The prevalence of musculoskeletal troubles among car drivers

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In order to explore the relationship between car driving and musculoskeletal troubles, a cross-sectional structured-interview survey of low- to high-mileage drivers (including individuals who drove as part of their job) was conducted based on the Nordic Musculoskeletal Questionnaire. The results clearly showed that exposure to car driving was associated with reported sickness absence due to low back trouble and that those who drive as part of their job appear to be more at risk from low back trouble than those whose jobs primarily involve sitting (not driving) and standing activities. The frequency of reported discomfort also increased with higher annual mileage. In addition, drivers of cars with more adjustable driving packages had fewer reported musculoskeletal troubles. This identifies an urgent need for the training of managers of fleet vehicles in the importance of developing measures to reduce this problem, for example, the selection of an individual's car with respect to comfort and postural criteria.

Key words: Driving; low back pain; musculoskeletal problems; posture; questionnaires.

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Introduction

The fact that low back discomfort frequently accompanies driving is no surprise to many researchers. In a study of 1000 drivers at motorway service stations in England [1], it was found that 25% of all drivers and 66% of all business drivers were suffering from some low back discomfort at the time of the interview. There is concern about low back pain and the costs incurred in its management. There is now an increasing number of authors whose research has identified that prolonged exposure to car driving is a risk factor for low back pain. It has been reported as a risk factor for acute herniated lumbar disc in males [2–4] and for low back pain in American males [5,6], British males [7] and French commercial travellers [8]. Interestingly, the risks have been noted to be higher for similar exposures, i.e. driving for more than half the working day [2], >4 h/day [7] and >20 h/week [8]. Also, in the study of commercial travellers [8], it was found that the odds ratios for having low back pain in the previous 12 months increased with exposure to driving: 1.5 for driving a car 15–19 h/week, 2.0 for 20–24 h/week and 2.1 for >25 h/week. In addition, driver discomfort has been found to be more prevalent with increased time driving and less discomfort reported in drivers of cars with more adjustable features, such as steering wheel adjustment [1]. Preventative strategies such as lumbar supports, arm supports and seat inclination are also important [5].

Epidemiological studies examining the relationship between driving and musculoskeletal troubles are relatively few, which is indicative of the difficulties of conducting such research. Driving is part of our culture, such that it is difficult to advise 'giving up' driving or, due to costs, to advise 'changing a vehicle' in order to investigate whether driving a particular vehicle is causing musculoskeletal troubles. There are many reasons why a high prevalence of back pain could be expected, for example prolonged sitting, fixed posture, vibration, loss of lumbar lordosis, asymmetric forces acting on the spine and perhaps periodic lifting, any of which individually could lead to musculoskeletal troubles. Variables such as gender, lifestyle, work tasks, mood and motivation may also have an effect on reports of symptoms of discomfort in the lumbar

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region. It is probable that symptoms arise from multiple relationships and influences [9]. Further work is clearly needed in order to understand these relationships more completely.

It has been hypothesized that the pattern of occurrence of musculoskeletal troubles could be described as a pyramid, with a large proportion of people (prevalence 70–90%) at the bottom who suffer task-related musculoskeletal trouble but do not complain very much [10]. A minority of these develop serious clinical conditions (at the top), but between the extremes is a continuum of problems, many of which could be prevented by redesign of the work or workplace, i.e. the driving workstation.

The main objective of this project was to explore the relationship between driving and musculoskeletal troubles by investigating the prevalence of musculoskeletal troubles and exposure to driving. It was also hoped to identify some of the major factors associated with driver-related discomfort. The paper reports on a cross-sectional structured-interview survey of a sample of low- to high-mileage drivers, including individuals who drove cars as part of their job. A complementary study of 200 police officers was also carried out, where a significant and positive relationship was found between police officers' exposure to driving and low back trouble [11,12].

Method

The survey proforma

An identical proforma was used as in the previously reported interview study of police officers [11,12]. The structured interview was based on the standardized format of the Nordic Musculoskeletal Questionnaire, or NMQ [13,14], which was found to be a useful tool for collecting self-reported prevalence and sickness absence data. The NMQ had already been tested for reliability; it is short; it can accommodate different workforces and individuals; and it has shown itself to be non-threatening and accepted by subjects. Briefly, the NMQ consists of a general questionnaire for the analysis of the period prevalence (12 months), point prevalence (7 days) and intensity of musculoskeletal troubles (i.e. aches, pain, discomfort, numbness or tingling) in different anatomical areas (i.e. neck, shoulders, elbows, wrists/hands, upper back, lower back, hips/thighs/buttocks, knees and ankles/feet). Optional, more detailed, sheets are included as part of the NMQ on the neck, shoulder and/or low back. These detail the participants lifetime prevalence of, and sickness absence due to such 'trouble', and the effects (if any) on work/leisure activities.

Additional questions were added to the NMQ based on the literature regarding other possible risk factors for low back pain, such as age, gender, cigarette smoking, work and leisure activities. With regard to their work activities, subjects were asked to indicate their exposure to sitting, standing, lifting (5 kg or more), sudden maximal effort and vibration on a 4-point scale (often, i.e. >4 h/day; sometimes; rarely, i.e. <2 h/day; or never). Subjects were also asked to indicate how many hours each week they regularly participated in sports identified by physiotherapists and osteopaths as 'high risk' for neck and back problems (e.g. rugby, aerobics, squash). Scales for measuring job satisfaction were considered too lengthy and threatening for a public interview, therefore a 5-point scale was included as a crude indicator. At the end of the interview, there was a series of questions regarding the age, type and adjustment features of their main vehicle, together with details of any discomfort experienced (5-point scale) and in which body area(s). Details of their exposure to driving in terms of annual mileage (private), driving for work/week (hours, miles) and journey to work (hours, miles) were collected. These questions were added at the end of the interview to avoid the possible bias created by subjects linking their own musculoskeletal troubles to their driving.

Sampling

Members of the British public were selected (n = 600, 303 males and 297 females), roughly distributed within six age groups (17–24, 25–34, 35–44, 45–54, 55–64 and 65–74 years). Venues around the UK (including town centres, shopping malls, sports halls, motorway service areas, holiday resorts, parks and small companies) were used for the structured interviews. Attempts were made to minimize sampling bias, by, for example, not informing subjects of the exact purpose of the study; using the incentive of a donation to charity in exchange for their time as a focus for participation; and recruiting subjects at different times of the day. Special cases, e.g. wheelchair users, were not interviewed as their vehicles may have adaptations and their physical disabilities may include musculoskeletal troubles. The lead researcher and a team of six trained interviewers conducted all of the interviews. The average completion time for each interview was between 10 and 15 min.

The original sample comprised a wide range of age groups, annual mileage, vehicle types, heights and body mass indices. Due to their small numbers, subjects who reported their main vehicle to be an HGV, motorbike or van were excluded from the sample. Table 1 shows descriptive data for the sample of non-drivers (n = 135); social, domestic and pleasure car drivers (S,D&P, n = 309); and those who drove cars as part of their job (n = 113). All working participants had been employed in their current job for at least 12 months. No significant differences were found between the groups for any of the prevalence data, but individuals who drove as part of their job had more occasions and days ever absent with low

Table 1. Descriptive statistics for the samples of non-drivers, social domestic and pleasure (S,D&P) car drivers and subjects who drive cars as part of their job (n = 557)

Variable	*Non-drivers (n = 135)*	*S,D&P car drivers (n = 309)*	*Drive cars as part of job (n = 113)*	*Significance*
Sample				
Males	43	142	79	
Females	92	167	34	
Age (mean ± SD)	36.0 ± 15.4	39.3 ± 13.6	39.3 ± 10.2	$P \leq 0.05$
Cigarettes smoked (mean ± SD)	4.4 ± 7.7	2.7 ± 6.5	3.7 ± 8.4	$P \leq 0.001$
Unemployed (%)	48	33	0	
Point prevalence (low back trouble) (%)	25	23	30	n.s.
Period prevalence (low back trouble) (%)	46	45	55	n.s.
Lifetime prevalence (low back trouble) (%)	55	55	61	n.s.
	Workers only (n = 70)	*Workers only (n = 207)*	*All workers (n = 113)*	
Days ever absent with low back trouble (mean ± SD)	1.7 (4.7)	5.0 (16.7)	16.2 (67.3)	$P \leq 0.01$
Hours worked (mean ± SD)		36.9 (14.4)	49.3 (16.6)	

back trouble than workers in the two other groups; for example, 16.2 ± 67.3 days (mean ± SD) ever absent with low back trouble, compared with 5.0 ± 16.7 days for 'social, domestic and pleasure' drivers and 1.7 ± 4.7 days for non-drivers. However, in this study those in the sample of non-drivers were considerably younger than the other two groups, they smoked more cigarettes and nearly half of them were unemployed. Individuals may not be able to drive for many reasons (for example, age, disability or financial difficulties), all which could have a confounding effect on the data. As 'exposure to driving' in the sample covered a good range, from 10 to 2000 miles a week and from 4 to 60 h/week, a decision was made to refine the sample and concentrate on low/high exposure to driving, rather than exposure/non-exposure. Non-drivers were thus also excluded from the sample, such that the results reported in this paper refer to the sample of car drivers only (Table 2).

Table 2. Descriptive statistics for the refined sample of low- to high-mileage drivers (n = 422)

	Annual mileage			
Variable	*<5000*	*5001–12 000*	*12 001–25 000*	*25 001+*
Total	128	145	89	60
Males	48	65	65	44
Females	89	80	24	16
Age[a]	40.1 ± 14.2	39.7 ± 13.5	38.1 ± 11.3	37.1 ± 9.5

[a]Mean ± SD.

Results

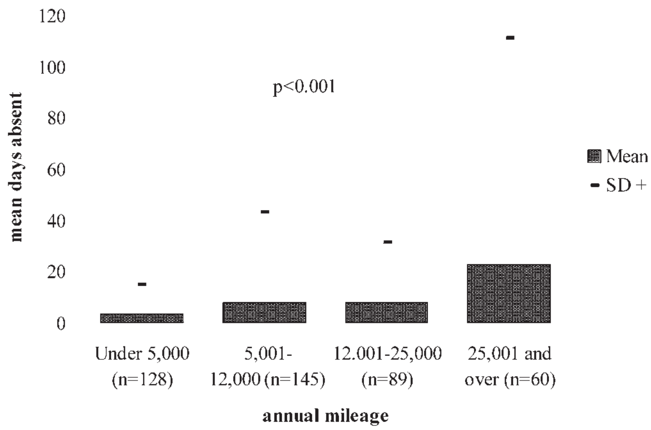
Analyses were carried out using SPSS and the statistical tests employed are indicated in the text. Relevant descriptive data, statistically significant findings ($P \leq 0.05$) and consistent trends ($0.1 \geq P \geq 0.05$) only are reported.

Exposure to driving

The results clearly indicate that exposure to driving a car in terms of annual mileage, distance driven to work and time taken to drive this distance are associated with reported sickness absence due to low back trouble. Figure 1 shows that the mean number of days ever absent from work with low back trouble was 22.4 ± 111.3 for high annual mileage drivers (≥25 001 miles), compared with 3.3 ± 14.7 days for low annual mileage drivers (<5000 miles). There were positive, significant correlations between annual mileage and the number of occasions (Pearson's r correlation coefficient = 0.1, $P \leq 0.05$) and days ($r = 0.2$, $P \leq 0.001$) ever absent from work with low back trouble. These correlations were found to be stronger if males were considered separately, i.e. $r = 0.2$, $P \leq 0.01$ (occasions) and $r = 0.2$, $P \leq 0.001$ (days ever). This was thought to be due to the considerably higher exposure to car driving of the males; a mean of 17 777 ± 16 871 miles, compared with 9707 ± 10 796 miles for the females (t-test, $P \leq 0.001$). Male drivers with longer journeys to work, perhaps representing regular daily exposure, also reported experiencing more low back trouble in the previous 12 months, but not necessarily more days absent (Spearman's rank correlation coefficient = 0.2, $P \leq 0.001$). This figure was approaching significance for females (Spearman's rank correlation coefficient = 0.2, $0.1 \geq P \geq 0.05$).

Considering those whose work involved driving a car as part of their job, the results again clearly showed that the number of occasions and days ever absent with low back

Figure 1. Number of days ever absent from work with low back trouble for car drivers according to annual mileage ($n = 422$).



trouble were higher in those with the greatest exposure to driving (Table 3). For example, there was a positive, significant correlation between the number of days ever absent from work with low back trouble and hours driven as part of work ($r = 0.4$, $P \leq 0.001$). Figure 2 shows that individuals who drove >20 h/week as part of their job had a mean number of days ever absent with low back trouble which was six times higher than those who drove <10 h/week as part of their job (51.4 ± 192.9 versus 8.1 ± 34.2 days). Also, the mean number of days ever absent from work with low back trouble was nearly three times higher for those who drove >500 miles/week as part of their job compared with those who drove <200 miles/week (33.7 ± 192.9 versus 11.2 ± 41.18 days).

Subjects who drove cars 'as part of their job' were compared with 'social, domestic and pleasure drivers'. No significant differences were found between the groups for any of the prevalence data, but individuals who drove cars as part of their job had more occasions and days ever absent with low back trouble than workers in the other group. For example, they had 16.2 ± 67.3 days ever absent with low back trouble compared with 5.0 ± 16.7 days for 'social, domestic and pleasure' drivers who worked (t-test, $P \leq 0.01$). Some of this difference could be explained by the fact that 'social, domestic and pleasure' drivers worked fewer hours (Table 1).

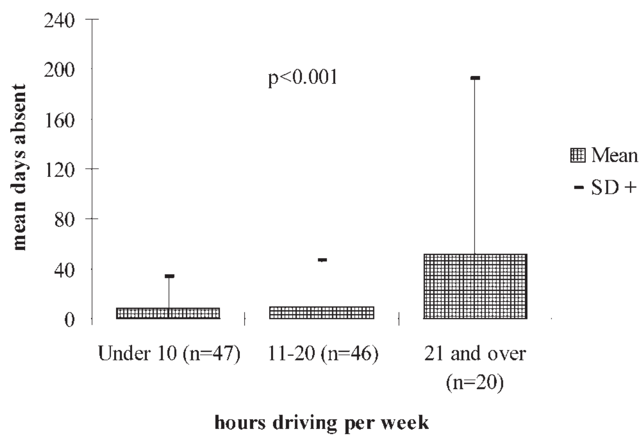
Multiple regression analysis was used to explore the variables important in being linked to sickness absence due to low back trouble. A statistical approach based on adjusted r^2 was used to decide the set of variables for the best fit to the model [15]. The number of 'hours driven as part of work' was selected, along with the variables 'having had a back accident' and the 'number of cigarettes smoked a day', as being significantly important in explaining the 'number of days ever absent with low back trouble' for the sample of those who drove cars as part of their job, accounting for 25% of the variance (Table 4). Despite this, it should be remembered that these data do not fit all of the assumptions for multiple regression analysis, affecting the ability to draw conclusions based on the actual value of the correlation coefficients. However, it was judged by the authors that confidence could be given in the variables selected by the technique as being important in explaining 'days ever absent with low back trouble' for this sample.

Table 3. Correlation coefficients (Pearson's r) for exposure to driving (hours and distance) and low back trouble for subjects who drive as part of their job ($n = 113$)

Criteria	*Hours driven as part of work (n = 113)*	*Distance driven as part of work (n = 113)*
No. of occasions ever absent from work with low back trouble	0.4^{***}	0.2^{*}
No. of days ever absent from work with low back trouble	0.4^{***}	0.3^{**}

$^{*}P \leq 0.05$; $^{**}P \leq 0.01$; $^{***}P \leq 0.001$.

Figure 2. Number of days ever absent from work with low back trouble for car drivers according to hours travelled as part of work ($n = 113$).



Discomfort was reported in at least one body area by 54% of car drivers, which is comparable with a survey of 1000 drivers [1], where 53% of the sample reported some discomfort. Also, the most frequently reported areas of discomfort were the low back (26%) and neck (8%), again comparable with the survey [1] where the figures were 25% (low back) and 10% (neck). In addition, 20% of high-mileage drivers (≥25 001 miles) 'always' or 'often' had discomfort with their car, compared with 7% of low-mileage drivers (<5000 miles).

Comparison of driving with other working postures

Considering the working population only, the question on self-reported work activities was used to divide the sample of 'social, domestic and pleasure' drivers into

Table 4. Variables entered into the multiple regression equation for 'best fit' of the model to the sample of those who drive as part of their job (n = 113)

Independent variable	*Adjusted r^2*	*Significant change in f*
Hours driven at work	0.16	0.0000
Back accident	0.21	0.0035
No. of cigarettes smoked	0.25	0.0129

The dependent variable is sickness absence ever due to low back trouble.

three subgroups. These were: those whose work involved sitting (not driving) for >20 h/week (n = 114); a group whose job involved standing for >20 h/week (n = 159); and a group whose job involved regular lifting (≥5 kg, >10 times/h; n = 53). Some of these individuals were in more than one subgroup, but none of them drove as part of their job. Each of these subgroups was then compared with a subgroup of the sample of 'drivers as part of their job', i.e. those who drove a car for >20 h/week as part of their work (n = 50). The results clearly indicate that driving a car can be more detrimental than sitting and standing postures with regard to low back trouble. For example, Figure 3 shows that 36% of the group who drove >20 h/week for work experienced low back trouble for >8 days in the previous 12 months, compared with only 16% of the group that sat for >20 h/week at work. Car drivers who drove for >20 h/week for work have also had nearly four times as many days ever absent from work with low back trouble than the standing group (13.3 ± 39.5 versus 3.6 ± 12.9 days, $0.1 \geq P \geq 0.05$); however, the standing group did have more occasions and days absent with shoulder trouble. Comparisons with the lifting group showed no significant differences with regard to low back trouble, but neck trouble prevented normal activity for a greater number of days in the previous 12 months for the lifting group. The number of subjects whose work involved exposure to sudden maximal effort or vibration was too small for separate analysis.

Adjustability of the car

Drivers of cars that had an adjustable lumbar support reported fewer occasions ever absent with low back trouble than those without this feature (0.3 ± 0.8 versus 0.7 ± 2.4 days, $P \leq 0.05$). Also, drivers of cars with steering wheel adjustment, or an automatic gearbox, or cruise control had fewer days absent from work with neck and shoulder trouble in the previous 12 months than those drivers without these features. For example, drivers without steering wheel adjustment had 0.3 ± 3.4 days absent from work with shoulder trouble in the previous 12 months, compared with only 0.02 ± 0.2 days for car drivers with steering wheel adjustment ($P \leq 0.05$).

The small percentage of drivers who reported not enough headroom (7%), poor pedal position (10%), poor steering wheel position (5%) and no backrest angle adjustment (9%) also reported significantly higher frequencies of discomfort with their car. No differences were found with these subjects for any of the sickness absence measures.

When the three most common vehicle types were compared, i.e. supermini or small hatchback, small family car and large family car, it was found that, despite drivers of the large family car being of a slightly older age group and having a considerably higher mean mileage, the number of days of being prevented from carrying out normal activity due to neck or shoulder trouble was higher for drivers from the supermini and small family car groups. For example, 12% of drivers of superminis, compared with 3% of drivers of the large family car, had neck trouble which prevented normal activity in the previous 12 months. Interestingly, 12% of supermini drivers and 12% of drivers of large family cars reported having low back trouble that prevented normal activity in the previous 12 months.

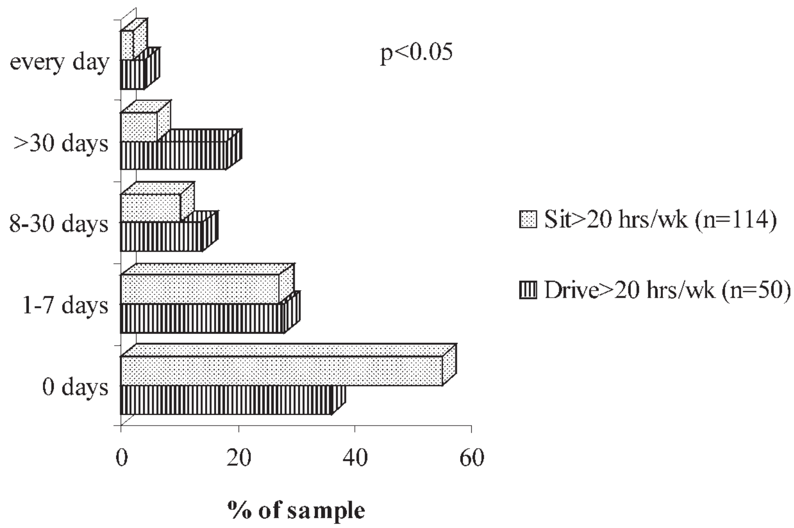
Discussion

The results of this research support the findings of our study in police [11] and those of other authors [1–8] that there is a relationship between car driving and musculoskeletal troubles. The risks identified similar exposures: driving a car for more than half the working day [2]; >20 h/week [8]; and >4 h/day [7].

It seems from the multiple regression analysis that having had a back accident is highly likely to be of significant importance in predicting the incidence of future low back trouble. It was a significant factor in two data sets: people who drive cars as part of their job and police officers, as reported in a complementary study by the authors [11]. It is also supported by the work of other authors: Biering-Sorenson [16] found that previous back trauma increased the risk of future low back pain, and Riihimaki *et al.* [17] reported that back accidents were strongly associated with the 12 month prevalence of sciatic pain.

When comparisons were made between four groups whose main work activities (i.e. for >20 h/week) were driving, sitting (not driving), standing and lifting, the drivers were found to suffer more low back trouble than the sitting and standing groups. Once again, these results generally agree with findings in the literature. For example, in an investigation of prolonged sitting at work, it was found that the relative risk of acute herniated lumbar disc whilst driving was twice as high as when sitting in a chair, regardless of the type of chair [2]. Also, derived risk estimates of low back pain for exposure to a work activity compared with non-exposure indicated that the relative risk for males sitting for >2 h/day was 1.3,

Figure 3. Number of days low back trouble experienced in the previous 12 months according to driving a car compared with sitting tasks.



compared with 1.2 for walking or standing, 2.1 for driving a car >4 h/day and 1.9 for lifting weights of ≥25 kg [7].

The improved postures and freedom of movement permitted by an adjustable lumbar support, adjustable steering wheel, cruise control and automatic gearbox appear to have a beneficial relationship with the sickness absence criteria. These judgements are also likely to be underestimates, as they were made away from their vehicle and also not by experts in posture. For example, some drivers may have unwittingly compensated for a lack of headroom by reclining the seat back more than they normally would for comfort. Again, the poor postures and biomechanically inefficient movement directions created are clearly the most probable causes of the discomfort.

The lower sickness absence due to neck and shoulder trouble in drivers of cars with features such as steering wheel adjustment and an automatic gearbox is probably due to a reduction in the number of postural constraints arising. Additionally, cars with an adjustable steering wheel and automatic gearbox typically have power steering, which considerably reduces the physical workload on the neck and shoulders.

The benefits of the large family car could be due to the higher mean number of adjustable design features (3.2 ± 0.9 versus 1.2 ± 0.9). Also, a greater number of the large family cars also had cruise control and an automatic gearbox (and possibly power steering), reducing the load on the neck and upper body. A similar percentage of drivers of both large family cars and superminis reported low back trouble preventing normal activity over the previous 12 months. However, whilst the supermini had only a low number of adjustable features, the mean annual mileage was only 9034 ± 9984 miles, compared with 21 734 ± 18 109 miles for the large family car. Just under half of the large family cars (41%) had an adjustable lumbar support, although its effectiveness could be questioned for these high-mileage drivers. In addition, an important point is that many lumbar supports also do not have height adjustment.

Other factors

Symptoms of low back trouble are likely to be due to multiple relationships and influences [9]. The facts that the maximum variance explained by the multiple regression analyses was only 25% and that the significant correlation coefficients themselves were generally low (e.g. 0.2, $P \leq 0.001$) were not surprising. Using data from an extensive study of 31 200 employees of an airline company [18], it was reported [19] that out of 56 variables, only job satisfaction and emotional stress were significantly correlated with initial reports of low back pain. In light of this, it is unlikely that all of the factors and influences associated with low back trouble were measured in this survey of car drivers. Also, due to time constraints and the fact that the interviews were conducted in public places, data regarding other factors such as socio-economic status and motivation were not collected. Some of the factors that were considered are now discussed with the relevant literature.

There were no significant differences between males and females for any of the prevalence or sickness absence measures of low back trouble in this study. The results in the literature are conflicting. For example, males have a higher prevalence of low back trouble at work than females [20]; females have an overall prevalence of low back pain 4% higher than that of males [21]; and females report a significantly higher frequency of musculoskeletal troubles related to their work in the neck, shoulders and knees [22]. Reasons for gender differences have been put forward as being the fact that females have to cope with childbearing, they have multiple role obligations, different anatomy and different responses to stress [21].

However, females in this study did report a significantly higher point prevalence, period prevalence and severity of neck, shoulder, upper back and wrist/hand trouble than males. One reason for this could be that more females worked in jobs that were classified as clerical and related (18%, compared with 2% of males), and consequently were perhaps exposed to high levels of keyboard work. Similar prevalence results to these were found in another study [19], although no reasons were put forward by the authors as to why this should be. This, together with conflicting results from the literature and the fact that men had a considerably higher mean mileage than women (17 777 ± 16 871 versus 9707 ± 10 796 miles, $P \leq 0.001$), led to the separate analysis of males and females when appropriate.

It would be reasonable to criticize the view that reported low back trouble (ever) is likely to be related to age. However, in this sample, exposure to driving did not significantly correlate with increasing age and there were no statistically significant correlations between age and any of the prevalence or sickness absence data for the low back. It can therefore be assumed that the effect of age on driving and low back trouble in this sample was minimal, agreeing with other authors [21,23,24].

However, the prevalence of musculoskeletal troubles reported in the large joints, such as the hips, ankles and elbows, was found to be higher with age. In the study by Porter *et al.* [1], older drivers actually reported less low back discomfort with their cars than younger drivers. Interestingly, it was found that the price of the car and the driver's age were positively correlated ($P \leq 0.001$), and that drivers of cars with more luxury features, such as an automatic gearbox, were older. This led the authors to suggest that age may be secondary to the price and thus the specification of the car.

Body mass index was calculated by dividing weight (in kilograms) by the square of height (in metres). For males only, the body mass index does seem to be related to the number of occasions and days ever absent from work with low back trouble. However, it is unlikely to be a major cause of low back trouble in high-mileage drivers, as the body mass index in males did not show a significant correlation with exposure to driving. Also, as may be expected (as it is a weight-bearing joint), the body mass index was found to be related to the point prevalence, period prevalence and severity of knee trouble, although again only for males.

Some authors [5,23,25] have reported an association between cigarette smoking and low back trouble, but in this study no significant correlations were found. However, in the multiple regression analysis for the sample of car drivers who drove as part of their job, the 'number of cigarettes smoked a day' was one of three significant variables (Table 4) selected as being important in predicting the variable 'days ever absent with low back trouble'. These three variables together explained 25% of the variance in the data. Also, when smokers were compared with non-smokers, they were absent from work with neck trouble on more occasions (0.2 ± 0.6 versus 0.1 ± 0.4, $P \leq 0.05$) and for a greater number of days (4.1 ± 18.1 versus 1.4 ± 9.5, $0.1 \geq P \geq 0.05$) than non-smokers. It is not clear from these data as to why this should be the case.

There was a significant positive correlation (for females only) between the number of hours participating in sports identified as being at risk for neck and back injuries (i.e. rugby, football, golf) and 'days ever absent with low back trouble'. The reason for this is not known, as out of the 'risk sports' identified, females reported more hours than males only for high intensity aerobics and horse riding. With the sample of males, there were correlations with 'risk sports' and the length of time neck and shoulder trouble prevented normal activity (work and leisure) in the previous 12 months. It is likely that neck and shoulder injuries would affect participation in demanding sports such as rugby, squash and football, and males participated in significantly more hours of 'risk sports' than females (1.5 ± 2.6 versus 0.8 ± 1.6 h, $P \leq 0.001$). The number of hours that sports were participated in did not show a significant correlation with exposure to driving and therefore the confounding due to 'risk sports' was likely to be minimal. Other authors [5] have also concluded that sports activity has a minimal effect on low back pain.

There were no significant relationships between job satisfaction and any of the sickness absence or prevalence measures. Most of the sample were generally satisfied with their jobs, with only 12% reporting that they 'would like a change'. It could be argued that more detailed questions regarding stress, motivation and other factors could have given a different result, but this would have been too lengthy and threatening for a public interview.

Limitations of the study

The main limitation of the study is that it is cross-sectional in design and therefore the variables identified as being important cannot be assumed to be predictive. In order to be of importance, the association between variables should be strong, repeatedly observed, the underlying cause specific, and the degree of time exposure and time interval should relate to the effect [9]. The authors agree with this statement but, due to constraints of time and cost, it was not possible to design a study which met all these criteria. However, efforts were made to ensure that the results had meaning. For example, preventing selection bias by avoiding the selective admission of those with back pain into the driving group, minimizing observation bias by not informing subjects of the precise reason for the survey and collecting as much information as possible on confounding factors. Although this study would not allow the examination of cause and effect, it is believed that the prevalence data and other details collected enhance an understanding of musculoskeletal troubles and driving.

Another limitation of the study is that, due to time constraints, it was not possible to triangulate the data with records (e.g. work histories, medical records) or observation (e.g. car measurements), therefore absolute confidence cannot be given in the validity of the self-reported interview data. Care was taken to be as specific as possible in the questions and 'check questions' were included.

A criticism of the data is that as we did not seek to obtain a sample of back pain sufferers, data for sickness absence due to low back trouble, for example, are not normally distributed and are positively skewed. Data are still presented in 'raw form', i.e. the full data set (except where indicated) and without transformations, for example logarithms or removing outliers. Despite this, the authors believe that the findings taken in their entirety are of value in judging the contribution of high exposure to car driving to reported musculoskeletal troubles.

Summary

The main findings are as follows.

- This survey has provided further evidence to support high exposure to driving cars as a contributing factor for sickness absence due to low back trouble. For example, individuals who drove for >20 h/week as part of their work had a mean number of days ever absent with low back trouble which was six times higher than those who drove for <10 h/week as part of work.
- There was a significantly higher frequency of reported discomfort, notably in the low back and neck, as annual mileage increased. The prevalence of wrist/hand trouble was also more frequently reported with high exposure to driving cars.
- Drivers of cars with the most adjustable driving packages, for example, a highly adjustable seat and steering wheel, were those with less reported sickness absence and discomfort. The authors believe that affordable, highly adjustable driving packages are needed which can be adjusted with minimum effort (even during a journey if necessary), with guidance provided on how to adjust the seat and controls for optimum postural comfort.
- Having had a back accident/acute injury is likely to be predictive of future low back trouble. The authors believe that it is important for employers to recognize these members of the driving workforce as being more at risk and so implement appropriate prevention strategies.
- As a result of this work, it is proposed that training programmes be devised to inform drivers and their employers of the potential risks of exposure to driving. Those particularly at risk are people who drive cars for >4 h/day. Encouragement is required, possibly in the form of legislation, to improve the management and prevention of the problems associated with discomfort and driving. Education will gradually increase employer and general public awareness of the benefits of driving packages which offer more adjustments and it is hoped that eventually car manufacturers will be motivated to provide suitably adjustable driving packages as standard.

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