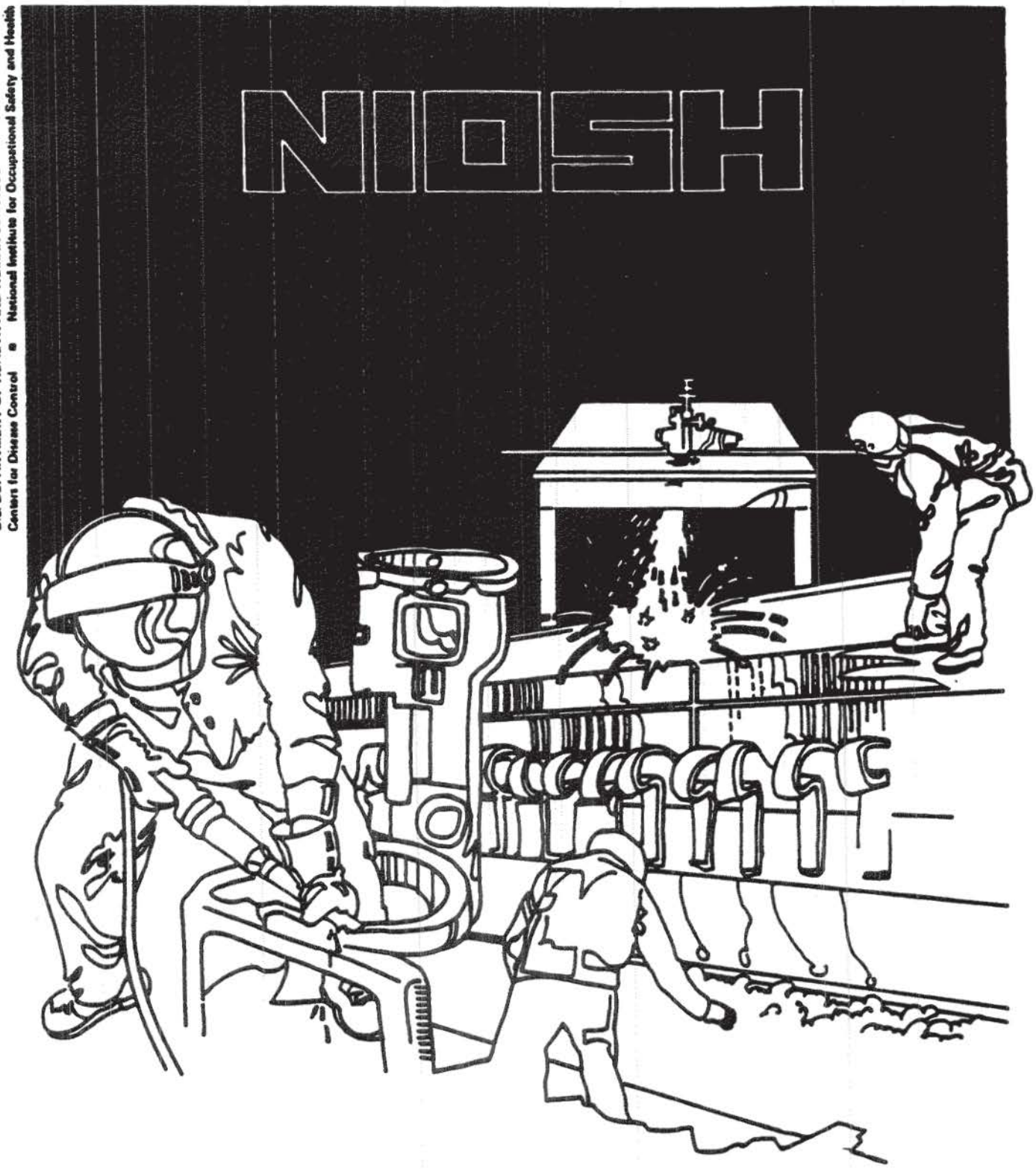
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES • Public Health Service
Centers for Disease Control • National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 82-065-1664
CARPET AND FLOORLAYERS
CINCINNATI, OHIO

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 82-065-1664
February 1986
CARPET AND FLOORLAYERS
CINCINNATI, OHIO

NIOSH INVESTIGATORS:
Shiro Tanaka, M.D.
Michael Thun, M.D.
Alexander B. Smith, M.D.
William E. Halperin, M.D.
Shiu T. Lee, M.S.
Michael Luggen, M.D.
Evelyn V. Hess, M.D.

1. SUMMARY

In November, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate knee injuries occurring in members of the Resilient Floor Layers and Decorator's Union Local, Number 873. The request described problems of injury to cartilage and knee effusions (water on the knee).

The majority of members of Local 873 work primarily as carpetlayers. Workers who install wall-to-wall carpet experience multiple sources of acute and chronic knee trauma from kneeling, pressure from sharp objects, and use of a tool called a "knee kicker" to stretch the carpet. NIOSH investigators sought to examine the occurrence of knee disease among carpetlayers in three ways.

First, we reviewed claims submitted for Worker's Compensation, as compiled by the U.S. Department of Labor. Carpet- and floorlayers submit a disproportionately large fraction of claims for knee joint inflamation attributed to kneeling, leaning, repetition of pressure, or striking against a stationary object. Although carpetlayers comprise less than 0.06% of the U.S. workforce, they submit 6.2% of compensation claims for traumatic knee inflamation, a nearly 108-fold proportionate increase.

Second, NIOSH contracted with the University of Cincinnati, Kettering Laboratory, to assess the ergonomic forces transmitted to the knee during use of the "knee kicker". The ergonomic study (Mueller, 1984) found that a vigorous worker using the "knee kicker" generates forces of up to 3200 newtons (N), equivalent to four times body weight, transmitted directly to the suprapatellar area.

Third, investigators from NIOSH and from the University of Cincinnati, College of Medicine conducted a medical study of knee disease in construction workers from three local Cincinnati unions. Participants included carpet- and floorlayers from Local 873 of the Resilient Floor Layers and Decorator's Union, bricklayers and tile- terrazo- and marble setters from Local 18 of the Bricklayers Union, and millwrights from Local 1454 of the Millwrights and Machinery Erectors Union. The millwrights and bricklayers (MWBL) participated as comparison populations, since they kneel only intermittently and never use a knee kicker.

A questionnaire revealed that, compared to the MWBL, the carpetlayers reported more frequent bursitis (20% vs. 6%), needle aspiration of knee fluid (32% vs. 6%), skin infections of the knee (7% vs. 2%), and "other" miscellaneous knee conditions (19% vs. 10%). Nearly half (47%) of the floorlayers reported having had at least one episode of either knee aspiration or bursitis, versus only 11% of MWBL. A score indicating frequency of using the "knee kicker" was the only statistically significant predictor of bursitis, whereas factors representing years of employment, occupational kneeling, and the interaction of occupational kneeling with age were statistically significant predictors of "knee taps". Physical and X-ray examinations, conducted on a subset of 108 participants in the questionnaire survey, indicated that the questionnaire responses were an insensitive but specific (over 80%) predictor of chronic bursitis.

The study shows that carpet- and floorlayers are at increased risk of traumatic knee disease. "Carpetlayer's knee" is clearly associated with bursitis and effusions ("water on the knee"), and with increased disability from knee injury. Both chronic kneeling and use of the "knee kicker" to stretch wall to wall carpet appear to be associated with more prevalent knee injury. Whenever possible, workers should reduce knee trauma by wearing knee pads and using the hand operated "power stretcher", rather than the "knee kicker". Further research is needed to develop a carpet stretching device that will be mobile and efficient and yet will reduce ergonomic trauma to the knee.

KEYWORDS: SOC 6162 (Carpet and Soft Tile Installers), bursitis, arthritis, osteoarthritis, knee injury, disability, repetitive trauma, ergonomics, occupation, carpetlayers, floorlayers, tilesetters, millwrights, bricklayers

I.I. INTRODUCTION

In November, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request from Local 873, Cincinnati, Ohio, of the Resilient Floor Layers and Decorator's Union to evaluate knee injuries among carpet and floorlayers. The request stated that members of this union were prone to knee injuries resulting in accumulation of fluid and damage to cartilage.

I.II. BACKGROUND

Local 873 represents approximately 170 members who work as carpetlayers, floorlayers, and decorators. Carpet- and floorlayers are overlapping groups of workers who install linoleum, asphalt tile, and wall-to-wall carpet. Since both carpet- and floorlayers in Local 873 install carpet and other types of resilient flooring, we will refer to them collectively as "floorlayers". These workers experience multiple sources of acute and chronic knee trauma from kneeling, pressure from sharp objects, and use of a tool called a "knee kicker" to stretch carpet. Workers using the "knee kicker" generate force by striking the suprapatellar area of their knee against the instrument.

Floorlayers also describe frequent knee surgery, evacuation of knee effusions ("knee taps"), and skin infections of the knee. To substantiate these anecdotal reports, we examined Worker's Compensation claims complied by the U.S. Department of Labor, Bureau of Labor Statistics, Supplemental Data System (Root and McCaffrey 1982). Both carpet- and floorlayers submit a disproportionately large fraction of the claims for worker's compensation for knee joint inflammation attributed to kneeling, leaning, repetition of pressure, or striking against a stationary object (Tanaka, et al., 1982). The estimated 88,000 carpet installers in the United States comprise only 0.05?5% of the total workforce (Table 1) yet they account for approximately 6.2% of such claims, a nearly 108-fold proportionate excess.

A second component of the evaluation of knee trauma among carpet- and floorlayers consisted of an ergonomic evaluation of the forces transmitted to the knee during use of the "knee kicker". This study was conducted by researchers at the University of Cincinnati, Kettering Laboratory under contract from the NIOSH Division of Biomedical and Behavioral Science, and is described in detail elsewhere (Mueller and Bhattacharya). The ergonomic study found that a vigorous worker using the "knee kicker" generates forces of up to 3200 newtons (N), equivalent to four times body weight, transmitted directly to the suprapatellar area.

The purpose of the present interview and medical survey was to further define the nature and magnitude of the knee morbidity among carpetlayers, and to identify causative factors that may be eliminated or controlled. We preface the description of the medical study with a brief review of the literature on the relation between knee trauma and musculoskeletal disease.

IV. REVIEW OF THE LITERATURE AND EVALUATION CRITERIA

A. REVIEW OF THE LITERATURE

Workers who kneel to perform their jobs inflict chronic trauma to their knee joints. "Housemaid's knee" is a well recognized disorder occurring among women who kneel to scrub floors (Hunter, 1978). The characteristic feature is a prepatellar bursitis. It is unclear to what extent bursal disease is accompanied by degeneration of cartilage or bone. The "beat knee" of British low seam coalminers has been studied extensively. Bursitis and a disfiguring cellulitis are the most conspicuous features of "beat knee" (Collis and Llewellyn 1924, Atkins and Marks 1952, Watkins et. al. 1958, Sharrard 1965, Williamson, 1972). However, an increased occurrence of meniscal lesions and arthrosis in British coal miners is also fairly well documented (Adamson 1946, Atkins 1957, Kellgren and Lawrence 1952, Sharrard 1965). Kellgren and Lawrence documented that 39 of 84 (46%) miners had some radiologic evidence of osteoarthritis of the knee, compared with 10 of 42 (24%) office workers.

Other occupations have received relatively less attention with regard to chronic knee injury. "Plumber's knee", calcification of the soft tissue over the knee, has been described in a plumber who repeatedly bent water pipes using his knee joint as a fulcrum (Ellis et. al. 1984). Knee disease is recognized anecdotally in wrestlers, U.S. football players, skiers, and sports athletes who incur extreme external trauma (Hadler 1984). Carpet and floorlayers were first identified as a group at high risk of knee trauma by the report, described above (Tanaka, 1982). The observation that carpet and floor layers in the U.S. file a disproportionately large number of the worker's compensation claims for knee injury is supported by a questionnaire survey of construction workers in Sweden. In the Swedish study of 125,000 construction workers, floor- and parquet- layers reported the highest prevalence of pain and stiffness of the knee. The prevalence of knee symptoms was 3.26 times that of clerks (Ekstrom, 1983). Unfortunately the Scandinavian study has not yet been published in English.

B. EVALUATION CRITERIA

No official regulations or standards have been promulgated limiting occupational trauma to the knee. Thus, no evaluation criteria, in the sense of standards, will be referred to.

V. MATERIALS, PARTICIPANTS, AND METHODS

Hypotheses- The question of interest in the current study was whether floorlayers, who both kneel and strike their knees repeatedly against the "knee kicker" have increased prevalence of knee symptoms and of physical and radiologic abnormalities than workers who neither kneel nor use this tool. A secondary question was whether the increased knee morbidity, if such

occurs, results from repetitive use of the knee kicker, from chronic kneeling, or from both.

The Study Population- The carpet- and floorlayers were recruited through the Resilient Floor Layers and Decorators' Union, Local 873. This union local represents an estimated 20-33% of the carpet- and floorlayers in the Cincinnati area. Because union members install linoleum flooring and venetian blinds in addition to carpet, we further categorized workers according to usual occupation, based upon questionnaire data (Figure 1). Carpetlayers, who both kneel and use a "knee kicker", were grouped with other resilient floorlayers who kneel but may use a knee kicker infrequently. Decorators were grouped with workers who infrequently kneel and do not use a "knee kicker".

Comparison Populations- No comparison population was available in which workers used the "knee kicker" in the absence of kneeling. Instead, we sought two referent groups, corresponding to "activity categories" II, and III in Figure 1. We approached Local 18 of the Bricklayers' Union expecting that bricklayers would kneel extensively but not use a knee kicker (Category II). In actuality, only a small subgroup of tilesetters, marble and terrazo workers within the bricklayer's union spend most of their worktime kneeling. This subgroup, called "tilesetters" was retained in category II. The majority of the bricklayers spend a large portion of their workday standing to construct walls; thus, bricklayers were included in category III. Also included in category III were members of Local 1458 of the Millwrights and Machinery Erectors Union . The millwrights kneel occasionally while assembling industrial fixtures and machinery. Like the bricklayers, they do not use the "knee kicker".

Sampling Strategy: All retired workers were recruited into the study, regardless of union membership. Although the purpose of including retired workers was to minimize losses from the study due to premature retirement from knee disease, only dues-paying retired workers were listed on the union roster. Thus, workers who had ceased paying dues after leaving the trade were lost. All active floorlayers, and one third of currently active members of the larger Bricklayers' and Millwrights' unions were sampled.

Outcomes Measured: The study consisted of two questionnaires and a medical examination (Figure 2). Initially a self-administered "NIOSH" questionnaire was mailed to all sampled subjects. Questions enquired about the lifetime prevalence of seven knee conditions, listed in Appendix A. The questionnaire also enquired about non-occupational knee injury, personal characteristics (age, weight, and height), and work practices (retirement status, usual occupation, use of the "knee kicker", use of the power carpet stretcher, and percent of time spent kneeling, standing, squatting, etc. while at work).

A second interview was subsequently administered by telephone to all respondents to the initial questionnaire. Trained interviewers asked standardized questions about seven symptoms of knee disease from the

arthritis supplement of the National Health and Nutrition Examination (NHANES) Survey (Maurer, 1979). The questions are listed in Appendix B. Their purpose was to provide standardized information about symptom prevalence that could be compared to the U.S. population.

Medical examinations: Physical and X ray examinations of the knee were offered to all persons who completed the self administered and telephone questionnaires who resided in Indiana, Kentucky or Ohio. The medical examination data were not intended to be representative of the entire study group; rather, they were obtained to validate the questionnaire responses. Knee examinations were conducted by eight physician faculty members of the University of Cincinnati, Department of Immunology/Rheumatology. Participants were randomly assigned to one of these eight physicians who were unaware of the subject's occupation or past medical history. The examiners assessed gait, lower leg alignment, tibial torsion, knee skin changes, patellar bursitis, knee joint mobility, crepitation, tenderness, swelling, pain, ligament stability, meniscus, and measurements for girth and range of motion of knee joint. The criteria used to define a bursitis and arthritis from the physical examination findings are presented in Appendix C.

Knee X-rays included antero-posterior, lateral, tunnel and axial views. Two radiologists separately reviewed the films for a variety of outcomes; 1) osseous spurs, erosions, cysts or sclerosis of either the distal femur or the proximal tibia; 2) narrowing of the knee joint space; 3) patellar spurs; 4) approximation of the patella to the femur; 5) loose bodies; 6) osteochondromatosis; 7) chondrocalcinosis; 8) soft tissue calcification; 9) suprapatellar effusion. Because of the low participation in the physical and X-ray examinations, only those data used to validate the questionnaire responses will be presented here.

Data Transformation: Two different classification schemes were used to reflect exposure status in the analysis. The crudest measure was the trichotomy of "activity categories" seen in Figure 1. As discussed, these activity categories provided a qualitative measure of whether the usual job involved both kneeling and use of the "knee kicker", kneeling alone, or neither. A more quantitative, although still subjective, measure of exposure was the score with which each worker described the frequency of standing, sitting, squatting, bending, kneeling, heavy lifting, use of a knee kicker or of a power carpet stretcher. Workers rated each activity on a scale of from one (never) to six (always). To simplify these scores, we subsequently reduced the categories to three: 1-2 (seldom), 3-4 (intermediate), and 5-6 (frequent). We also used factor analysis to combine pairs of related working postures into groups. The resultant three pairs of working postures were bending/lifting (Factor 1), kneeling/standing (Factor 2), and sitting/squatting (Factor 3). Kneeling and standing were inversely related to each other, whereas the other two posture pairs were related directly.

Data Analysis- Initial analyses characterized the demographics of the three occupational "activity" groups, and compared the prevalence of the various knee conditions and symptoms between groups. Comparisons between groups were restricted to males (N=397) with no history of non-occupational knee injury. The age-adjusted prevalence of each of the seven knee conditions in each of the three occupational activity groups was computed, using the age distribution of the entire study group as the standard population. Prevalence in millwrights and bricklayers (MWBL) was used as the denominator in computing the prevalence ratio for "reported knee conditions" (Table 4). Prevalence in the NHANES sample of U.S. males was used as the referent value in computing prevalence ratios for the NHANES questions. The age distribution of the NHANES weighted sample of males was used as the standard population for direct standardization. Ninty-percent confidence intervals were computed around the directly standardized prevalence ratios to determine whether these were statistically significantly above 1.0.

Multivariate analyses Stepwise logistic regression was used to identify those personal and occupational characteristics that best predicted any of the seven reported knee conditions. Variables considered in the model included age, usual occupation, length of employment, the self-reported score for use of the knee kicker, postural factors 1-3, and all two-way interactions. Main effect variables and interaction terms were retained if the p value was less than .05. Only the final, most parsimonious models for bursitis and for knee taps are reported here.

Use of the Physical and X-ray Examinations to Validate The Questionnaire Data- Physical examination and radiologic findings were used to validate the questionnaire responses. We anticipated that only certain knee conditions such as arthritis, history of knee surgery, or fractured patella would be documentable on the medical examination. Even though we expected that workers who had experienced soft tissue injury such as bursitis might have recovered, we also included bursitis in the validation study. Analyses to validate the questionnaire responses have to date disregarded information about left- and right- handedness.

Validation Using Physician's Records- We also attempted to contact the physicians of workers reporting specific knee conditions in order to validate the diagnoses.

VI. RESULTS

The number of workers participating in the questionnaire and medical phases of the study is presented in Table 2, categorized by union membership. Participation could only be assessed by union membership, rather than "usual occupation", since the latter was determined only on participants in the questionnaire study. Nearly identical proportions of workers sampled from the three unions participated in the questionnaire phase of the study (76-78%). Only 19% of workers sampled participated in the medical examination.

Table 3 presents selected demographic characteristics of participants in the questionnaire survey. In this and subsequent tables the study subjects are classified by "usual occupation" instead of by union membership. Slight differences in age and employment status are evident between the three groups. Floorlayers were on average younger and less likely to be retired than either of the other two groups. The tile- terrazo- and marblesetters (N=42) were slightly older and had been employed the longest. The millwrights and bricklayers (MWBL) included the largest proportion of retired workers.

Table 4 summarizes some of the job practices of the three occupational groups. As seen, only floorlayers used a "knee kicker" frequently. Over 80% of workers in all three groups stated that their work involved some kneeling, but floorlayers and tilesetters reported substantially higher kneeling scores than did the MWBL. Among workers who kneeled to perform their job, tilesetters were far more likely to use knee pads (97% v.s. 51%).

Table 5 shows the prevalence of reported knee conditions among floorlayers and tilesetters, compared to MWBL. Floorlayers reported a more frequent history of "knee tap" (needle aspiration of the knee), bursitis, skin infections of the knee, and "other knee disease" than did the millwrights and bricklayers. "Other knee conditions" included miscellaneous conditions such as ruptured cartilage, strained ligament, or puncture wounds due to kneeling on sharp objects. Nearly half (47%) of the floorlayers reported having had at least one episode of either knee aspiration or bursitis, versus only 11% of MWBL. For knee taps, arthritis, and knee surgery, the small group of tile- terrazo- and marble-setters reported prevalences that were equal to or greater than those of the resilient floorlayers. Arthritis was the single condition which tilesetters reported statistically more frequently than did MWBL, but floorlayers did not.

A similar pattern was evident when comparing the age-adjusted prevalence of the seven NHANES symptoms among these workers with that of the NHANES sample. Table 6 shows the age-adjusted prevalence of these symptoms in each occupational group. Here each occupational group is compared to males of comparable age in the NHANES sample of the U.S. population rather than to the MWBL. Relative to U.S. males, floorlayers reported 3-8 times the age-adjusted prevalence of knee pain, swelling, tenderness to touch, and locking of the knee joint. Symptom reporting was highest among the floorlayers, but was also significantly higher than that of U.S. males among tilesetters and even among the bricklayers and millwrights. The millwrights and bricklayers reported a 2-6 fold higher prevalence of all symptoms than did males in the NHANES sample.

Use of the Physical and X-ray Examinations to Validate The Questionnaire Data- Low participation in the physical and X-ray examinations precluded comparisons of medical findings between the occupational groups. However, the physical and X-ray data did provide some validation of the questionnaire reports. Table 7 shows the correspondance between a questionnaire report of

bursitis or arthritis and the physical or X-ray findings. In these analyses the questionnaire report is considered the screening test; physical or radiologic signs of disease are accepted as the confirmatory "gold standard". Disregarding the problem that the questionnaire refers to lifetime prevalence (ever having had bursitis or arthritis), whereas the medical tests refer to current disease, the physical and x-ray findings provide some support for the questionnaire responses. For both bursitis and arthritis, the questionnaire response shows low (38-44%) sensitivity but moderate (82-89%) specificity. A negative questionnaire response is likely to be "falsely negative", but a positive questionnaire response is likely to represent a "true positive".

For arthritis, the radiologists classified many more subjects as having joint changes consistent with "arthritis" than did the questionnaire or the physical examination. The radiologist identified 32 subjects with some degree of osteoarthritis, compared with the physical examination finding of 12, and the questionnaire report of 22. Although more subjects may have reported symptoms of arthritis on questionnaire, only 22 reported a diagnosis of arthritis. Such a questionnaire report detects only 44% of persons with radiologic changes consistent with osteoarthritis, and the physical examination detects even fewer, only 19%.

On physical examination, bursitis was observed more often over the infrapatellar than the prepatellar bursa. The criteria used to define bursitis on physical examination included detectable swelling and/or tenderness to palpation. Such findings involved the infrapatellar bursa in 62% of cases, and the prepatellar bursa in 38%. This finding contrasts with the reported preponderance of prepatellar bursitis in "Housemaid's knee".

Validation Using Physician's Records- The attempt to contact physicians to document past episodes of knee disease met with limited success. For example, of 35 floorlayers reporting "knee tap", we were able to contact the physicians of only 16. In many cases the physician was deceased or retired or the record could not be found. Of the 16 physicians contacted, records were obtained from 12, all of which confirmed that the patient had undergone needle aspiration of the knee. In seven responses the physician specified that the prepatellar bursa had been aspirated. These limited data suggest that some unquantified fraction of the cases of "knee taps" among the floorlayers represent effusions of the bursa rather than of the joint space.

Multivariate Analyses- Tables 8 and 9 show the results of stepwise logistic regression analyses to identify those demographic and occupational characteristics that best predicted a history of bursitis and of "knee taps". Table 8 shows the optimal model for bursitis. Only the self-reported score for use of the "knee kicker" was statistically significant as a predictor of bursitis. No other main effects and no interaction terms were statistically significant, and so none are retained in the model. Even though use of the knee kicker was statistically significant, it explained only a small fraction of the variance (6%).

Table 9 shows the corresponding logistic model for "knee taps". The two important main effect terms were total years of employment and the factor representing standing-kneeling. The negative relationship between the kneeling-standing factor and "knee taps" indicates that the probability of knee taps decreases with standing and increases with kneeling.

The statistically significant interaction term between age and the kneeling-standing factor reflects a marked difference in the effect of age between workers who kneel frequently and those who kneel rarely. The probability of knee taps actually decreased with age among workers reporting frequent kneeling (a negative standing-kneeling score), whereas it increased with age among persons reporting rare kneeling (a high standing-kneeling score). Such a pattern is consistent with a survivorship phenomenon, workers with knee disease tending to self-select out of jobs that require extensive kneeling.

VII. DISCUSSION

Carpet- and floorlayers report substantially more knee morbidity than either the general U.S. white male population or a blue-collar working population of comparable age, sex, and race. In particular, floorlayers describe more frequent bursitis, needle aspiration of knee fluid, skin infections of the knee, and miscellaneous "other knee conditions". Frequent reporting of knee problems by carpetlayers has been noted in a previous survey of musculoskeletal complaints among carpetlayers in Sweden, and is evident in the disproportionate number of disability claims for knee injury observed among U.S. carpet- and floorlayers.(Ekstrom, Tanaka)

The study provides some, although limited, information about the clinical features of "carpetlayers knee". Although we could not define the precise nature and magnitude of the knee disease, we did determine that effusions are an important component. Approximately one third of floorlayers reported needle aspiration of the knee at some point in their career. It is unclear whether such effusions involve predominantly the bursae or the joint space. Our limited follow-back to the medical records of workers reporting "knee tap" found that the effusion involved the prepatellar bursa whenever a specific diagnosis was mentioned.

A second interesting finding is that the bursitis identified by the rheumatologists in our medical study involved the infrapatellar bursa in nearly two-thirds of cases. The criteria used for infrapatellar bursitis were tenderness and/or swelling in the infrapatellar area. We could not assess how or whether the "knee tap" reported on questionnaire relates to this infrapatellar bursitis observed on physical examination. Pre- rather than infrapatellar bursitis is reported to be the characteristic feature among other workers who kneel, namely in "Housemaid's knee", the beat knee of coal miners, and the bursitis of clergymen and nuns.

It remains unclear whether "carpetlayer's knee" is also associated with more serious types of knee disease, such as osteoarthritis, or injury to cartilage and ligaments. That the carpetlayers did not report a more frequent history of "arthritis", and reported less frequent knee surgery than the other trades is not reassuring. Workers with disabling knee disease would be likely to leave the trade and be lost from a cross-sectional study such as ours. There are three lines of indirect evidence that floorlayers with serious knee morbidity may indeed leave the trade. First, symptoms of knee disease increase with age in the general population, but decrease with age among floorlayers, suggesting that symptomatic floorlayers change their occupation. Second, there is a 100-fold increase in compensation claims among floorlayers over other trades, but only a 3-6 fold increase in symptom prevalence in our study. This difference may be explained by migration out of floorlaying because of disability. Third, and finally, there is anecdotal reporting by floorlayers that colleagues with serious knee problems leave to find other work. Although we attempted to deal with this problem of selective retirement by including former workers, we were only able to locate retired workers who continued to pay union dues. The motivation to pay such dues is directly related to seniority; for example, only one of the retired floorlayers in our study had stopped work prematurely with less than 20 years seniority. Thus, the retired study participants are a "survivor" population and may not include workers of shorter tenure who left prematurely due to knee disability.

We were partly successful in identifying the occupational determinants of "carpetlayer's knee". Multivariate statistical analyses of the questionnaire data showed that a worker's self-reported score for using a "knee kicker", an instrument used only by the carpetlayers, was the single important determinant of bursitis. Kneeling, and it's interaction with age, were more important for "knee tap". Although interesting, this distinction is difficult to interpret biologically. We cannot determine whether "knee taps" represent aspiration of bursae in cases of severe bursitis, or aspiration of the joint space.

The prevalence of many reported knee problems was as high or higher among the small group of tile-terrazo- and marbleworkers than among the carpetlayers. Despite the small study population, tilesetters reported conditions such as "arthritis" significantly more frequently than did the MWBL. The tilesetters, or "non-resilient" floorlayers, spend their workdays kneeling on hard, unyielding surfaces. Although they do not use the "knee kicker", these workers undoubtably experience occupational knee trauma.

In addition, our comparison population of MWBL also kneel to perform their work (Table 4) and almost certainly incur some occupational knee trauma. Symptoms of knee disease were 2-6 fold more common among the millwrights and bricklayers participating in our study than in the NHANES survey (Table 6). Other evidence that the millwrights and bricklayers may themselves incur occupational knee injury comes from workers' compensation claims (Table 1). In 1979, bricklayers submitted nearly 6-fold, and millwrights nearly 3-fold

the proportion of workers' compensation claims for knee injury expected from their numbers. Because knee trauma occurs in a number of construction trades, it is difficult to find an "unexposed" yet comparable comparison group.

The implications of "carpetlayer's knee" are clearly most immediate for the estimated 88,000 carpet and floorlayers (SIC 175) for whom it carries both medical and economic consequences.(USDL, Bureau Labor Statistics) The number of these workers is substantial, although small in relation to the general population. Of potentially larger public health consequence are the incompletely understood effects of chronic kneeling in a variety of trades.

In summary, a cross-sectional questionnaire study of knee symptoms among three groups of current and retired construction workers revealed that carpet and floorlayers report an increased frequency of bursitis, needle aspiration of knee fluid, skin infections of the knee, and a variety of knee symptoms compared to millwrights and bricklayers. Tile-terazzo-and marble setters report similar problems. Medical examinations on a subset of subjects served to validate the questionnaire data. Further research is needed 1) to characterize the nature and extent of knee disease in workers who incur chronic knee trauma, 2) to develop an effective, ergonomically suitable substitute for the "knee kicker" for stretching carpet.

VIII. RECOMMENDATIONS

1. Wherever possible, workers should reduce knee trauma by wearing knee pads and using the hand-operated "power stretcher", rather than the "knee kicker".

2. Further research is needed to develop a carpet stretching device that will be mobile and efficient and yet will reduce ergonomic trauma to the knee.

IX. References

Adamson WAD. Injury of the cartilage in miners. Edinburgh Medical J 1946; 53:37-45.

Atkins JB, Marks J: The role of staphylococcal infection in beat disorders of miners. Brit J Industr Med 1952; 9:296-302.

Atkins JB. Internal derangement of the knee joint in miners. Brit J Industr Med 1957;14:121-126.

Collis EL and Llewellyn TL: Report on miners beat knee, beat hand, and beat elbow. Special report series medical research council 1924; 89, pp 5-49.

Ekstrom H, Engholm G, Nyqvist B, Wallenquist A. Knee pains, an occupational medical problem. Bygghalsans Forskingsstiftelse. Supported by grant # 81-0169, Labor Safety Board, BHF 1983-1, 80 pages.

Ellis IO, Foster MC, Womack C. Plumber's knee: calcinosis cutis after repeated minor trauma in a plumber. Brit Med J 1984;288:1723.

Hadler NM: The knee: diagnosis, management and causal inferences. Chapter 12 In: Hadler NM, Medical management of the regional musculoskeletal diseases. Grune & Stratton Inc. Harcourt Brace. Orlando, San Diego, New York. 1984: 251-277.

Hunter D: The Diseases of Occupations. London, Sidney, Auckland, Toronto, Hodder and Stoughton, 1978, pp 780-785.

Kellgren JH, Lawrence JS. Rheumatism in miners Part II: X-ray study. Brit J Industr Med 1952; 9:197-207.

Kleinbaum DG, Kupper LL, and Morganstern H. Epidemiologic Research, Principles and Quantitative Methods. Lifetime Learning Publications, Belmont, California, 1982.

Maurer K: Basic data on arthritis knee, hip, and sacroilliac joints in adults ages 25-74 years, United States, 1971-1975. U.S, Department of Health, Education, and Welfare, Public Health Service, Office of Health Research, Statistics and Technology, National Center for Health Statistics, Hyattsville, Md. 1979 DHEW publication No. (PHS) 79-1661.

Mueller MR, Bhattacharya A: A study of postural changes associated with carpet installation, in Mital A (ed): Trends in Ergonomics/Health Factors I. North Holland, Elsevier Science Publishers B.V., 1984, pp59-64.

Polly HF, Hunter GG: The knee, in Polly HF, Hunter GG (eds) Rheumatologic Interviewing and Physical Examination of the Joints. Philadelphia, W.B. Saunders Co, 1978, pp 208-238.

Roantree WB: A review of 102 cases of beat conditions of the knee. Brit J Industr Med 1957; 14:253-257.

Root N, McCaffrey D. Producing more information on work injury and illness. Mon Labor Rev 1978; 101:16-21.

Sharrard WJ: Aetiology and pathology of beat knee. Brit J Ind Med 1963; 20:24-31.

Sharrard WJ: Pressure effects on the knee in kneeling miners. Ann Royal Coll Surgeons 1965;36:309-324.

Tanaka S, Smith AB, Halperin W, Jensen R: Carpet-layer's knee. NEJM 1982; 307:1275-76.

U.S. Dept. Labor, Bureau of Labor Statistics, Current Population Survey, Employment and Earnings, Jan. 1985.

Watkins JT, Hunt TA, Fernandez HP, Edmonds OP: A clinical study of beat knee. Brit J Industr Med 1958;15:105-109.

Wells JA, Zipp JF, Schuette PT, McEleney J: Musculoskeletal disorders among letter carriers, a comparison of weight carrying, walking, and sedentary occupations. JOM 1983; 25: 814-820.

Wickstrom G, Hanninen K, Mattsson T, Niskanen T, Riihimaki H, Waris P, Zitting A: Knee degeneration in concrete reinforcement workers. Brit J Industr Med 1983; 40:216-219.

Williamson DM: Beat diseases, in Rogan JM (ed): Medicine in the mining industries. Philadelphia, F.A. Davis Co, 1972, pp 199-208.

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Project Director

Shiro Tanaka M.D.
Medical Officer
Epidemiology 2 Section

Report Prepared by:

Michael J. Thun M.D. M.S.
Chief
Epidemiology 2 Section

Shiro Tanaka M.D.
Medical Officer
Epidemiology 2 Section

It remains unclear whether "carpetlayer's knee" is also associated with more serious types of knee disease, such as osteoarthritis, or injury to cartilage and ligaments. That the carpetlayers did not report a more frequent history of "arthritis", and reported less frequent knee surgery than the other trades is not reassuring. Workers with disabling knee disease would be likely to leave the trade and be lost from a cross-sectional study such as ours. There are three lines of indirect evidence that floorlayers with serious knee morbidity may indeed leave the trade. First, symptoms of knee disease increase with age in the general population, but decrease with age among floorlayers, suggesting that symptomatic floorlayers change their occupation. Second, there is a 100-fold increase in compensation claims among floorlayers over other trades, but only a 3-6 fold increase in symptom prevalence in our study. This difference may be explained by migration out of floorlaying because of disability. Third, and finally, there is anecdotal reporting by floorlayers that colleagues with serious knee problems leave to find other work. Although we attempted to deal with this problem of selective retirement by including former workers, we were only able to locate retired workers who continued to pay union dues. The motivation to pay such dues is directly related to seniority; for example, only one of the retired floorlayers in our study had stopped work prematurely with less than 20 years seniority. Thus, the retired study participants are a "survivor" population and may not include workers of shorter tenure who left prematurely due to knee disability.

We were partly successful in identifying the occupational determinants of "carpetlayer's knee". Multivariate statistical analyses of the questionnaire data showed that a worker's self-reported score for using a "knee kicker", an instrument used only by the carpetlayers, was the single important determinant of bursitis. Kneeling, and it's interaction with age, were more important for "knee tap". Although interesting, this distinction is difficult to interpret biologically. We cannot determine whether "knee taps" represent aspiration of bursae in cases of severe bursitis, or aspiration of the joint space.

The prevalence of many reported knee problems was as high or higher among the small group of tile-terrazo- and marbleworkers than among the carpetlayers. Despite the small study population, tilesetters reported conditions such as "arthritis" significantly more frequently than did the MWBL. The tilesetters, or "non-resilient" floorlayers, spend their workdays kneeling on hard, unyielding surfaces. Although they do not use the "knee kicker", these workers undoubtably experience occupational knee trauma.

In addition, our comparison population of MWBL also kneel to perform their work (Table 4) and almost certainly incur some occupational knee trauma. Symptoms of knee disease were 2-6 fold more common among the millwrights and bricklayers participating in our study than in the NHANES survey (Table 6). Other evidence that the millwrights and bricklayers may themselves incur occupational knee injury comes from workers' compensation claims (Table 1). In 1979, bricklayers submitted nearly 6-fold, and millwrights nearly 3-fold

the proportion of workers' compensation claims for knee injury expected from their numbers. Because knee trauma occurs in a number of construction trades, it is difficult to find an "unexposed" yet comparable comparison group.

The implications of "carpetlayer's knee" are clearly most immediate for the estimated 88,000 carpet and floorlayers (SIC 175) for whom it carries both medical and economic consequences.(USDL, Bureau Labor Statistics) The number of these workers is substantial, although small in relation to the general population. Of potentially larger public health consequence are the incompletely understood effects of chronic kneeling in a variety of trades.

In summary, a cross-sectional questionnaire study of knee symptoms among three groups of current and retired construction workers revealed that carpet and floorlayers report an increased frequency of bursitis, needle aspiration of knee fluid, skin infections of the knee, and a variety of knee symptoms compared to millwrights and bricklayers. Tile-terazzo-and marble setters report similar problems. Medical examinations on a subset of subjects served to validate the questionnaire data. Further research is needed 1) to characterize the nature and extent of knee disease in workers who incur chronic knee trauma, 2) to develop an effective, ergonomically suitable substitute for the "knee kicker" for stretching carpet.

VIII. RECOMMENDATIONS

1. Wherever possible, workers should reduce knee trauma by wearing knee pads and using the hand-operated "power stretcher", rather than the "knee kicker".

2. Further research is needed to develop a carpet stretching device that will be mobile and efficient and yet will reduce ergonomic trauma to the knee.

IX. References

Adamson WAD. Injury of the cartilage in miners. Edinburgh Medical J 1946; 53:37-45.

Atkins JB, Marks J: The role of staphylococcal infection in beat disorders of miners. Brit J Industr Med 1952; 9:296-302.

Atkins JB. Internal derangement of the knee joint in miners. Brit J Industr Med 1957;14:121-126.

Collis EL and Llewellyn TL: Report on miners beat knee, beat hand, and beat elbow. Special report series medical research council 1924; 89, pp 5-49.

Ekstrom H, Engholm G, Nyqvist B, Wallenquist A. Knee pains, an occupational medical problem. Bygghalsans Forskingsstiftelse. Supported by grant # 81-0169, Labor Safety Board, BHF 1983-1, 80 pages.

Ellis IO, Foster MC, Womack C. Plumber's knee: calcinosis cutis after repeated minor trauma in a plumber. Brit Med J 1984;288:1723.

Hadler NM: The knee: diagnosis, management and causal inferences. Chapter 12 In: Hadler NM, Medical management of the regional musculoskeletal diseases. Grune & Stratton Inc. Harcourt Brace. Orlando, San Diego, New York. 1984: 251-277.

Hunter D: The Diseases of Occupations. London, Sidney, Auckland, Toronto, Hodder and Stoughton, 1978, pp 780-785.

Kellgren JH, Lawrence JS. Rheumatism in miners Part II: X-ray study. Brit J Industr Med 1952; 9:197-207.

Kleinbaum DG, Kupper LL, and Morganstern H. Epidemiologic Research, Principles and Quantitative Methods. Lifetime Learning Publications, Belmont, California, 1982.

Maurer K: Basic data on arthritis knee, hip, and sacroilliac joints in adults ages 25-74 years, United States, 1971-1975. U.S, Department of Health, Education, and Welfare, Public Health Service, Office of Health Research, Statistics and Technology, National Center for Health Statistics, Hyattsville, Md. 1979 DHEW publication No. (PHS) 79-1661.

Mueller MR, Bhattacharya A: A study of postural changes associated with carpet installation, in Mital A (ed): Trends in Ergonomics/Health Factors I. North Holland, Elsevier Science Publishers B.V., 1984, pp59-64.

Polly HF, Hunter GG: The knee, in Polly HF, Hunter GG (eds) Rheumatologic Interviewing and Physical Examination of the Joints. Philadelphia, W.B. Saunders Co, 1978, pp 208-238.

Roantree WB: A review of 102 cases of beat conditions of the knee. Brit J Industr Med 1957; 14:253-257.

Root N, McCaffrey D. Producing more information on work injury and illness. Mon Labor Rev 1978; 101:16-21.

Sharrard WJ: Aetiology and pathology of beat knee. Brit J Ind Med 1963; 20:24-31.

Sharrard WJ: Pressure effects on the knee in kneeling miners. Ann Royal Coll Surgeons 1965;36:309-324.

Tanaka S, Smith AB, Halperin W, Jensen R: Carpet-layer's knee. NEJM 1982; 307:1275-76.

U.S. Dept. Labor, Bureau of Labor Statistics, Current Population Survey, Employment and Earnings, Jan. 1985.

Watkins JT, Hunt TA, Fernandez HP, Edmonds OP: A clinical study of beat knee. Brit J Industr Med 1958;15:105-109.

Wells JA, Zipp JF, Schuette PT, McEleney J: Musculoskeletal disorders among letter carriers, a comparison of weight carrying, walking, and sedentary occupations. JOM 1983; 25: 814-820.

Wickstrom G, Hanninen K, Mattsson T, Niskanen T, Riihimaki H, Waris P, Zitting A: Knee degeneration in concrete reinforcement workers. Brit J Industr Med 1983; 40:216-219.

Williamson DM: Beat diseases, in Rogan JM (ed): Medicine in the mining industries. Philadelphia, F.A. Davis Co, 1972, pp 199-208.

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Project Director

Shiro Tanaka M.D.
Medical Officer
Epidemiology 2 Section

Report Prepared by:

Michael J. Thun M.D. M.S.
Chief
Epidemiology 2 Section

Shiro Tanaka M.D.
Medical Officer
Epidemiology 2 Section

Statistical Analysis by

Shiu T. Lee, M.S.
Support Services Branch

Medical Evaluation Assistance:

Alexander B. Smith, M.D., M.S.
Chief
Medical Section
Hazard Evaluation Branch

William E. Halperin, M.D. MPH
Chief
Industrywide Studies Branch

Michael E. Luggen, M.D. and
Evelyn V. Hess, M.D.
Division of Immunology
Department of Internal Medicine
University of Cincinnati
College of Medicine

NIOSH wishes to extend special thanks to the leadership and members of the three local unions which participated in this study. NIOSH also wishes to thank faculty members of the Division of Immunology, Department of Internal Medicine, and the Department of Radiology, University of Cincinnati College of Medicine, who conducted the medical and X-ray examinations.

Originating Office:	Industrywide Studies Branch Division of Surveillance, Hazard Evaluations, and Field Studies Cincinnati, Ohio
Report Typed By:	Frances Guerra Donald Bates Clerk-Typists Epidemiology 2 Section

XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of the final report have been sent to.

1. Authorized Representatives of Employees, Local 873, Resilient Floorlayers and Decorators Union, Cincinnati, Ohio.

2. Authorized Representatives of Employees, Local 18, Bricklayers, Terrazo, Mosaic Tile Layers Union, Cincinnati, Ohio.

3. Authorized Representatives of Employees, Local 1454, Millwrights Union, Cincinnati, Ohio.

4. NIOSH, Region V

5. OSHA, Region V

For the purpose of informing affected employees, a copy of the summary pages of this report, when finalized, will be sent to all employees who participated in the NIOSH medical survey.

FIGURE 1

Categorization of Workers According to Union Membership

Occupation, and "Activity" Category

Union Membership	Usual Occupation	Activity Category
Resilient Floorlayers and Decorators	Floorlayers & Carpetlayers	Category I (Kneel and use knee kicker)
Bricklayers, Terrazo, Mosaic and Tilelayers	Tilesetters, Terrazzo, Stonelayers	Category II (Kneel but do not use knee kicker)
Millwrights and Machinery Erectors	All Millwrights, Bricklayers, Decorators	Category III (Neither kneel nor use knee kicker)

Table 1

Workers' Compensation Claims in 1979 for Knee Joint Inflammation Attributed to Kneeling, Leaning, Repetition of Pressure, or Striking against a Stationary Object.*

Occupation	No. of Claims	Per Cent of Claims	Percent of Work Force	Occupational Knee Morbidity Ratio**
Carpet installers	46	6.199	0.0575	107.81
Tile setters	16	2.156	0.0410	52.59
Floor layers	10	1.348	0.0291	46.32
Dry-wall installers and lathers	10	1.348	0.0605	22.28
Cement and concrete finishers	10	1.348	0.0814	16.56
Brick or stonemasons	9	1.213	0.2026	5.99
Millwrights	3	0.404	0.1497	2.70

*From the Supplementary Data System of the Bureau of Labor Statistics, 1979. Modified from Tanaka et. al.. List includes the five occupations with the highest proportionate increase, plus brickmasons and millwrights, the comparison population in this study.

** Percent of claims/percent of workforce

Figure 2

Outcomes Measured In Knee Study

Instrument	Outcome Measured
1) NIOSH Questionnaire (Mailed, self-administered)	Lifetime Prevalence Of Seven knee conditions (Bursitis, arthritis, knee taps, infections, fractured patella surgery, other)
2) NHANES Questionnaire (Telephone, Trained Interviewers)	Prevalence of seven Standardized knee symptoms
3) Physical and X-ray examinations	Quantitative assessment of approximately sixty parameters on self-selected subset of subjects

Table 2

Participation In Knee Disease Study

Union	Membership (#)	Sampled For Study (#)	Participation	
			Questionnaires (#) (%)	Medical (#) (%)
Resilient Floorlayers and Decorators	170	170	132 (78%)	47 (28%)
Bricklayers, Terrazo, Mosaic and Tilelayers	440	190	146 (77%)	40 (21%)
Millwrights And Machinery Erectors	420	202	154 (76%)	21 (10%)
Totals		562	432 (77%)	108 (19%)

TABLE 3

Demographic Characteristics of Workers Participating In The Questionnaire Survey, Grouped By Usual Occupation

	Carpet- and Floorlayers (Floorlayers)	Tile- Terrazo- Marblesetters (Tilesetters)	Millwrights, Bricklayers & Decorators (MWBL)
Participants	112	42	243
Age			
Mean	50.7	57.8	53.9
S.D.	15.1	15.8	16.0
Range	23-79	24-86	19-87
Retired	31%	36%	38%
Years Employed			
Mean	25.0	31.2	24.3
S.D.	12.1	14.1	12.8
Range	1.5-47.6	5.3-61	1.2-61
Height (Inches)			
Mean	70.0	70.0	70.0
S.D.	2.7	3.3	2.6
Range	64.0-81.0	63.0-81.0	64.0-77.0
Weight (Kgs)			
Mean	80.1	80.7	81.3
S.D	12.7	11.1	13.4
Range	47.6-113.4	59.0-115.7	45.4-117.9

Table 4

Selected Job Characteristics of Participants in the Questionnaire Survey, By Usual Occupation

	Carpet and Floorlayers (Floorlayers)	Tile- Terrazo- Marblesetters (Tilesetters)	Millwrights Bricklayers, & Decorators (MWBL)
Participants	112	42	243
Knee Kicker Score*			
Mean	3.9	1.0	1.1
S.D.	1.8	0.0	0.6
Range	1-6	1-1	1-6
Kneeling Score*			
Mean	5.5	4.9	2.9
S.D	6	5	3
Range	1-6	1-6	1-6
Any Kneeling # (%)	111 (99%)	41 (97%)	201 (83%)
Regularly Use Knee Pads**	57 (51%)	34 (97%)	31 (15%)
Percent of Time Using Knee Pads** (Mean)	43.4%	83.4%	29.9%

* Self-assigned qualitative score from 1 (never) to 6 (always).

** Analyses restricted to workers who kneel at work.

TABLE 5

AGE-ADJUSTED PREVALENCE AND PREVALENCE RATIO
OF REPORTED KNEE CONDITIONS IN FLOORLAYERS AND TILESETTERS
RELATIVE TO MILLWRIGHTS AND BRICKLAYERS (MWBL)

KNEE CONDITION	OCCUPATION	PREVALENCE[1] (%)	PREVALENCE[2] RATIO	90%[3] C.I.
KNEE "TAPS"	Floorlayers	31.5	5.0	3.2-7.8
	Tilesetters	31.0	4.9	2.7-8.7
	MWBL	6.3	1.0	N.A.
BURSITIS	Floorlayers	20.0	3.2	1.9-5.4
	Tilesetters	11.2	1.8	0.8-3.9
	MWBL	6.2	1.0	N.A.
ARTHRITIS	Floorlayers	14.3	1.1	0.7-1.8
	Tilesetters	25.7	2.0	1.2-3.3
	MWBL	12.9	1.0	N.A.
SKIN INFECTIONS OF KNEE	Floorlayers	7.0	4.1	1.5-10.8
	Tilesetters	2.6	1.5	0.3-8.2
	MWBL	1.7	1.0	N.A.
FRACTURED PATELLA	Floorlayers	0	--	--
	Tilesetters	0	--	--
	MWBL	3.7	1.0	N.A.
KNEE SURGERY	Floorlayers	2.4	0.4	0.1-1.1
	Tilesetters	7.6	1.3	0.5-3.4
	MWBL	6.1	1.0	N.A.
OTHER KNEE CONDITIONS	Floorlayers	19.1	2.0	1.3-3.1
	Tilesetters	16.2	1.7	0.9-3.3
	MWBL	9.5	1.0	N.A.

1) Age adjusted prevalence directly standardized using males in the NHANES sample as the standard population.

2) Ratio of age adjusted prevalence in the exposed relative to millwrights and bricklayers.

3) 90% confidence intervals for the directly standardized prevalence ratio using method from Kleinbaum and Kupper.

TABLE 6

PREVALENCE OF SEVEN NHANES KNEE SYMPTOMS[1]
IN THE THREE OCCUPATIONAL GROUPS INTERVIEWED
AND PREVALENCE RATIOS RELATIVE TO U.S. WHITE MALES, AGES 25-74

SYMPTOM[1]	OCCUPATION	PREVALENCE[2] (%)	PREVALENCE RATIO	90%[3] C.I.
KNEE PAIN	Floorlayers	33.4	3.5	2.8- 4.5
FOR AT LEAST	Tilesetters	34.1	3.6	2.1- 6.1
ONE MONTH	MWBL	23.1	2.4	1.9- 3.0
PAIN AT	Floorlayers	22.1	5.0	3.6- 6.9
REST	Tilesetters	28.8	6.5	3.5-12.2
	MWBL	13.9	3.1	2.3- 4.3
SWELLING OF	Floorlayers	19.2	4.9	3.4- 7.0
KNEE JOINT	Tilesetters	19.7	5.0	2.2-11.7
	MWBL	12.7	3.2	2.3- 4.6
LOCKING OF	Floorlayers	6.8	7.0	3.6-13.9
THE KNEE	Tilesetters	5.3	5.5	2.1-14.3
	MWBL	5.4	5.6	3.1-11.2
KNEE	Floorlayers	17.0	4.9	3.4- 7.3
"GIVES AWAY"	Tilesetters	9.7	2.8	1.3- 6.1
	MWBL	11.2	3.2	2.1- 4.6
SWELLING AND	Floorlayers	15.4	8.4	5.6-12.7
TENDERNESS ON	Tilesetters	5.6	3.1	1.3- 7.0
TOUCHING	MWBL	7.2	4.0	2.6- 6.2
MORNING	Floorlayers	22.7	3.8	2.8-5.3
STIFFNESS	Tilesetters	14.5	2.4	1.4-4.3
	MWBL	22.2	3.7	3.0-4.7

1) The symptoms were those used in the NHANES standardized supplemental questionnaire on arthritis.

2) Prevalence has been age-adjusted using direct standardization, with the age distribution of the NHANES sample as the standard population.

3) 95% confidence intervals for the directly standardized prevalence ratio using method from Kleinbaum and Kupper.

Table 7

Correspondence Between The Questionnaire Report
and Summary Impression of Bursitis and Arthritis On Physical or X-Ray

BURSITIS

	Physical Examination: Summary Impression			
Questionnaire Response	Bursitis +	Bursitis -	Total	
Bursitis +	8	14	22	Sensitivity=38%
Bursitis -	13	73	86	Specificity=84%
Total	21	87	108	

ARTHRITIS

	Physical Examination: Summary Impression			
Questionnaire Response	Arthritis +	Arthritis -	Total	
Arthritis +	5	17	22	Sensitivity=42%
Arthritis -	7	79	86	Specificity=82%
Total	12	96	108	

	X-ray Examination: Summary Impression			
Questionnaire Response	Arthritis +	Arthritis -	Total	
Arthritis +	14	8	22	Sensitivity=43.8
Arthritis -	18	67	85	Specificity=89.3
	32	75	107	

TABLE 8

LOGISTIC REGRESSION MODEL FOR HISTORY OF BURSITIS

VARIABLE	BETA	P VALUE	R^2
INTERCEPT	- 2.86	-	-
KNEE KICKER	0.33	.0000	0.057

TABLE 9

LOGISTIC REGRESSION MODEL FOR HISTORY OF "KNEE TAPS"

VARIABLE	COEFFICIENT (BETA)	P VALUE	R^2
INTERCEPT	-3.43	0.0000	-
TOTAL YEARS EMPLOYED	0.046	0.03	.009
FACTOR 2*	-0.022	0.0004	.032
AGE	0.0002	0.99	.000
AGE X FACTOR 2*	0.0002	0.03	.008

* FACTOR 2 IS THE STANDING-KNEELING FACTOR

Appendix A

Questions Concerning Past Knee Conditions, NIOSH Questionnaire

1) Have you ever had your knee tapped for an accumulation of fluid or blood in the knee joint?

2) Have you ever had bursitis (inflammation of a joint sac) of the knee?

3) Have you ever had arthritis of the knee?

4) Have you ever had a skin infection in the knee joint area?

5) Have you ever had a broken knee cap?

6) Any other illness or injury to the knee joint?

7) Have you ever had any operation (surgery) of the knee joint?

* For each positive response, the subject was asked in what year the condition first occurred, last occurred, in which leg it occurred, and the name of the physician treating the problem.

Appendix B

The questions adopted from the National Health and Nutrition Survey included:

1) Have you had pain in or around the knee on most days for at least one month?

2) When this knee pain is present, does it hurt at rest as well as moving?

3) When this knee pain is present, is there also swelling of the knee joint?

4) When this pain is present, have you ever had "locking" of the knee?

5) Has either knee "given away" under you?

6) Have you ever had any swelling of joints with pain present when the joint was touched on most days for at least one month? (This is a two-step question. The second part asks which joint is affected.)

7) Have you had stiffness in your joints and muscles when getting out of bed in the morning on most mornings for at least one month? (This is a two-step question. The second part asks which joint is affected.))

APPENDIX C

CRITERIA FOR BURSITIS AND ARTHRITIS BASED UPON PHYSICAL EXAMINATIONS

BURSITIS	Presence of swelling or tenderness on physical examination in either the pre- or infra-patellar bursal area. No radiologic correlate.
ARTHRITIS	Presence of any two of the following signs on physical examination: tenderness to palpation, pain on motion, swelling by positive bulge sign or positive synovial swelling, range of motion restricted to less than 130 degrees.

CRITERIA FOR ARTHRITIS BASED UPON X-RAY EXAMINATIONS

ARTHRITIS

1) Narrowing of the knee joint space (defined as mild narrowing of both the medial and lateral aspect of the knee joint space or moderate or severe narrowing of either).

2) The presence of erosions, cysts, or sclerosis (defined as mild evidence of two or more findings or moderate evidence of a single finding).

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY, CINCINNATI, OHIO 45226

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE. $300

Third Class Mail

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF HHS
HHS 396