emergency room. A survey of US orthopedic surgeons conducted in 1997 found that the knee was the most often treated anatomic site, accounting for 26% of all orthopedic visits.[13] Pain relief remains one of the major reasons for joint replacement.[14] In 1999, 311 106 inpatient hospital stays involving total knee replacement in the United States accrued a "national bill" of more than $6.5 billion.[15] The annual rate at which patients request total knee replacements to ameliorate knee pain and restore mobility has increased since the early 1990s.[13] A similar trend also has been reported in Europe. After examining data from the Swedish Knee Arthroplasty Registry, researchers found that the number of knee arthroplasties per year between the periods 1976–1980 and 1996–1997 increased more than fivefold.[16] On the basis of the 1996 and 1997 data, it was projected that, from 2000 through 2030, in the absence of an effective preventive treatment, the number of knee arthroplasties per year will increase by at least one third.

Moreover, knee pain imposes a significant disability burden on modern societies.[3,17–20] Both cross-sectional and prospective studies have consistently shown that knee pain, rather than radiographically detectable abnormalities, is the major determinant of knee osteoarthritis–related physical disability.[6,21–26] Longitudinal studies have demonstrated that previous knee pain is associated with both the development of disease[27] and the progression of radiographically evident knee osteoarthritis.[28,29] In the NHANES Epidemiologic Follow-Up Study[30] on the relative risk of experiencing difficulty in ambulation and transfer (as from a chair to a standing position), the estimated relative risk for knee osteoarthritis patients (4.42 and 4.08, respectively) were twice those for heart disease patients (2.27 and 2.13). Framingham Osteoarthritis Study[31] researchers estimated that approximately 15% of the risk for the overall population of experiencing difficulty in walking—the highest attributable proportion for any single medical comorbidity—was attributable to knee osteoarthritis. Knee pain also may lead to accidental falls,[32–35] which, together with arthritis, account for more than 30% of all restricted-activity days among older US adults.[36] As the baby boom generation ages, the knee pain–related disability burden will become even more substantial; therefore, studying the multifaceted problem of knee pain is a public health task of fundamental importance.

Researchers should seek a better understanding of the mechanisms and the impacts on health of knee pain.[2,17,37] Because most musculoskeletal pain is chronic and recurrent,[38] studies of knee pain with onset at a younger age, such as knee pain precipitated by work-related injury or strain, and the contribution of knee pain to later disability will provide us with better information about the natural history of knee osteoarthritis. Such knowledge will help us to develop effective prevention strategies and management modalities tailored to different stages of the disease. A similar research direction has been adopted in studies of other types of musculoskeletal pain.[39–43]

Descriptive results of 2 previous reports directed our attention to work-related knee pain among professional drivers. Anderson and Raanaas[44] conducted a survey of musculoskeletal complaints of taxi drivers in Norway. They used the Nordic musculoskeletal questionnaire[45] and found that the 1-year prevalence of knee pain among 703 full-time taxi drivers was higher than that among the reference group from the local community (29% vs 25%, respectively). A nationwide occupational health survey in Taiwan[46,47] that used a modified version of the Nordic musculoskeletal questionnaire also found that employed professional drivers had a knee pain prevalence slightly higher than the national average (11% vs 8.6%). However, no further data were available to explain the higher prevalence of knee pain among professional drivers observed in these 2 studies.

In 2000, the Taxi Drivers' Health Study (TDHS)[48]—an occupational, epidemiological study of cardiovascular disease risk, job stress, and low back pain—was launched in Taipei, Taiwan. The TDHS baseline data allowed us to test the hypothesis that prolonged driving is associated with increased knee pain prevalence among taxi drivers.

METHODS

The TDHS is integral to a medical-monitoring program sponsored by the Taipei city government that provides taxi drivers with free physical examinations each year.[48,49] From January 31 to May 31, 2000, 3295 taxi drivers participated in this program. From the 5 hospitals designated to provide free physical examinations (each hospital had a maximum number of taxi drivers it could serve), we selected the one with the largest assigned service volume as our study base for the TDHS. For drivers to be eligible for enrollment in our study, they had to (1) have been registered taxi drivers in Taipei for at least 1 year, (2) be voluntary participants, and (3) be able to read.

A standardized, self-administered questionnaire was delivered to each participant in the selected hospital. Its feasibility was tested among a volunteer sample of taxi drivers, who were recruited from cab companies, cooperative practices, local unions, and resting areas (a large parking area wher drivers can take a break, wash their cars, etc.), before the study began. In addition to questions about demographics and health behaviors, the questionnaire contained items regarding driver profiles (professional seniority in years, average number of driving days per month, and duration of daily driving in hours) and average frequency of physical activities (lifting and bending/twisting) during both work and leisure time. Previous studies[50,51] have shown that self-reporting is a relatively reliable and valid method to assess time spent driving a motor vehicle. In a small subset of baseline data from drivers who also participated in an exposure assessment study,[52] we found that 97% of self-reported daily driving times (grouped by periodic categories) agreed with data we retrieved from diary records and structured interviews. Although self-reported daily driving estimates exceeded actual measurements by an average of 0.9 hour, this measurement error was independent of knee pain (P=.73). The modified Nordic musculoskeletal questionnaire, the same questionnaire used in a previous nationwide survey,[47] presented a graph of 9 body parts and asked subjects to mark the anatomic sites at which they had experienced any pain in the past 12 months. (The Nordic musculoskeletal questionnaire has been demonstrated to possess acceptable validity and reliability.[45,53]) The modified questionnaire also included a job dissatisfaction subscale from the Job Content Questionnaire (Chinese version) and 5 questions about mental health from the Taiwanese version of the 36-item Medical Outcomes Study short form (SF-36).[54,55] Anthropometric and laboratory data were retrieved from annual free physical examination records.

We used multiple logistic regression analysis to estimate the odds ratio of knee pain prevalence associated with a change in duration of driving time. We grouped drivers by 4 categories according to duration of daily driving (≤6, >6 through 8, >8 through 10, and >10 hours) and calculated the crude odds ratio for knee pain prevalence in each group. Drivers who had driving times of 6 or fewer hours composed the reference group. We wanted to make a statistical inference about the effect of daily driving time on knee pain prevalence that controlled for biomechanically or biologically plausible risk factors for knee pain and osteoarthritis. We searched for these potential predictors before we examined the relationship between any covariate and knee pain prevalence in the univariate analysis. This process identified age, body mass index (BMI), education, smoking, lifting, bending/twisting, and psychosocial variables as predictors retained in the final model. We then fit the univariate model, driving time only (base model). All other variables had to cause at least a 10% change in the estimate of the odds ratio of knee pain prevalence associated with duration of daily driving in the base model to be included in the final logistic model, or they had to be significant in the univariate analysis (P=.25). We assumed no interactions among the potential predictors and included only subjects with complete data in the final analyses. The Hosmer–Lemeshow test[56] was used to assess the goodness of fit. Finally, we performed the jackknife dispersion test[57] to obtain an unbiased adjusted odds ratio of knee pain prevalence associated with a change in duration of daily driving. All of these statistical analyses were conducted with Stata 7.0 statistical software (Stata Corp, College Station, Tex).

RESULTS

Of the 1355 drivers who received medical examinations in the selected hospital, 1242 (92%) completed the 2 sets of questionnaires. The study population's mean age±SD was 44.5±8.7 years, drivers drove an average of 9.8 hours per day and 26 days per month, and 234 (19%) drivers had experienced knee pain in the past 12 months. Personal characteristics and occupational factors are shown in Table 1. We also tabulated the population reference statistics[58] and the demographic and other characteristics of the other 1940 drivers who were not enrolled in the TDHS but who had received physical examinations in other hospitals during the study period. With respect to the distribution of age, gender, professional seniority, daily driving duration, BMI, marital status, and registration type, the TDHS–enrolled drivers were not significantly

TABLE 1—Demographic and Occupational Characteristics of Participants in the Taxi Drivers' Health Study (TDHS) and Other Drivers[a]: Taipei, Taiwan, 2000

	TDHS Participants (N = 1242)		Other Drivers (N = 1940)		
Characteristics	n1	Mean ± SD or %	n2	Mean ± SD or %	Reference Group[b]
Age, y	1242	44.5 ± 8.7	1403	46.6 ± 8.7	43.9
Professional seniority, y	1234	11.4 ± 7.8	1890	11.0 ± 7.5	9.2
Total driving per month, days	1239	26.2 ± 2.6	1780	25.2 ± 3.6	26.8
Total driving per day, h	1238	9.8 ± 2.8	1889	9.9 ± 2.5	10
Body mass index, kg/m^2	1242	24.9 ± 3.6	1780	25.2 ± 3.6	...
Gender					
Male	1193	96%	1854	96%	97%
Female	49	4%	82	4%	3%
Education					
Less than high school	405	33%	770	40%	...
High school	782	63%	1067	56%	...
College or more	53	4%	69	4%	...
Marital status					
Single	201	16%	257	14%	...
Married	960	75%	1469	77%	...
Separated/divorced/widowed	116	9%	178	10%	...
Registration type					
Individual	497	40%	808	43%	...
Cooperative	395	32%	606	33%	...
Affiliated with taxicab company	341	28%	447	24%	...
Lifting activities					
Never/rare/seldom	604	49%	...	...	...
Often/sometimes	508	41%	...	...	...
Very frequently	122	10%	...	...	...
Bending/twisting					
Never/rare/seldom	643	52%	...	...	...
Often/sometimes	482	39%	...	...	...
Very frequently	111	9%	...	...	...
Leisure-time physical exertion					
Never/rare/seldom	602	49%	...	...	...
Often/sometimes	506	41%	...	...	...
Very frequently	126	10%	...	...	...
Perceived job stress					
None	282	23%	...	...	...
Mild	639	52%	...	...	...
Moderate to severe	311	25%	...	...	...
Mental health score (0–100)	1218	63.1 ± 16.8	...	...	...
Job dissatisfaction index (0.01–1.00)	1225	0.61 ± 0.17	...	...	...
Low back pain in past 12 months	628 (1241)	51%	988 (1798)	55%	...
Knee pain in past 12 months	234 (1241)	19%	395 (1798)	22%	...

Note. n1 = number of subjects in TDHS group; n2 = number of subjects not in study base. The total number summed up across each category varies slightly because of missing data.
[a]Other drivers received medical examinations at hospitals outside the study.
[b]Data from Dept of Statistics, Ministry of Transportation and Communication, Taiwan.[58]

different from drivers who were not enrolled, although they had a slightly lower prevalence of both knee pain and low back pain. We also noted that the demographic features of these 2 groups of drivers were comparable to the reference statistics.

Crude estimates of the 1-year prevalence of knee pain—stratified by duration of daily driving (≤6, 6–8, 8–10, and >10 hours)—were 11%, 17%, 19%, and 22%, respectively. Compared with drivers who drove 6 or fewer hours per day, the crude odds ratio of knee pain prevalence for drivers who drove more than 6 hours per day was 2.06 (95% confidence interval [CI] = 1.23, 3.43). Univariate analyses indicated that high frequency of bending/twisting activities during both work and leisure time, moderate to severe self-perceived job stress, a low mental health score, and high job dissatisfaction were significantly and positively associated with knee pain prevalence ($P < .05$).

The results of the multiple logistic regression analyses are shown in Table 2. After we adjusted for age, gender, BMI, income, education, marital status, smoking habit, frequency of regular exercise, mental health score, self-perceived job stress, job dissatisfaction index score, physical exertion during both work and leisure time, and professional seniority, taxi drivers with long driving times (>6 hours/day) had a significantly higher prevalence of knee pain than drivers with short driving times (≤6 hours/day): an adjusted odds ratio of 2.52 (95% CI = 1.36, 4.65). In contrast to the case for crude analyses, this increase in odds ratio estimate resulted mainly from the joint negative confounding by high physical exertion during leisure time, low income, and registration as an individual driver (as opposed to being in a cooperative practice or affiliated with a taxicab company). Those drivers with any 1 of these 3 characteristics tended to drive less than their counterparts.

The result of the Hosmer–Lemeshow test ($P = .74$) supported the goodness of fit of the multiple logistic model. The jackknifed odds ratio associated with long driving times (>6 hours/day) was 2.40 (95% CI = 1.24, 4.63). All of the jackknife estimates of the odds ratios for knee pain prevalence associated with each category of daily driving time were similar to estimates provided by all observations,

TABLE 2—Odds Ratios (ORs) and 95% Confidence Intervals (CIs) for Prevalence of Knee Pain in Past 12 Months (n = 1115): TDHS, Taipei, Taiwan, 2000

Characteristic	Crude OR (95% CI)	Adjusted[a] OR (95% CI)
Total driving per day, h		
≤6	1.00	1.00
6–8	1.70 (0.93, 3.11)	1.99 (1.00, 3.98)
8–10	1.95 (1.12, 3.40)*	2.55 (1.32, 4.94)**
>10	2.30 (1.35, 3.93)**	3.14 (1.62, 6.08)**
Bending/twisting		
Never/rare/seldom	1.00	1.00
Often/sometimes	1.25 (0.92, 1.29)	1.08 (0.75, 1.55)
Very frequently	1.75 (1.09, 2.80)*	1.56 (0.88, 2.75)
Leisure-time physical exertion[b]		
Never/rare/seldom	1.00	1.00
Often/sometimes	1.48 (1.09, 2.01)*	1.35 (0.94, 1.93)
Very frequently	1.78 (1.12, 2.82)*	1.94 (1.12, 3.34)*
Perceived job stress		
None	1.00	1.00
Mild	1.58 (1.05, 2.38)*	1.36 (0.85, 2.15)
Moderate to severe	2.49 (1.61, 3.84)**	1.78 (1.06, 2.99)*
Low mental health score[c]		
No	1.00	1.00
Yes	2.12 (1.57, 2.88)**	1.77 (1.26, 2.50)**
High job dissatisfaction[d]		
No	1.00	1.00
Yes	1.50 (1.07, 2.11)*	1.31 (0.90, 1.91)
Registration type		
Affiliated with taxicab company or cooperative practice	1.00	1.00
Individual practice	1.22 (0.91, 1.62)	1.60 (1.09, 2.35)*

[a]Adjusted for age, gender, education level, body mass index, marital status, income, smoking, professional seniority in years, days of driving per month, full-time status, frequency of heavy lifting activities, regular exercise, and all the other covariates in the table.
[b]The frequency of bending/twisting and/or heavy lifting when not at work.
[c]Low mental health score is defined as standardized mental health score lower than the first quartile as measured by the Taiwanese version of the 36-item Medical Outcomes Study short form (SF-36).
[d]High job dissatisfaction is defined as those whose job dissatisfaction index are in the highest quartile as measured by the job dissatisfaction subscale in the Job Content Questionnaire.
*$P<.05$; **$P<.01$.

suggesting that no observations were overly influential.

DISCUSSION

To our knowledge, analytic studies that show the association between knee pain and long driving times have not been reported in the literature in English. Our study indicated a likely association between long driving times and increased knee pain prevalence, both in the crude analysis and after adjustment for a large set of potential confounders and risk factors for knee pain and knee osteoarthritis.

Few previous studies have examined this interesting association. In a nationwide survey of musculoskeletal symptoms among post office pensioners in England,[59] Sobti et al. found that having driven more than 4 hours per day in previous occupations was common (15%) among post office employees. About 43% of pensioners reported experiencing knee pain or stiffness in the past month, but a significant association between driving and knee pain was not reported. In a survey of musculoskeletal pain in 12 groups of newly hired young workers (median age=23 years), Nahit et al.[60] examined whether the 1-month prevalence of knee pain (22%) was related to daily driving duration. The odds ratio associated with driving 15 minutes or more per day was found to be nonsignificant (odds ratio [OR]=1.0; 95% CI=0.6, 1.7). Because both study populations in Sobit et al. and Nahit et al. consisted of members of occupation groups with different background risks for musculoskeletal disorders, the limited variability in driving duration may not have provided the investigators with sufficient power to detect a significant association between long driving times and knee pain.

Our finding of a significant association between daily driving duration and knee pain was in accord with the results of previous studies. In an earlier study by Jajic et al.,[61] a significant increased concentration of 99 ^{m}Tc-polyphosphate in bone scans of knee joints (indicating increased bone rebuild, an early sign of degenerative changes referred to as a "preosteoarthrotic condition" in the report) was found among professional drivers. A recent study by Coggon et al.[62] showed an association (OR=2.3; 95% CI=1.4, 4.0) between long driving times (≥4 hours/day) and knee cartilage injuries in a community-based case–control study. Several survey results[63–65] have indicated that the knee is one of the joints most frequently injured in motor vehicle accidents. Studies of musculoskeletal injuries among bus drivers also showed that injuries to the lower extremities, including the knees, were the most common musculoskeletal injuries.[66] In a subset of 893 drivers who had information on previous motor vehicle accident–related knee injuries, we found previous knee injury to be strongly associated with knee pain prevalence (adjusted OR=6.54; 95% CI=1.62, 26.4). However, after we adjusted for previous motor vehicle accident–related knee injuries, long driving times were still significantly associated with increased knee pain prevalence (adjusted OR=2.30; 95% CI=1.18, 4.47).

We further examined the associations between knee pain and vehicle characteristics to provide some mechanic implications of our findings. Our analyses yielded no consistent association between knee pain and vehicle manufacturers or engine sizes. Interestingly, the crude knee pain prevalence among drivers who operated vehicles made in 1990 or earlier was 25%, but only 18% among those who operated vehicles made after 1990. This association was marginally significant (adjusted OR=1.63; *P*=.07) after we controlled for all variables retained in the final multiple logistic model (Table 2). In a previous exposure assessment study on back disorders,[52] we found that 37% of the taxicabs in Taipei had manual transmissions. Presumably, most taxicabs made before 1990 had manual transmissions; more repetitive motion in the lower extremities is required when driving such vehicles. Nevertheless, it is noteworthy that the association between duration of daily driving and knee pain remained statistically significant (OR=2.63; 95% CI=1.42, 4.88). Regardless of the potential measurement errors of this rough classification, our analyses imply that in addition to repetitive motions of lower extremities, the contribution of other physical factors associated with prolonged driving (e.g., strenuous knee postures, relative immobilization of the left knee when using an automatic transmission) should be investigated in future studies.

Other physical and psychosocial factors associated with knee pain in our study conform to previous observations. Physical activity during both work and leisure time has been found to be a risk factor for developing knee osteoarthritis.[67,68] Many studies have identified psychosocial variables, such as self-perceived job stress, job dissatisfaction, and mental health (all included in our study), that are important determinants of knee pain in both occupational and community settings.[4,19,69–71] Another interesting finding, which is probably related to psychosocial context as well, was that independent drivers had slightly higher knee pain prevalence (21%) than did drivers in a cooperative practice (18%) or those affiliated with taxicab companies (17%). This difference was statistically significant in the multiple logistic regression, which suggests that factors other than the physical and psychosocial variables retained in our model may be more common among independent drivers and may account for their higher knee pain prevalence. We posited that the social-network function (e.g., social support) could partially explain this observation, because independent taxi drivers may be more isolated than other taxi drivers. Detailed analysis of data from the Job Content Questionnaire is needed to support this speculation.

We wanted to be cautious about the observed association between driving and knee pain. Therefore, we took the following steps to rule out plausible alternative explanations of our finding. Because a few studies had found that clustering of musculoskeletal symptoms is very common,[59,70,72] we first examined whether the reported knee pain was merely a co-symptom of other more frequent musculoskeletal complaints, such as pain in the low back (51%), neck (50%), and shoulder (30%) in this group of taxi drivers. After adding these 3 variables into the final multiple logistic regression, we found that our data did support the clustering of musculoskeletal symptoms. Taxi drivers who reported musculoskeletal pain in these 3 sites had significantly higher knee pain prevalence, with a corresponding adjusted odds ratio of 1.88 (95% CI=1.35, 2.65) for those who had low back pain, 1.90 (95% CI=1.35, 2.71) for those who had neck pain, and 1.71 (95% CI=1.22, 2.41) for those who had shoulder pain. However, even after we adjusted for the clustering of musculoskeletal symptoms, the association between long driving times and knee pain remained statistically significant (adjusted OR=2.41; 95% CI=1.28, 4.50).

Our sensitivity analysis[73] (data not shown) was intended to examine the likelihood that our analyses had missed an important confounder not provided by the TDHS data. The sensitivity analysis was conducted to determine how severe an unmeasured confounder would have to be to affect our results. For a presumably confounded odds ratio to be depressed from 2.52, for example, to 1.50, we would have had to miss an unmeasured confounder. However, such a confounder either must be related to long driving times (>6 hours/day) with an odds ratio greater than 3 *and* associated with knee pain with an odds ratio of 4 or greater or must be related to long driving times with an odds ratio of 2 *and* associated with knee pain with an odds ratio greater than 5. Because no such strong factors have ever been documented, and because our association had been adjusted for a large set of variables retained in the multiple logistic model, we considered the odds of having missed such important factors to be small.

As a secondary analysis of existing data, our study had several limitations. First, the TDHS baseline data depended on subjective reporting to estimate the frequency of musculoskeletal disorders. No further objective information was available on the nature of the reported knee pain, such as the sidedness of knee complaints and the clinical significance of the observed association between driving and knee pain. Future studies need to include these distinctions, especially when investigating knee pain in relation to early knee osteoarthritis and the resultant disability among professional drivers.

Second, our study may have been limited by shortcomings of the cross-sectional design. Although we employed a widely used occupational study questionnaire to measure the prevalence of knee pain, the Nordic musculoskeletal questionnaire does not include detailed items that assess severity of musculoskeletal symptoms. In a small subset of 319 drivers who were administered questionnaire items on severity of musculoskeletal complaints, 61% of those who had knee pain recalled that they had lost at least 1 day of work in the past year because of knee pain. The average number of lost workdays likely related to knee pain was 4.4 days (range: 1–30 days). Because of the study's cross-sectional design, it is therefore arguable that the TDHS baseline data may overrepresent cases of knee pain with relatively longer symptomatic duration (and probably with less severe underlying knee joint disorders). Counteracting this length-biased sampling is the healthy worker effect, which may either have excluded former drivers who had more severe knee pain (and therefore were forced to retire or quit) from the TDHS baseline data or led to changes of driving duration among symptomatic drivers who remained in the taxicab business. A prospective study should provide a more appropriate design to address these complexities.

CONCLUSIONS

Our exploratory analyses of the TDHS baseline data revealed a strong and robust association between long driving times and knee pain. The public health impact of work-related knee pain among professional drivers could be substantial. For this reason, findings from our cross-sectional study need to be replicated in longitudinal studies and in biomechanical studies that examine the nature and the mechanisms of knee pain and its relationship with early osteoarthritis. ■

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Contributors

All of the authors conceptualized the study and interpreted the results. J.C. Chen, W.P. Chang, and Y. Cheng developed the survey instrument. J.C. Chen performed the analysis and led the writing of the article. L.M. Ryan supervised the data analysis. W.P. Chang and C.J. Chen were the principal investigators of the Taxi Drivers' Health Study.

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Human Participant Protection

The study protocol was approved by the human subjects committee of the Harvard School of Public Health and by the institutional review board of the Taipei Veterans General Hospital, Taipei, Taiwan.

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