

Effect of fork-lift truck driving on low-back trouble

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BRENDSTRUP T, BIERING-SØRENSEN F. Effect of fork-lift truck driving on low-back trouble. *Scand J Work Environ Health* 13 (1987) 445–452. In a population of 240 male fork-lift truck drivers who drove at least 4 h daily, the occurrence of low-back trouble was studied in relation to that of two reference groups. The participation rate of the fork-lift truck drivers was 88 %. The responses to a questionnaire concerning low-back trouble were reviewed. Among the fork-lift truck drivers, a statistically significant higher occurrence of low-back trouble was reported for the year preceding the study, in comparison, according to age, to that of a reference group of 399 working men (65 against 47 %); however, there was no significantly increased frequency when compared to that of a reference group of 66 unskilled male workers (65 against 51 %). The fork-lift truck drivers had a significantly higher rate of absence from work within the previous year due to low-back trouble than the two reference groups (22 % compared to 7 and 9 %). These findings were confirmed during the follow-up year. A correlation was found between length of employment as a fork-lift truck driver and the occurrence of low-back trouble within the preceding year. It was concluded that fork-lift truck driving may be a contributory cause for low-back trouble.

Key terms: sideways trunk-bending, static sedentary position, stooping, twisting of trunk, whole-body vibration.

An average of 62 % of the Danish population between 30 and 60 years of age has experienced pain or other trouble with their lower back at some period in their lives (4), and 7 to 8 % of occupationally active men and women have been reported to be sick each year because of low-back trouble (5).

In the occupational environment of fork-lift truck drivers, five conditions occur which can be assumed to increase the risk for contracting low-back trouble (3). The fork-lift truck drivers assume a *static sedentary position* while driving, with their hands and feet held steady on handles and pedals. During the course of performing typical tasks, the driver assumes the following positions as well: *twisting of the trunk in relation to the pelvis, stooping positions, and deep sideways trunk-bendings*. Finally, while driving, the driver is exposed to *whole-body vibration*. The influence of the occupational environment on fork-lift truck drivers has been described in more detail elsewhere (7).

On the basis of the aforementioned risk, an investigation of the incidence of low-back trouble among fork-lift truck drivers was found relevant.

Subjects and methods

Fork-lift truck drivers from 13 companies in the greater Copenhagen metropolitan area participated in this study. From these companies, all of the 240 employees were invited who, at the time of invitation, 1979–1980, drove fork-lift trucks for at least 4 h a day.

The 13 companies included trades such as large grocery stores, metal works, warehouses, and lumber and paper warehouses. The task of the fork-lift truck driver consists of transporting goods, usually stacked on pallets, to and from warehouses, trucks, freight cars, or ships.

As no collected registration of fork-lift truck drivers in Denmark was available at the time of the investigation and because no single trade union covers all fork-lift truck drivers, the population of fork-lift truck drivers had to be selected through contacts with companies which were assumed to have a considerable number of employees with fork-lift truck driving as a main occupation.

In the 13 companies, mainly small fork-lift trucks with a loading capacity of 1.25 to 2.5 t were used. These fork-lift trucks are designed to operate in narrow spaces and are thus very compact, a fact which has resulted in an ergonomically poor construction of the driver's seat (7).

The companies were contacted through the management or shop steward/safety representative. During work hours, a 30-min meeting was held with the drivers, during which the investigation was explained and the workers were invited to participate. The participation entailed the drivers' filling out a questionnaire which was handed out at the meeting and their under-

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going a health examination. The few truck drivers who were unable to attend the meetings had the invitation and questionnaire given to them by the shop steward/safety representative. The complete content of the health examination has been reported elsewhere (7). It included a physical examination of the lower back.

The health examination and review of the completed questionnaires took place at the Glostrup Population Studies, Department of Internal Medicine C, Copenhagen County Hospital, Glostrup, for 174 of the 211 participating fork-lift truck drivers and at one of the companies for the remaining 37. The period of investigation was from 1 September 1979 to 16 June 1980.

The low-back trouble among the fork-lift truck drivers was compared with that of reference groups selected from a population study which had been undertaken at the Population Studies in Glostrup during the period 22 November 1977 to 15 October 1978 (4). In this population study, everyone from the Glostrup municipality in the exact age groups 30, 40, 50, and 60 years was invited. Participating in the investigation were 928 men and women, corresponding to 82 % of those invited. This study population was representative of the population in the same age groups in Copenhagen County with regard to marital status, income, hospitalizations, and occupation (4).

One of the reference groups was selected from this study, namely, all those men who answered "yes" to the following question: "Are you presently employed?" — a total of 415 men. Among these 415 men were 16 who were currently working as fork-lift truck drivers or drivers. These 16 men were excluded from all the analyses as they must be assumed to have been exposed to the same risk factors for low-back trouble as our fork-lift truck driver population. Remaining were 399 men, hereafter referred to as the "working Glostrup men."

To set up a reference group which resembled the fork-lift truck drivers as much as possible socially and economically, we selected a subgroup of unskilled male workers from the working Glostrup men. There were 66 in this second reference group, hereafter referred to as the "unskilled Glostrup men."

The same questionnaire concerning low-back trouble was employed in the population study and in the fork-lift truck driver study, and the staff used in the two studies was more or less identical.

On the day of examination all of the fork-lift truck drivers were examined during the morning hours, almost all of them before they had driven a fork-lift truck that day. On this day the fork-lift truck drivers returned the questionnaire which had been given to them at the introductory meeting and which they had filled out at home. The questionnaire concerned current influences of the occupational environment and health problems, as well as earlier employment history. On the day of the examination, the participants were given a questionnaire dealing with low-back

trouble, which they filled out during a coffeebreak. The questionnaires were reviewed, unanswered questions were repeated verbatim, and the answers noted on the form.

During the year following the health examination, each fork-lift truck driver was sent a questionnaire every third month requesting information on the occurrence of low-back trouble during the follow-up year, as well as information on any retirement from the job as a fork-lift truck driver. After the end of the year, the fork-lift truck drivers who had not answered the last inquiry were sent a reminder. The reference groups only had one questionnaire sent to them, ie, one year after the health examination. It concerned, among other items, questions about low-back trouble during the 12 months which had elapsed since the day of the examination.

Determination of low-back trouble

The frequencies for low-back trouble in this study are based on the answers to the following questions from the questionnaires:

1. "Have you ever had pain or other trouble with the lowest part of your back?"
2. "How many days during the last year have you had trouble with your back?"
- 3a. "Has the back trouble resulted in absence from work?"
- 3b. "If yes, how many days within the last year?"

In addition, the following question was asked during the interview on the day of the examination:

4. "Have you experienced pain in your back today?"

The concept of "the back" was perceived by the participants as the lumbar region of the back, since all previous questions and examinations exclusively concerned the low back.

During the follow-up year, the fork-lift truck drivers were asked the following question:

5. "Have you had pain or other trouble with your low back within the last three months?"

The reference group was presented with a similar follow-up question concerning the last 12 months after the day of the health examination.

For questions 2 and 3b only the number of persons having had low-back trouble and possibly absence from work, eg, a notation of above 0 days to the two questions, has been used.

Statistical analysis

A multiplicative model, described in more detail by Ahlbom (1), has been employed in the comparison between the low-back parameters of the fork-lift truck driver group with each of the reference groups. In the multiplicative model the frequency of a given param-

eter of low-back trouble in age group i within population j (fork-lift truck drivers or reference group) is defined as

$$I_{ij} = \alpha_i \cdot \beta_j,$$

where α_i is an age factor which is consistent in the two populations and β_j is a factor which can be different in the two populations, but which is the same in all age groups. Thus α_i can be described as the frequency of a parameter of low-back trouble in age group i for both populations. Correspondingly β_j can describe the frequency of a parameter of low-back trouble in population j for all age groups. β_j can be described as a "sophisticated" standard morbidity rate (SMR) for population j . For a given parameter of low-back trouble, maximum likelihood estimation calculation was used to find those values of α and β which fitted the model best. Hereafter the expected frequencies in each population and age group were calculated. These expected frequencies were then compared with the observed frequencies. The chi-square test was used as a control of the model. Thereafter the hypothesis was tested that all β_j values were the same in the populations. Thus it was possible to take age differences between the groups into account.

A logistic regression analysis and odds ratio was employed for relations between low-back trouble and length of employment as a fork-lift truck driver. The differences were regarded as statistically significant for $P < 0.05$.

Results

The number of fork-lift truck drivers invited from each of the 13 companies varied between 2 and 44. The median percentage of participation was 88 (range 50–100 %). In a single company containing a small department, the fork-lift truck drivers possibly did not receive the invitation which had to be arranged by the chief of the section. These fork-lift truck drivers have been calculated among the nonparticipants.

Table 1 shows the age distribution of the fork-lift truck drivers and the two reference groups. It is to be noted that in the oldest age range there were only half as many fork-lift truck drivers as referents. As the fork-lift truck drivers were not selected according to an age criterion as the reference groups were, there are no referents for the 42 fork-lift truck drivers in the age group 20–24 years. This age group has therefore been deleted from the comparative analyses with the reference groups.

Table 2 shows the length of employment of the fork-lift truck drivers on the job. On the average, they had driven fork-lift trucks for seven years, but most of them had been on the job for 0–5 years. Of this group 75 % drove 6–8 h a day, and most of the 75 % only had pauses or relief work during the remaining work-hours. Among the remaining 53 fork-lift truck drivers,

who drove 4–5 h a day, half had lifting/carrying work for the rest of their daily workhours (corresponding to 13 % of the participating fork-lift truck drivers).

Table 3 gives an overview of the previous occupations of the fork-lift truck drivers before they entered their current job. In many of these occupations, the fork-lift truck drivers had been exposed to backstraining factors in their occupational environment. As an example, 78 of the fork-lift truck drivers (37 %) had previously been driving for more than half of their workhours per day for an average of eight years (between 0.5 and 30 years), eg, as a driver of a truck, tractor, or contractor's machine.

In figure 1, the occurrence of low-back trouble ever (the life-time prevalence) among the fork-lift truck

Table 1. Age distribution of the fork-lift truck drivers and referents.^a

Age (years)	Fork-lift truck drivers		Working Glostrup men		Unskilled Glostrup men	
	N	%	N	%	N	%
25–34	64	38	118	29	18	27
35–44	51	30	84	21	16	24
45–54	36	21	109	27	16	24
55–64	18	11	88	22	16	24
Total	169	100	399	99	66	99

^a The youngest age group of fork-lift truck drivers (20–24 years, N = 24) has been excluded from all the analyses in which fork-lift truck drivers have been compared with the reference groups because no referents were available for that age group.

Table 2. Length of employment in fork-lift truck driving.

Length of employment (years)	Fork-lift truck drivers	
	Number	Percent
< 1	8	4
1–5	115	54
6–10	51	24
11–15	21	10
16–26	16	8
Total	211	100

Table 3. Previous employments among fork-lift truck drivers (N = 211).^a

Previous employment	Fork-lift truck drivers (%)	Mean number of years
Self-employed, civil servants, salaried employees	20	9.6
Skilled workers, apprentices	21	7.8
Other unskilled work than fork-lift truck driving	81	9.4

^a Several persons had more than one kind of previous employment. Therefore the total percentage exceeds 100.

drivers and the reference groups is shown. Of the fork-lift truck drivers, 79 % (133 of 169) had at some time experienced low-back trouble in contrast to 63 % (251 of 399) of the working Glostrup men and 64 % (42 of 66) of the unskilled Glostrup men. The difference between the fork-lift truck drivers and the working Glostrup men was statistically significant, but that between the fork-lift truck drivers and the unskilled Glostrup men was not. About half of the fork-lift truck drivers indicated that they had experienced their first attack of back trouble before entering their current

occupation. This information was attained from a combination of the answers to two different questions, one concerning age at first attack of low-back trouble and the other concerning the year of starting fork-lift truck driving. Half of the fork-lift truck drivers, however, had no history of low back trouble before becoming fork-lift truck drivers.

Figure 2 shows the occurrence of low-back trouble during the year immediately preceding the investigation period (the one-year period prevalence, retrospectively). Among the fork-lift truck drivers, 65 % (110 of 169) had experienced low-back trouble within the last year in contrast to 47 % (186 of 399) of the working Glostrup men and 52 % (34 of 66) of the unskilled Glostrup men. The difference was statistically significant in relation to the working Glostrup men, but not in relation to the unskilled Glostrup men.

Figure 3 shows the consequences of low-back trouble in terms of absence from work during the year preceding the investigation. Among the fork-lift truck drivers, 22 % (37 of 169) had been absent from work due to low-back trouble during the year preceding the investigation in contrast to 7 % (28 of 399) of the Glostrup men and 9 % (6 of 66) of the unskilled Glostrup men. The differences were statistically significant in relation to both reference groups. The total work absence (low-back trouble + all other work absence) among fork-lift truck drivers was, on the average, 13 d per person during the preceding year, corresponding to an absence percentage of 5.2; the absence percentage has been calculated as number of days of absence as the percentage of the number of possible workdays.

Figure 4 shows the occurrence of low-back trouble on the day of the health examination of each single person (point prevalence). Twice as many fork-lift truck drivers — 21 % (36 of 169) — as working Glostrup men — 11 % (42 of 399) — indicated low-back trouble on the day of the health examination, and al-

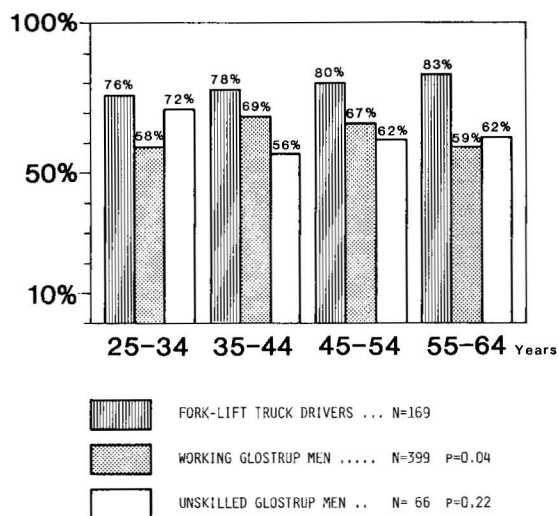


Figure 1. Lifetime prevalence of low-back trouble among the fork-lift truck drivers and the referents (P-values calculated for the comparisons of the fork-lift truck drivers with the respective reference group).

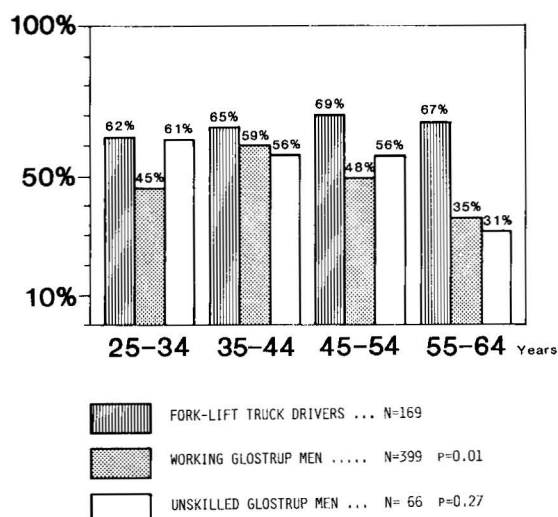


Figure 2. Prevalence of low-back trouble (determined retrospectively) among fork-lift truck drivers and referents during a period of one year (P-values calculated for the comparisons of the fork-lift truck drivers with the respective reference group).

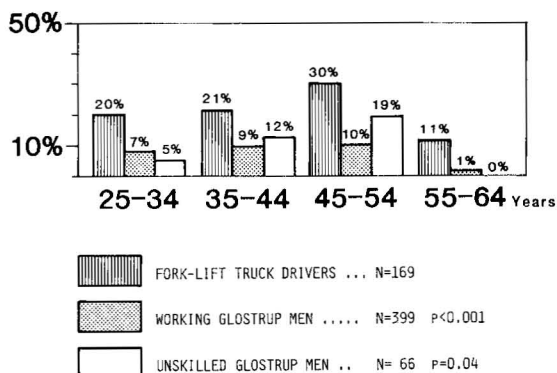


Figure 3. Work absence because of low-back trouble among the fork-lift truck drivers and the referents in the year preceding the examination (P-values calculated for the comparisons of the fork-lift truck drivers with the respective reference group).

most three times as many as the unskilled Glostrup men — 8 % (5 of 66). Both differences were statistically significant.

The participation in percentage during the follow-up year was 80 for the fork-lift truck drivers who had participated in the health examination and 99 for those in the reference groups. The follow-up questionnaires were sent by mail, and several questions were unanswered in the forms returned. In the calculations concerning the follow-up year the nonrespondents have been included in the denominators.

Figure 5 shows the occurrence of low-back trouble during the follow-up year (one-year prevalence, prospectively). During the follow-up year, the occurrence of low-back trouble was indicated as somewhat lower than in the preceding year. Among the fork-lift truck drivers, 51 % (86 of 169) reported to have experienced low-back trouble during the follow-up year as compared to 43 % (172 of 399) of the working Glostrup men and 47 % (31 of 66) of the unskilled Glostrup men. None of these differences were statistically significant.

Table 4 shows the occurrence of absence from work due to low-back trouble during the follow-up year. For two of the groups such absence occurred less frequently than in the year preceding the health examination. Among the fork-lift truck drivers, a total of 17 % (28 of 169) had had absence due to low-back trouble compared to 7 % (29 of 399) of the working Glostrup men and 3 % (2 of 66) of the unskilled Glostrup men. Both differences were statistically significant.

No significant differences appeared between the fork-lift truck drivers (16 %) and the reference groups with respect to the men who had received treatment for low-back trouble during the follow-up year (13 and 9 %, respectively).

In all, 21 % of the fork-lift truck drivers stopped working as fork-lift truck drivers during the follow-up year. Among this 21 % eight persons, corresponding to 4 % of the fork-lift truck drivers, reported that the change was due to back trouble.

Employing logistic regression analysis, we investigated the importance of age, length of employment as a fork-lift truck driver (0–2, 3–5, 6–10, > 10 years), and daily driving hours (4–5, 6–8) of the fork-lift truck drivers for the occurrence of low-back trouble during the year preceding the health examination for those 100 fork-lift truck drivers who reported not having experienced low-back trouble before starting this work. The logistic regression analysis showed that age and daily driving hours did not explain the occurrence of low-back trouble, whereas length of employment as a fork-lift truck driver was the factor related to low-back trouble ($P < 0.02$). Among the groups with different lengths of employment as a fork-lift truck driver, was an increasing occurrence of low-back trouble during the year preceding the study. The odds ratio for the 3- to 5-year group in relation to that of the < 3-year group was 7.0, that for the 6- to 10-year

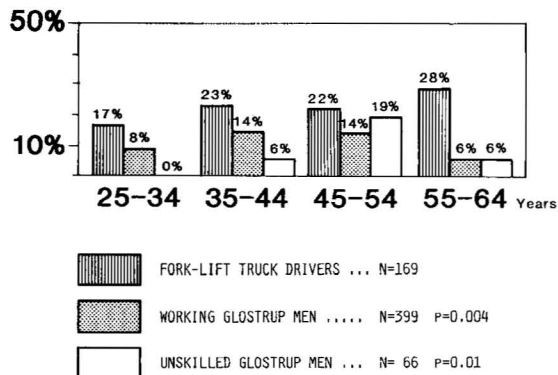


Figure 4. Low-back trouble (point prevalence) among the fork-lift truck drivers and the referents on the day of the investigation (P-values calculated for the comparisons of the fork-lift truck drivers with the respective reference group).

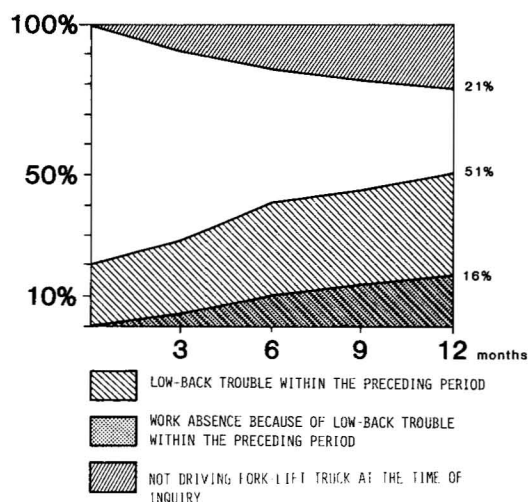


Figure 5. Low-back trouble among the fork-lift truck drivers (N = 199) during the follow-up year (cumulative percentage).

Table 4. Work absence because of low-back trouble among the fork-lift truck drivers and referents during the follow-up year.^a

Age (years)	Fork-lift truck drivers		Working Glostrup men		Unskilled Glostrup men	
	N	%	N	%	N	%
25–34	11	17	6	5	0	0
35–44	5	10	7	8	1	6
45–54	6	17	10	9	1	6
55–64	6	33	6	7	0	0
Total	28	17	29	7	2	3

^a The multiplicative statistical model showed a significant difference between the fork-lift truck drivers and the working Glostrup men ($P = 0.001$) and the unskilled Glostrup men ($P = 0.002$).

group in relation to that of the 3- to 5-year group was 1.3, and that for the > 10-year group in relation to that of the 6- to 10-year group was 1.5.

Discussion

Low-back trouble is a subjective phenomenon which is difficult to define objectively. Therefore, the most reasonable method, in accordance with Nordic recommendations (2), for determining low-back trouble has been found to be the use of a number of questions.

Question 1 (which gives the lifetime prevalence of low-back trouble) of our study was answered consistently by 84 % at two different examinations with an interval of approximately seven months in a sub-investigation (6) of 127 participants from the Population Study. This result was in accordance with the findings of earlier studies.

The 240 fork-lift truck drivers of our study were not selected as a representative group for the approximately 40,000 fork-lift truck drivers in Denmark for the reasons mentioned earlier. However, there is no reason to believe that the participating fork-lift truck drivers differed from other fork-lift truck drivers with the same daily driving hours. The high percentage of participation of the subjects entails the probability that the results are valid for fork-lift truck drivers at large.

This study showed that low-back trouble occurred more often among fork-lift truck drivers than among working Glostrup men. However, there was no significant difference between the occurrence of low-back trouble in fork-lift truck drivers and in unskilled Glostrup men. This lack of significant difference was possibly due to the small size of the reference group ($N = 66$), as the trend in differences between the fork-lift truck drivers and the unskilled Glostrup men moved in the same direction as for the larger reference group of working Glostrup men.

The reference groups employed were probably partly loaded by some of the same risk factors for low-back trouble as the fork-lift truck drivers. The unskilled male workers were probably especially exposed to stooping and twisted work postures, as well as to heavy lifting, which also increases the risk for low-back trouble. The occurrence of these risk factors for low-back trouble in the reference groups lessens the frequency differences of low-back trouble among the fork-lift truck drivers in relation to the reference groups. Ideally, a reference group of unskilled male workers should have been used in which risk factors for low-back trouble in the occupational environment did not occur. Such a study design was, however, beyond our possibilities.

The high occurrence of low-back trouble among the fork-lift truck drivers could be due to a primary selection of the job, i.e., that especially persons with low-back trouble apply for jobs as fork-lift truck drivers in the belief that the job is easy on the back. No ques-

tion was directly designed to elucidate why the job as fork-lift truck driver was applied for. All we know is that about half of the fork-lift truck drivers enter this work without having ever experienced low-back trouble earlier. According to figure 1 low-back trouble affects fork-lift truck drivers at an early age, and it continues to bother these workers at all ages if they stay on the job. In the reference groups the lifetime prevalence of low-back trouble seems to decrease a little with age. This phenomenon might be explained by recall bias or a change in the concept of low-back trouble in the older generations.

According to figure 2 about two-thirds of the fork-lift truck drivers in all the age groups had low-back trouble during a one-year period, while in the reference groups the occurrence of low-back trouble decreased with age, probably because the workers leave their back-straining jobs. These facts might indicate that, if a person keeps his job as a fork-lift truck driver, he will also continue to suffer from low-back trouble.

Information about total absence from work was not available for the reference groups. However a comparison of the general absence from work for the fork-lift truck drivers (absence percentage 5.2) with that of male workers in the metropolitan area from the statistics of the Danish association of employers (absence percentage 6.2 in the first quarter of 1982) (12) shows that the absenteeism of the fork-lift truck drivers was not increased. But when fork-lift truck drivers are absent from work, it is more frequently due to low-back trouble than is the case among other male workers in the area.

According to table 2 many fork-lift truck drivers leave the job after five years, and according to table 1 only a few stay in the job after the age of 55 years. These findings indicate selection out of jobs as fork-lift truck drivers.

In a separate study of 68 former fork-lift truck drivers, the reasons for leaving this type of work were compared to those given by 168 unskilled male workers who had left their job during the same period as the fork-lift truck drivers (7). Both groups had been employed in three of the companies which also participated in the main study reported in this article. The study is impaired by low response rates (69 % of the former fork-lift truck drivers and 55 % of the unskilled male workers), but still the reasons for leaving are of interest in the present context. Among the fork-lift truck drivers 32 % left their job partly because of health problems as compared to 43 % of the unskilled male workers. The health problem which was most commonly mentioned in both groups was back trouble.

During the follow-up year, a generally lower frequency of low-back trouble was found than during the year preceding the health examination. Part of this difference can be explained by the different study methods employed (4). While the first questionnaires were examined and supplemented on the day of the health examination, the study during the follow-up year was

conducted via a postal questionnaire. An interview after a questionnaire is filled out will elevate the proportion of positive answers. Only 80 % of the fork-lift truck drivers participated in this part of the study, and some of the returned questionnaires were incomplete. These circumstances probably also contributed to the fact that the number of positive answers was lower in the follow-up year. The fork-lift truck drivers received a questionnaire every third month in the follow-up year, while the reference groups only received a questionnaire at the end of the follow-up year. This difference might have distorted the comparison with the reference groups to a certain extent, as better recall of even slight back trouble within three months than within one year might tend to give a higher percentage of positive answers among the fork-lift truck drivers than in the reference groups.

In the described calculations concerning the follow-up year the nonrespondents were included in the denominators. The use of this procedure implies that there has not been any low-back trouble among the nonrespondents during the follow-up year. In other words, the frequencies given are minimum estimates. If the nonrespondents were excluded from the analyses, the frequency of low-back trouble among the fork-lift truck drivers would increase to 64 % (86 of 135). The frequency of absence due to low-back trouble among the fork-lift truck drivers would increase to 21 % (28 of 135). These percentages are very much in accordance with those from the year preceding the examination. The true value of the frequency of low-back trouble among the fork-lift truck drivers in the follow-up year was not revealed in this study because of the unknown frequency of low-back trouble among the nonrespondents. But it will probably be somewhere between the two set of percentages reported.

No other controlled study of low-back trouble among fork-lift truck drivers exists. Correlations with other studies are impaired by the fact that questions about trouble with the musculoskeletal system were not standardized at the time of these studies.

A number of different groups of professional drivers has been studied. A common feature for these and the fork-lift truck drivers is the fixed sedentary work position. Moreover, whole-body vibration, twisting of the body, side bendings, and stooping occur to a varying extent. In a study of the health conditions of Swedish professional drivers (8), a corresponding frequency of low-back trouble was found as in the present study.

Among male bus drivers in Copenhagen an occurrence of pain in the low back and/or buttock similar to that in this study was also found (11). Among a group of professional drivers, mostly truck drivers, driving more than half of the workday, an increased frequency of acute herniated lumbar intervertebral discs was found (9). Among Finnish tractor drivers in forestry work, an increased frequency of low-back trouble was found in a comparison with a group of

lumberjacks and in a comparison with a group of men in other occupations (10). Moreover, the tractor drivers had an increased frequency of spondylarthropathy in a radiographic examination of the lumbar spine. The tractor drivers were more frequently absent from work due to back trouble than were the other groups.

Only a few of these studies mention which specific influences the groups under investigation have been subject to in their occupational environment. Therefore, they cannot readily form a basis for preventive measures against low-back trouble.

From the present study, it can be concluded that fork-lift truck driving can be a contributing cause of low-back trouble. Brendstrup (7) has shown the occurrence of risk factors for low-back trouble in the occupational environment of fork-lift truck drivers in an observation study, and fork-lift trucks have been ergonomically evaluated. These procedures have been the basis for a number of proposals for improvement to minimize the risk for low-back trouble in fork-lift truck driving.

The most radical proposal is an entirely new construction of the fork-lift truck, giving the driver a better outlook. Existing fork-lift trucks should be thoroughly evaluated ergonomically, not only including the construction and flexibility of the driver's seat, but also the position of the handles and pedals. To diminish the amount of whole-body vibration, a smooth surface on which to operate is essential.

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