Industrial accidents are related to relative body weight: the Israeli CORDIS study

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Abstract

Objectives—The accident rate might be influenced by intrinsic characteristics of the workers, by risks inherent in the work environment, or a combination of these factors. As increased weight may be associated with sleep disturbances and fatigue, a high body mass index (BMI) might be an independent risk factor for accidents in industrial workers.

Methods—3801 men were examined and followed up for two years for the occurrence of accidents. The objective environmental conditions were recorded and translated into a single score of ergonomic stress level. Height and weight were recorded, as were possible confounding factors including measures of fatigue, type A personality, total night time sleep, job satisfaction, somatic complaints, smoking, and educational levels.

Results—Both BMI and ergonomic stress levels independently predicted involvement in accidents (two or more) with those in the highest BMI quartile who worked in an environment with high ergonomic stress levels having a 4·6 times increased risk of accidents compared with those in the lowest BMI quartile who worked in an environment with low ergonomic stress levels (95% confidence interval (95% CI) 2·4–9·0, P < 0·001). Although increasing somatic complaints and a low educational level also were predictors of accidents, they did not mediate the effect of the BMI on the accident rate. Increasing age, less smoking, and decreased sleep hours were significantly associated with an increased BMI, but the association of BMI and involvement in accidents also could not be explained by those factors or the other confounders.

Conclusions—BMI independently influences the accident rate. Further studies are warranted to confirm these findings and to explore mechanisms supporting biological plausibility.

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Individual variations in accident rates may be due to intrinsic characteristics of the workers, because some people are exposed to more risks, or because the occurrence of an accident increases the probability of having subsequent accidents. Accidents at work have been found to be related to personal characteristics including type A personality, dysfunctional personal backgrounds, work dissatisfaction, strain at work, smoking, fatigue, negative feelings occurring when defences against hostility conflict with authority fail, and age, with both younger workers and older workers having more accidents than those in the middle age range. The effect of the "riskiness" of the work environment on the accident rate, however, was taken into account in only one of the studies and may have biased the results.

Body mass index (BMI = weight (kg) divided by height (m²)) is an intrinsic characteristic which is easy to measure, and assesses degrees of obesity. An extremely high or low body mass index was reported to be a risk factor for injuries related to training in infantry soldiers, and Stooths et al reported that commercial long haul lorry drivers with a BMI of >30 kg/m² had a twofold higher accident rate than non-obese drivers. In a previous study we found that there was a twofold risk of serious accidents due to fighter pilot error in those pilots with a high body mass index. This effect is biologically plausible as factors negatively affecting personality or performance associated with an increased BMI lead to an increased accident rate. We are unaware, however, of previous studies of BMI and industrial accidents.

In this study we hypothesised that an increased BMI will be positively associated with the industrial accident rate. To control for inherent risks of the workplace, we measured the ergonomic stress level (a composite measure of several adverse job and environmental conditions) at each work station, which has been shown previously to predict factory accidents. Furthermore other intrinsic characteristics reported to be associated with accidents, such as education, type A personality, fatigue, and a history of smoking were examined to explain how the BMI may influence accident rates.

Methods

A total of 4306 men, employees of 21 industrial plants throughout Israel, were screened on site for cardiovascular risk factors between 1985 and 1987 in the CORDIS study. The ergonomic stress levels was not measured for 449 subjects, and BMI was missing in 70 men, leaving 3801 men after excluding those with missing data. The industries included furniture factories, electronics, textiles, food factories, tyre factories, and iron product production plants. The popu-
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...lation was confined to those working in industry. Nearly 70% were blue collar workers. Workers were offered free of charge an extensive history, physical examination, and cardiovascular risk factor evaluation. The response rate was 59.5%, and failure to participate was found to be largely due to technical and logistic factors rather than to worker reluctance. The examining team were only able to be at the plant for a limited time, and workers who were on leave, in reserve military service, or working outside the factory at the time of examination were not included. Also, senior employees were provided with periodic check ups at centres outside the factory often chose not to undergo additional examinations. Amongst men, examinees were about five years older than non-examinees, and this was probably due to the fact that younger men were more likely to be away from the workplace for the reasons already mentioned. In a subsequent questionnaire study of non-responders, of those who gave a definitive answer 52% had logistical problems in being examined, 35% thought that the test was not necessary because they were well, and 13% thought that examinations should be done by their personal physician.

Each month, employees from one or two factories were screened. Physical examinations were obtained and questionnaires completed (about 10 subjects a day). Weight and height were measured.

The ergonomic evaluation was done by an experienced industrial hygienist who used the walk through inventory described previously.13 The scale of ergonomic stress levels consisted of 70 items which included six major areas of stress evaluation; (a) body motion and posture, physical effort—for example, sitting, bending, lifting; (b) job related stressors—for example, task complexity; (c) active hazards—for example, dangerous tools and machines; (d) safety guards, controls, and displays—for example, unguarded sharp angles; (e) environmental stressors—for example, noise; and (f) use of personal protection devices (masks). The observer went through the plant and surveyed the hazards, supplementing the assessments by noise measurements, gas or dust analyses, scanning of materials and processes, and discussions with expert plant staff or a safety warden. A summary score was given of the general impression, which varied from 1–5 with a high ergonomic stress levels defined arbitrarily as either 4 or 5.

Reliability within the observers was assessed in a previous study12 with four independent raters, who used the same item assessments for 39 workstations. The median of reliability coefficients obtained for the various items was 0.97. There was a high degree of stability of exposure over time. Job related and environmental conditions were steady, and workers were nearly always permanently (>99%) assigned to a given task.

Data on accidents were compiled from all accidents registered at the participating factories over a period of two years (1986–7) which resulted in at least one day's loss of work and were recorded in the worker's personal records. Accidents of three days or more are required to be reported to the National Insurance agency. Of those reported, all were found in the worker's personal records. It is likely however, that accidents of two days or less were underreported and therefore were underrepresented in our study.

Type A personality was measured by an adaptation of a shortened version of the Vickers scale.19 Fatigue was assessed by two questions. Are you usually wide awake during your work shift? (yes or no) and how often do you have significant fatigue? Somatic complaints were assessed by 12 four point scales based on the index reported by Caplan et al.15 It measures the frequency of symptoms experienced during the month before participation—for example, dizziness, shortness of breath, and headaches. Job satisfaction was measured by the "satisfaction with work itself" facet of the job description index (JDI).16

The SAS package (SAS Institute, 1989) was used for data editing and analysis. For dichotomous data, the x² test was used and when small numbers were present Fisher's exact test was substituted. Relative risks with 95% confidence intervals (95% CIs) were also calculated. For comparison between the means analysis of variance (ANOVA) was used except when the data were not distributed normally, in which case Kruskal-Wallis one way non-parametric analysis of variance was substituted. Odds ratios (ORs) and 95% confidence intervals (95% CIs) were calculated from logistic regression. Significant differences were those with P < 0.05.

Results
There were 870 reported accidents concerning 707 of the 3801 male workers (18.6%) who experienced at least one accident over the two years. The number of workers remained stable over the two years with around a 5% retirement and hiring rate over the study period. One hundred and twenty three workers experienced between two and six accidents. The frequencies fit a Poisson distribution: one accident 584 (15.4%); two accidents 94 (2.5%); three accidents 22 (0.6%); and four to six accidents 7 (0.2%). The median number of days lost due to accidents was nine days with over 93% of cases being absent for at least two days.

Univariate Analysis
Comparison of those with two or more accidents with those with no accidents showed a significant increase in BMI, somatic complaints, ergonomic stress levels, and education < 12 years, but not the other variables (table 1). The cohort was divided into BMI quartiles. Age, smoking, education, and sleep hours were significantly different between these groups (table 2). There was a similar proportion, however, of those with a high ergonomic stress level in the various groups.

The accidents were divided into four groups: falls, struck by moving objects or caught in machinery, road accidents, and other. The mean (SD) BMI was similar in those four categories (25.8 (3.6), 25.6 (3.7), 25.8 (3.5), and 25.3 (3.7), respectively).
The main finding of our study is that an increased BMI increased the risk of reported multiple but not single industrial accidents over a two year period. This effect was independent of workplace conditions as measured by the ergonomic stress levels. This is consistent with the association of BMI and accidents reported in drivers,10 and pilots.11 However, as there are no other reports of BMI and accidents in industrial workers, further studies are clearly needed to substantiate our findings.

The relation between BMI and accidents theoretically could be explained by fatigue and altered arousal states possibly related to sleep disturbances. Sleep disturbances are a well known phenomena in obese people, related to the sleep apnoea syndrome.17 Furthermore short sleepers were reported to be more likely to be overweight than longer sleepers in a study of 200 college students.16 We found an association with an increased BMI and less night sleep. The hours of sleep were identical in those with multiple accidents and those without accidents. We did not find a relation between BMI and self reported fatigue or alertness. Hughes et al also did not find an association between obesity and fatigue,18 and Gardner et al found no differences in physiological arousal between subjects who were obese and those of normal weight.20 Further studies including sensitive measures of sleep disturbances and fatigue are needed.

It is also possible that those with an increased BMI may be less mobile or have more chronic diseases, leading to increased risk of accidents. The BMI in our study however, was not increased in those with falls compared with the other types of accidents. We did not have detailed data on chronic diseases to determine if illness explains the observed association between BMI and accidents.

We did not find a difference in Vicker's type A personality measurements between those in the
various BMI quartile groups. Cooper et al found that type A coronary prone behaviour was a significant predictor of increased rates of accidents among offshore workers in the oil and gas extraction industries. Niemczyk et al found that the Jenkins activity survey predicted accidents in air traffic controllers. We are unable to determine whether the lack of such an association in our study was due to methodological differences or to the fact that a relation between type A personality measurements and accidents is found in only selected occupational cohorts.

Our results should be interpreted with caution. It is possible that more obese subjects are more likely to report the accidents than leaner subjects especially if they are less satisfied with their job, or define themselves as sicker. We did not, however, find any relation between BMI and either job satisfaction or somatic complaints, although somatic complaints in themselves independently predicted those with multiple accidents. Furthermore, most of the accidents were serious enough to require at least two days of absenteeism, and therefore would be likely to be recorded because of the necessity for evaluation and treatment by a physician. It is likely, however, that minor injuries with less than two days absenteeism were underreported. Secondly, extrapolation of our findings to other countries and ethnicities may be unwarranted. Although ethnicity was not found to be a causative factor in the incidence of work accidents in one study, we are unaware of studies in third world countries. However, it is likely that our results can be extrapolated to other modern industrial societies.

It is unclear whether interventions in weight reduction could lower accident rates. We did not find any influence of the BMI on the occurrence of one accident, and if the BMI is only a risk factor for involvement in multiple accidents, then the possible effect on the accident rate is minimal. Only 3% of our cohort had multiple accidents, and given even a 100% decrease in accidents by successful intervention in those workers in the upper quartile of BMI, there would be less than a 1% decrease in the two year accident rate (3% × 0-25%/2 = 0-38%). Thus it is unlikely that overall injury rates in the workplace would be effectively reduced by screening out workers with excessive numbers of injuries or those at increased risk of such occurrences. However, for overweight workers accident prevention is perhaps another reason to lose weight.

We found a significant effect of ergonomic stress levels on the accident rate which substantiates the findings of our previous study on a much smaller cohort. Contrary to our previous report, however, it was somatic complaints rather than job satisfaction which predicted accidents. We have no certain explanation for these findings. Because of small numbers the previous study had limited sensitivity and we were able to use as an end point only the occurrence of one accident or more. This does not explain, however, the lack of job satisfaction as a predictor of accidents in this study although we found a trend in the same direction. Thus it may be feeling sick more than a disturbing job and work environment which serves as a distracting stress factor, and such preoccupation may make the worker less attentive to danger cues, leading to a higher accident rate.

In conclusion, we found that BMI independently influenced the accident rate. Further studies are warranted to confirm our findings and to explore mechanisms which can support the biological plausibility of such a concept.

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