Occupational and Environmental Medicine 1996;53:686–691

Older workers in the construction industry: results of a routine health examination and a five year follow up

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Abstract

***Objective*—To describe the health status of older construction workers and the occurrence of early retirement due to disability or of mortality within a five year follow up.**

***Methods*—Firstly, a cross sectional study was performed among 4958 employees in the German construction industry, aged 40–64 years, who underwent standardised routine occupational health examinations in 1986–8. The study population included plumbers, carpenters, painters/varnishers, plasterers, unskilled workers, and white collar workers (control group). Job specific prevalence and age adjusted relative prevalence were calculated for hearing loss, abnormal findings at lung auscultation, reduced forced expiratory volume, increased diastolic blood pressure, abnormalities in the electrocardiogram, increased body mass index, hypercholesterolaemia, increased liver enzymes, abnormal findings in an examination of the musculoskeletal system, and abnormalities of the skin. Secondly, follow up for disability and all cause mortality was ascertained between 1992 and 1994 (mean follow up period = 4·5 y). Job specific crude rates were calculated for the occurrence of early retirement due to disability and for all cause mortality. With Cox's proportional hazards model, job specific relative risks, adjusted for age, nationality, and smoking were obtained.**

***Results*—Compared with the white collar workers, a higher prevalence of hearing deficiencies, signs of obstructive lung diseases, increased body mass index, and musculoskeletal abnormalities were found among the construction workers at the baseline exam. During the follow up period, 141 men died and 341 men left the labour market due to disability. Compared with white collar workers, the construction workers showed a 3·5 to 8·4-fold increased rate of disability ($P < 0·05$ for all occupational groups) and a 1·2 to 2·1-fold increased all cause mortality (NS).**

***Conclusions*—This study shows the need and possibilities for further health promotion in workers employed in the construction industry, targeting both work related conditions and personal lifestyle factors. Rehabilitation measures should be enforced to limit the rate of disability among construction workers.**

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Accepted 10 May 1996

(*Occup Environ Med* 1996;53:686–691)

Keywords: construction workers; early retirement; disability; mortality

The working conditions in the construction industry have been improved during the past decades and efforts have been made to reduce the amount of heavy lifting and carrying, but hard physical labour, static work, climatic influences, noise, and dust are still considerable burdens for construction workers.

Official statistics of occupational diseases published by the German Workmen's Compensation Board show that deafness caused by exposure to noise, occupational dermatoses, pneumoconioses, and disorders of the musculoskeletal system are the most frequent occupational diseases in the German construction industry.[1] Although young workers may compensate for these strains or may choose another occupation, older workers have more limited capacities and cannot easily transfer to another field of work. Among construction workers 63% of all retirements are due to medical conditions. In contrast, among the general workforce in Germany this proportion is about 44%.[2] Disorders of the musculoskeletal system are the predominant cause of disability among construction workers. Demographic changes and a loss of interest among young people in a career in the construction industry are probably leading to an increase of the proportion of older workers in this branch of industry. This development and the considerable work related strains emphasise the importance of evaluating the health and the related risk of disability of older construction workers. It suggests also further investigations to prevent far reaching social and medical consequences.

Subjects and methods

CROSS SECTIONAL STUDY

The study population consisted of 4958 men, aged 40–64 years, who were working in Wuerttemberg in the south western part of Germany. They were examined between August 1986 and December 1988 by the Occupational Health Service of the Workmen's Compensation Board for Construction Workers Wuerttemberg as a part of routine occupational health surveillance. These occupational health examinations are based on legislation on health and safety at work (Arbeitsicherheitsgesetz). Although it is

the duty of the employer to offer medical examinations for the employees, this is voluntary for the employees. During the period of investigation 78% of the invited employees participated in the medical examination.

The medical examination consisted of a job and medical history, a physical examination, audiometry, test of visual acuity, electrocardiography (ECG), lung function, and a blood and serum analysis. The examination was conducted by experienced occupational health physicians and documented according to a standardised protocol with fixed order and content, considering all aspects of a complete medical history and physical examination.

The study population included 388 plumbers, 521 carpenters, 633 painters/varnishers, 544 plasterers, 804 unskilled workers, 1861 bricklayers, and 207 white collar workers. The white collar workers were used as the control group. It consisted of architects, engineers, and office employees.

FOLLOW UP STUDY

Between October 1992 and June 1994, an active follow up of employment and vital status of the employees was carried out. In the follow up mortality status was found for 96·2% for the workers and disability status for 92·3%. Overall, 141 men died and 341 had to leave their work due to disability. Observations of workers who left the construction industry for other reasons were considered in the analysis concerning disability only up to that date. Completeness of follow up was considerably lower among foreign workers (for mortality 92·4%, for disability 86·5%) than among workers of German nationality (97·4%, and 94·5%, respectively) due to migration.

STATISTICAL METHODS

Cross sectional study

In the cross sectional study, crude prevalence and age adjusted (Mantel-Haenszel) relative prevalence (95% confidence interval (95% CI)) were calculated by occupational group for the following outcomes: sum of hearing loss at 2, 3, and 4 kHz greater than 105 decibels (dB) in at least one ear, pathological findings at lung auscultation (which were defined as rales, rhonchi, or crackling), forced expiratory volume in one second (FEV_1) less than 80% predicted, diastolic blood pressure (DBP) higher than 95 mm Hg, abnormal findings in the electrocardiogram (ECG), body mass index (BMI) greater than 27·8 kg/m^2, γ-glutamyl-transpeptidase (GGT) greater than 28 U/l (measured at 37°C), reduced mobility of the spine (fingertips to floor test, Schober sign), local pain at the spine or tenderness of the paravertebral muscles (assessed by palpation of the paravertebral muscles and percussion of the spine), abnormal findings in the limbs (limited or disturbed mobility, pain, swelling, deformation, or amputation) and skin abnormalities (eczema/inflammation, itching, or dyshidrosis).

Follow up study

For the follow up study, job specific crude rates of early retirement and mortality were calculated. With the white collar group as controls, relative risks (95% CI), adjusted for age, nationality, and smoking history were calculated for each occupational group with Cox's proportional hazards model.[3]

Results

CHARACTERISTICS OF SUBJECTS AT BASELINE EXAMINATIONS (TABLE 1)

At the baseline physical examination, the mean age of the employees varied between 47·9 years (plumbers) and 51·0 years (carpenters). Overall, the employees had worked for about 30 years on average, with the mean duration of employment ranging from 26·2 years among unskilled workers to 32·0 years among plasterers. The proportion of foreign workers varied from 1·5% (white collar employees) to 57·7% (unskilled workers). Most of the foreign workers came from southern Europe (Turkey, former Yugoslavia, Italy).

Smoking history was recorded for 76% of all workers, and information about alcohol consumption was obtained from 83%. About half of all blue collar construction workers were current smokers and daily alcohol drinkers, whereas the respective proportions were much smaller for the white collar workers. The highest prevalence of abstainers was found among the unskilled workers, which is probably due to the higher proportion of Muslims in this group.

MORBIDITY (TABLE 2)

Table 2 shows the crude prevalence of selected findings at the baseline examination by each occupational group. Compared with the white collar workers, the construction workers showed higher crude prevalences for most of

Table 1 Characteristics of the study population: professions, age, average working period, nationality, smoking history, and alcohol consumption

	Plumbers	*Carpenters*	*Painters/ varnishers*	*Plasterers*	*Unskilled workers*	*Bricklayers*	*White collar employees*
Number	388	521	633	544	804	1861	207
Age (mean (SD), y)	47·9 (5·4)	51·0 (5·5)	49·3 (5·2)	50·1 (5·3)	50·4 (5·7)	50·1 (5·3)	49·9 (6·1)
Working period (mean (SD), y)	29·5 (6·9)	31·6 (8·0)	31·7 (7·5)	32·0 (7·3)	26·2 (8·6)	29·8 (7·9)	28·0 (7·9)
Foreign workers (%)	5·9	25·0	13·1	16·2	57·7	32·8	1·5
Smoking history (%):							
Never	19·7	26·5	16·3	14·8	19·5	19·4	38·5
Former	29·4	25·1	27·5	29·3	17·3	26·2	20·9
Current	50·9	48·4	56·2	55·9	63·2	54·4	40·6
Alcohol consumption (%):							
Never	3·1	8·2	2·6	4·4	15·2	9·0	9·5
Occasional	49·1	33·5	41·3	37·4	25·2	28·8	62·6
Daily	47·8	58·3	56·1	58·2	59·6	62·2	27·9

Table 2 Crude prevalence of abnormal findings by occupation (%)

Crude prevalence (%)	*Plumbers*	*Carpenters*	*Painters/ varnishers*	*Plasterers*	*Unskilled workers*	*Bricklayers*	*White collar employees*	*All blue collar workers*
Ear:								
Hearing loss at 2, 3, and 4 kHz > 105 dB	46·3	62·6	39·8	45·3	60·7	53·4	33·9	52·4
Lung:								
Findings at lung auscultation	5·2	8·1	3·6	7·5	11·8	6·9	2·9	7·4
FEV_1 < 80% predicted	12·7	17·7	18·3	17·2	22·5	16·7	14·3	17·7
Circulation:								
Diastolic blood pressure > 95 mm Hg	30·8	31·2	29·0	30·9	32·0	33·4	27·8	31·8
ECG abnormalities	4·9	6·0	6·2	7·5	8·1	6·9	5·3	6·8
BMI > 27·8 kg/m^2	36·2	40·9	33·1	39·9	32·6	40·3	24·1	37·7
Lipids:								
Cholesterol > 220 mg/dl	60·8	65·6	62·7	57·4	51·7	60·6	58·5	59·6
Liver:								
GGT > 28 U/l	35·8	34·4	41·1	38·1	30·2	35·3	21·7	35·5
Musculoskeletal system:								
Reduced mobility of the spine	17·8	24·3	15·2	20·3	23·1	23·7	9·4	21·7
Pain at the spine or tenderness of paravertebral muscles	30·0	30·6	25·7	28·4	32·0	32·5	18·5	30·7
Symptoms in the arms and legs	32·2	42·0	28·4	32·9	31·5	34·1	24·2	33·5
Skin:								
Abnormal findings	20·6	24·9	20·0	22·5	28·7	25·5	19·6	24·5

the investigated items. For example, the prevalence of hearing loss varied from 33·9% (white collar workers) to over 60% (unskilled workers, carpenters). The prevalence of findings related to obstructive lung disorders was highest among the unskilled workers. Nearly a third of all investigated men showed an increased diastolic blood pressure (> 95 mm Hg).

A higher proportion of construction workers had an increased BMI compared with white collar workers. The prevalence of increased GGT (> 28 U/l) was clearly higher among all groups of construction workers (30·2%–42·2%) than among the white collar workers (21·7%). All construction workers had a higher prevalence of musculoskeletal abnormalities than white collar workers and also a higher prevalence of skin disorders (eczema/inflammation, itching, dyshidrosis).

AGE ADJUSTED PREVALENCE RATIOS (TABLE 3)

After adjusting for age all groups of construction workers had a significantly higher prevalence (α = 0·05) of increased GGT, increased BMI, and reduced mobility of the spine than the white collar workers. A significantly higher prevalence of musculoskeletal abnormalities (local pain at the spine or tenderness of paravertebral muscles, findings in the arms and legs) were found in most groups of blue collar workers. Furthermore, the age adjusted relative prevalence of hearing loss and a pathological finding at lung auscultation were higher for construction workers than white collar workers. Significantly increased prevalences of reduced FEV_1 (< 80% predicted) and of dermal abnormalities were only found in the group of the unskilled workers.

RESULTS OF THE FOLLOW UP (TABLE 4)

During the follow up period, 340 men retired due to disability and 141 men died. The most important causes of disability were diseases of the musculoskeletal system (40%) and diseases of the cardiovascular system (24%).

Table 3 Age adjusted prevalence ratios (95% CI): white collar workers are controls

	Plumbers	*Carpenters*	*Painters/ varnishers*	*Plasterers*	*Unskilled workers*	*Bricklayers*	*White collar employees*	*All blue collar workers*
Ear:								
Hearing loss at 2, 3, and 4 kHz > 105 dB	1·49 (1·19–1·85)	1·77 (1·48–2·12)	1·20 (0·96–1·49)	1·29 (1·05–1·59)	1·75 (1·47–2·09)	1·55 (1·30–1·86)	1	1·53 (1·29–1·82)
Lung:								
Findings at lung auscultation	1·80 (0·72–4·50)	2·75 (1·24–6·10)	1·36 (0·56–3·34)	2·55 (1·12–5·81)	3·97 (1·92–8·19)	2·41 (1·11–5·21)	1	2·55 (1·20–5·39)
FEV_1 < 80% predicted	0·95 (0·56–1·59)	1·13 (0·74–1·74)	1·34 (0·88–2·04)	1·16 (0·75–1·81)	1·50 (1·01–2·22)	1·14 (0·77–1·70)	1	1·23 (0·84–1·40)
Circulation:								
Diastolic blood pressure > 95 mm Hg	1·18 (0·90–1·54)	1·05 (0·82–1·34)	1·05 (0·82–1·35)	1·08 (0·84–1·39)	1·12 (0·88–1·42)	1·19 (0·95–1·48)	1	1·13 (0·91–1·41)
ECG abnormalities	1·01 (0·39–2·61)	1·01 (0·47–2·17)	1·13 (0·52–2·46)	1·32 (0·62–2·79)	1·39 (0·68–2·83)	1·23 (0·62–2·47)	1	1·22 (0·62–2·71)
BMI > 27·8 kg/m^2	1·56 (1·19–2·03)	1·65 (1·29–2·12)	1·37 (1·05–1·77)	1·64 (1·28–2·10)	1·34 (1·04–1·73)	1·65 (1·31–2·06)	1	1·56 (1·25–1·94)
Lipids:								
Cholesterol > 220 mg/dl	1·07 (0·93–1·23)	1·12 (0·99–1·27)	1·07 (0·94–1·22)	0·97 (0·84–1·11)	0·88 (0·76–1·01)	1·03 (0·92–1·16)	1	1·02 (0·91–1·14)
Liver:								
GGT > 28 U/l	1·66 (1·25–2·20)	1·54 (1·18–2·01)	1·87 (1·46–2·40)	1·71 (1·33–2·22)	1·39 (1·06–1·81)	1·59 (1·25–2·03)	1	1·62 (1·28–2·09)
Musculoskeletal system:								
Reduced mobility of the spine	2·12 (1·34–3·34)	2·37 (1·56–3·60)	1·67 (1·07–2·61)	2·11 (1·38–3·22)	2·35 (1·57–3·53)	2·46 (1·67–3·63)	1	2·27 (1·54–3·33)
Pain at the spine or tenderness of paravertebral muscles	1·78 (1·23–2·56)	1·61 (1·13–2·29)	1·42 (0·98–2·06)	1·53 (1·07–2·19)	1·72 (1·23–2·40)	1·76 (1·29–2·42)	1	1·67 (1·22–2·24)
Symptoms in the arms and legs	1·41 (1·07–1·85)	1·67 (1·31–2·13)	1·20 (0·92–1·57)	1·35 (1·04–1·75)	1·26 (0·98–1·63)	1·41 (1·11–1·78)	1	1·38 (1·09–1·73)
Skin:								
Abnormal findings	1·06 (0·75–1·49)	1·28 (0·94–1·75)	1·02 (0·74–1·41)	1·13 (0·82–1·55)	1·47 (1·10–1·96)	1·30 (0·98–1·72)	1	1·25 (0·95–1·64)

Table 4 Job specific results of the follow up (crude disability and mortality rates;relative rates)*

	Plumbers	*Carpenters*	*Painters/ varnishers*	*Plasterers*	*Unskilled workers*	*Bricklayers*	*White collar*	*All blue collar workers pooled*
Number at start of follow up	388	521	633	544	804	1861	207	4751
Disability:								
Person-years	1756	2108	2794	2258	2898	7441	946	19254
Events (n)	16	38	33	46	68	136	3	337
Crude rate (/100 000 p-y)	911	1803	1181	2037	2347	1828	317	1750
Adjusted* relative rate	3·52	4·84	3·68	5·97	8·39	5·89	1	5·39
(95% CI)	(1·03–12·12)	(1·49–15·72)	(1·13–12·04)	(1·85–19·23)	(2·62–26·90)	(1·87–18·54)	(control)	(1·73–16·85)
Mortality:								
Person-years	1865	2315	2973	2485	3390	8120	971	21147
Deaths (n)	9	12	13	20	28	55	4	137
Crude rate (/100 000 p-y)	483	518	437	805	826	677	412	648
Adjusted* relative rate	1·55	1·29	1·21	2·05	2·51	1·96	1	1·78
(95% CI)	(0·47–5·09)	(0·41–4·03)	(0·39–3·74)	(0·69–6·07)	(0·86–7·33)	(0·70–5·49)	(control)	(0·65–4·87)

*Adjusted for age, nationality, and smoking history.

Unskilled workers, plasterers, bricklayers, and carpenters had the highest disability rates, followed by painters/varnishers, plumbers, and the white collar group. Compared with the white collar group, each group of construction workers had a significantly higher rate of disability after controlling for age, nationality, and smoking history. The unskilled workers, plasterers, and the bricklayers showed a six to eightfold higher rate of disability than the white collar workers.

Mortalities for the construction workers were also higher than rates for white collar workers, but the increase was smaller than for disability and was not significant. Unskilled workers, plasterers, and bricklayers had the highest mortalities.

Discussion

Among the limitations of this study is the fact that it is based on examinations that were routinely performed by many different physicians. Use of a fully standardised protocol, however, should have ensured a reasonable degree of comparability. Furthermore, although the size of the control group was comparatively small, it reflects the proportion of white collar workers to blue collar workers in the construction industry, especially in small companies. Other limitations include selection mechanisms, like the healthy worker effect or selective survival, but these would typically result in an underestimate of the associations. Therefore, despite these limitations, the results show a variety of restrictions concerning the health of older construction workers compared with the white collar control group. It is possible that as well as being affected by work the higher morbidity among the construction workers may be affected by other aspects, such as social conditions and attitudes.

For a long time hearing deficiencies caused by noise have been one of the most important occupational diseases in Germany, and the high number of elderly people with noise induced losses present a formidable challenge.[4] The National Institute for Occupational Safety and Health estimates that a quarter of workers of 55 years of age or older in the United States exposed to noise levels above 90 dB(A) have a substantial hearing impairment.[5,6] Hearing deficiencies may occur even after brief exposure to high decibel noises. Small but irreversible damage occurs during the earliest stages of beginning hearing loss without the person being cognisant that a physical injury has taken place.[6] Due to the frequent use of noisy machinery, such as mechanical saws, compressors, grinding machines, drills, and other cutting tools, the construction workers' exposure to noise is remarkably high. In our study, carpenters, unskilled workers, bricklayers, plumbers, and plasterers had the highest prevalence of hearing loss. This result is consistent with the findings of two other large studies among construction workers in Germany.[7,8] Furthermore, in a study of iron construction workers premature deafness and balance dysfunction were described to be due to the noisy work environment, mainly caused by air impact power tools.[9] It seems plausible that the higher prevalence of hearing loss found in these occupational groups is related to the work related noise exposure.

Unskilled workers, carpenters, and bricklayers had the highest prevalence of abnormal findings of the lung, which may indicate an obstructive lung disease (such as bronchitis, obstructive emphysema, or asthma). Similar results were found in other German studies.[7,8] Smoking, air pollution, recurrent infections of the airways, climatic conditions, predisposition, and socioeconomic factors are mainly responsible for developing such diseases.[10] Also, exposure to inert dust and organic solvents were described as risk factors for obstructive lung diseases.[11] Dust inhalation is very common in construction workers, leading to irritation of the mucosa resulting in a hypersecretion of mucus and obstruction of the airway.[12] The high prevalence of smoking among the construction workers in this study may also contribute to the increased prevalence of lung disease.

There were no significant differences in the prevalence of abnormalities on ECG or increased diastolic blood pressure between construction workers and white collar workers. A large variety of risk factors for hypertension have been discussed—namely, genetic predisposition, obesity, nutritional factors, and psychosociological factors.[13] Worksite and job characteristics have also been described as important predictors of blood pressure.[14,15] Several metals have been associated with disturbances in cardiovascular function, but their causative role has not been fully established.[16] Also, exposure to vibration might be a risk fac-

tor for hypertension.[17]

The role of obesity and hypercholesterolaemia as risk factors for coronary heart disease, diabetes, and gout is well known, and a relation between obesity and musculoskeletal disorders has also been described.[18 19] In our study, all groups of construction professionals showed a higher prevalence of increased BMI than white collar workers, but no differences were found for prevalence of an increased cholesterol concentration. In general BMI is a measure of obesity, but a high BMI may also partly result from high muscle mass among construction workers.

The prevalence of increased GGT was higher in all investigated professions of the construction industry than in the white collar group. Increased concentrations of GGT may be due to various causes,[20 21] but a very likely explanation for the increased concentrations in construction workers is their high alcohol consumption.[22] Nevertheless, there is a potential for liver disorders related to work due to the exposure to paints, varnishes, organic solvents, and adhesives in the construction industry.[23 24]

Disorders of the musculoskeletal system, especially back problems, are common in the general population as well as occupational cohorts. They are the most important cause of early retirement (invalidity) in Germany.[2] Many occupational studies have investigated the influence of occupational factors on musculoskeletal complaints.[25 30] Heavy lifting is consistently described as a risk factor of back pain in occupational studies,[29] but whole body vibration, bending, kneeling, smoking, and psychosocial stress have also been identified as risk factors.[27 31-34] Increased stress on the musculoskeletal system among construction workers, especially carpenters and bricklayers, is described in many studies of occupational medicine.[25 31 32 35 36] In our study the prevalence of musculoskeletal abnormalities of all types was higher for each group of construction workers than for white collar workers, indicating the strain on the musculoskeletal system.

Occupational diseases of the skin are common in Germany[1] and other countries. Among these, chronic irritant contact dermatitis is the most common occupational skin disease. This disorder often develops after weeks or even years of exposure to a mild irritant,[37] such as wet cement, plaster, wood preservatives, solvents, oils, detergents, paints, fibreglass, glues, tar, acids, and alkalis.[38 39] Allergic contact dermatitis accounts for about 20% of cases of occupational contact dermatitis.[37] There are many causes of this condition, but the most important for the construction industry might be exposure to chromate, cobalt, nickel, and epoxy resins.[39 40] These combined effects may explain the higher prevalence of dermal findings among construction workers.

The results of our cohort study show an increased risk of disability and all cause mortality in construction workers (although the differences between professional groups are much less pronounced and not significant for all cause mortality), with highest risk for unskilled workers, plasterers, bricklayers, and carpenters. Retirement due to disability is an issue of great social importance in Germany. As mentioned earlier, about 44% of all cases of retirement are due to disability, whereas in the construction industry this proportion is about 63%.[1] It has been asked whether the higher mortality and morbidity of workers in physically demanding jobs should be explained by occupational or social factors.[41] The effects of both types of factors could not be distinguished in this study. It has been shown, however, that especially unskilled workers in the construction industry face a wide range of hazardous exposures in the workplace and show widespread adverse health effects.[42] Other studies or registries showed no significant differences in all cause mortality between construction workers and the average of all workers,[43] but lung diseases, malignoma, accidents, and psychiatric disorders were found to be more frequent as causes of death among construction workers than in the general population. In a mortality study conducted in the United Kingdom, an excess mortality was found for all cancers, including cancer of the lung and stomach, and for accidental death.[44]

In summary, this study describes considerable health impairments among older construction workers. These impairments most likely reflect both work related conditions and personal lifestyle factors and show the need for further health promotion. To reduce the overall morbidity, the main efforts should be focused to prevent disorders of the musculoskeletal system, lungs, ears, liver, and skin. Health promotion should include lowering personal and work related risk factors and improvements in occupational safety and industrial hygiene. Examples may be the reduction of heavy lifting by technical support or the substitution of the water soluble hexavalent chromate in cement by addition of ferrous sulphate.[45] Working conditions should take the reduced work capacity of elderly workers into account. Workers with high risk of disability should be identified in time, and specific rehabilitation programmes should be offered to prevent further deterioration. Further research should be conducted to identify more specific predictors of disability.

This study was supported by the Association of the Workmen's Compensation Board for Construction Workers, Germany.

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