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Original Article

Knee Pain and its Associations with Age, Sex, Obesity, Occupation and Living Conditions in Rural Inhabitants of Japan

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Abstract

Factors associated with knee pain were investigated using 871 self-administered questionnaires (405 men and 466 women) from residents aged over 30 years in a rural area of Japan. The prevalence of knee pain increased with age, particularly in women over 50. It was significantly higher in women than in men. Body mass index (BMI) was significantly related to knee pain in women, though not in men. With reference to occupational factors, frequent heavy lifting on the job was significantly associated with knee pain in both men and women, whereas job-related standing and walking showed no such relationship. As for living conditions, residence on rather steep mountain slopes and the habit of sitting on Japanese tatami mats were significant factors related to knee pain in men, but not in women. There was no association of knee pain with the style of toilet (Japanese or Western). After controlling for all significant factors by multiple logistic regression analysis, age, heavy lifting, and residence on steep slopes were found to be independent factors related to knee pain in men; and age, BMI, and heavy lifting were the factors in women.

Key words: Knee pain, Age, Obesity, Occupation, Living conditions

Introduction

Knee osteoarthritis (OA) is a common age-related disease in the elderly. Its prevalence is reportedly 20-40% in those aged 75 and older.[1] Since the disorder often produces physical disability affecting daily life,[2-5] knee OA is considered a major health problem in the elderly.

Knee pain is frequently associated with knee OA. It is found in 30-40% of those with radiographic knee changes.[1] The more severe the radiographic changes in the knee joints are, the more prevalent knee pain becomes.[2, 6-11] Knee pain as well as knee OA is known to aggravate disability; over 50% of men and women with symptomatic knee OA have reported some disability or loss of function.[12]

A survey has found that about 25% of people aged over 55 years have knee pain, and that persons with knee pain more often suffer from disability than those without it.[5] It is, hence, important to elucidate the risk factors for knee pain from the point of view of quality of life. Previous studies mainly focused on risk factors for knee OA, but not for knee pain. In the present study, the authors surveyed knee pain in a rural area of Japan, and analyzed factors associated with the pain, such as age, sex, obesity, occupation, and living conditions.

Materials and Methods

The study population comprised all 1,466 residents aged 20 years and older (696 men and 770 women) in a district of Matsukawa, a town in Nagano Prefecture, Japan, located on a mountainside, where agriculture is prevalent. The district studied was selected because the community center there agreed to this research. Questionnaires eliciting information on knee pain and its related factors were distributed to the residents via the community center by the town public nurses, and self-administered questionnaires were collected about one month later by the same nurses. The survey was conducted between July and August 1992.

Knee pain was probed by asking: "Have you had pain in the knee joints which lasted for more than one month in the past year?", a question modified from the National Health and Nutrition Examination Survey (HANES).[13] We also asked about the self-estimated severity of the knee pain: "If so, how severe is it

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(mild, moderate, or severe)?" "Mild" was defined as pain not interfering with daily activity. "Moderate" was pain somewhat affecting daily activity. "Severe" was pain considerably or seriously affecting daily activity. Subjects were then asked: "If so, have you had injuries or accidents from which the knee pain resulted?" This question was designed to exclude such accident-related factors causing knee pain in the subsequent analysis.

In addition to knee pain, the questionnaire covered age, sex, height and weight, past history of diseases, diseases currently under treatment, and injuries or accidents. It also examined current occupational factors (white-collar or blue-collar; frequency of handling and lifting heavy objects [rare, occasional, or frequent]; standing [rare or rather frequent]; and walking during work [rare, occasional, or frequent]). Furthermore, it probed living conditions such as location of residence (on level ground, gentle slopes, or rather steep mountain slopes); habitually sitting on Japanese straw tatami or chairs or both; and use of a Japanese or Western style toilet.

One thousand eighty-eight residents (493 men and 595 women) responded to this survey (a response rate of 74%). Of those, 70 respondents (31 men and 39 women) were excluded due to insufficient answers about knee pain or age. We also excluded 54 subjects (24 men and 30 women) who reported accident-related factors causing knee pain, and 30 persons (8 men and 22 women) who suffered from rheumatoid arthritis. Thus, the subject count totalled 934 (430 men and 504 women) (Table 1). In the analysis of factors related to knee pain, the subjects were restricted to those aged over 30 years (405 men and 466 women), because the 20-29 age group reported no knee pain and the group had a low response rate of 39% in this survey (the response rate in other age groups was 70% or more). In the specific analyses of factors associated with knee pain, the subject count was further reduced because of inadequate answers about some factors.

The distributions of knee pain by age and sex were analyzed using the Mantel-Haenszel test adjusted for decade. The association of knee pain with each factor was estimated using unconditional logistic regression analysis, from which odds ratios (ORs) and their 95% confidence intervals (95% CIs) were calculated. In the analysis, knee pain was defined as all pain regardless of its severity. For analysis of the relation between knee pain and obesity, body mass index (BMI) was calculated as an indicator of obesity: weight was divided by height squared (kg/m^2). BMI was grouped into three categories: BMI<21 (underweight), 21=<BMI<25 (normal), 25=<BMI (overweight). Logistic regression analysis was then used to assess the relationship of knee pain to BMI while adjusting for age. When analyzing the association of knee pain with occupational factors and living conditions, BMI, like age, was adjusted for as a continuous value. When analyzing occupational factors, subjects were restricted to persons who worked regularly.

Results

Table 1 shows the prevalences of self-reported knee pain, which increased with age, particularly after 50 in women: 3% for men and women aged 30-39; 7% for men and 16% for women in middle age (40-59 years); and 22% for men and 37% for women aged over 60 years. Severe knee pain was prevalent in the elderly: 6% for men and 8% for women aged over 60. The prevalence of knee pain was significantly higher in women than in men ($p<0.01$, by Mantel-Haenszel test, adjusted for decade).

BMI was significantly associated with knee pain in women, but not in men (Table 2). The OR for knee pain increased with BMI in women ($p<0.05$; $21 \leq BMI<25$ OR=1.55, 95% CI=1.10-2.18; $25 \leq$ BMI OR=2.40, 95% CI=1.21-4.77). When BMI was counted as a continuous value in logistic regression analysis, the result similarly showed a significant positive relationship between

Table 1 Prevalence of reported knee pain among rural residents, by age group and sex

	Men			Women		
Age	Total n	With knee pain n (%)	With severe knee pain n (%)	Total n	With knee pain n (%)	With severe knee pain n (%)
20-29	25	0 (0.0)	0 (0.0)	38	0 (0.0)	0 (0.0)
30-39	60	2 (3.3)	0 (0.0)	100	3 (3.0)	0 (0.0)
40-49	88	4 (4.5)	1 (1.1)	84	7 (8.3)	2 (2.4)
50-59	77	7 (9.1)	0 (0.0)	99	22 (22.2)	1 (1.0)
60-69	115	22 (19.1)	3 (2.6)	105	31 (29.5)	7 (6.7)
70≤	65	18 (27.7)	8 (12.3)	78	36 (46.2)	8 (10.3)
Total	430	53 (12.3)	12 (2.8)	504	99 (19.6)	18 (3.6)

Table 2 Age-adjusted odds ratios (ORs) (and 95% confidence intervals (CIs)) for the association of knee pain with body mass index

	Men			Women		
Body mass index	With pain n+	Without pain n+	OR (95% CI)	With pain n+	Without pain n+	OR (95% CI)
< 21	20	104	1.00	34	176	1.00
21 - 25	24	183	0.86 (0.44-1.69)	50	153	1.55 (1.10-2.18)*
25 ≤	4	45	0.64 (0.20-2.04)	11	25	2.40 (1.21-4.77)*

*$p<0.05$. Odds ratios were adjusted for age.
+Answers were missing for 25 men and 17 women.

knee pain and BMI in women.

With reference to occupational factors, blue-collar workers had a higher OR than white-collar workers, but the difference was not significant (Table 3). A significant association was found between knee pain and frequent handling and lifting of heavy objects on the job, whether by men or women ($p<0.05$; in men, OR=3.03, 95% CI=1.24-7.41; $p<0.01$; in women, OR=5.75, 95% CI=2.43-13.61). The OR was elevated with the frequency of heavy lifting. Frequencies of standing and walking during work showed no significant associations with knee pain.

As for living conditions, the OR for knee pain was significantly higher in male residents living on rather steep mountain slopes than in those on level ground ($p<0.05$; OR=2.74, 95% CI=1.18-6.32, Table 4). Residence on steep slopes showed a slightly, but not significantly, higher OR in women. When compared with sitting in chairs, habitually sitting on Japanese tatami mats resulted in a significantly higher OR in men ($p<0.05$; OR=5.68, 95% CI=1.51-7.41), but not in women. The style of

Table 3 Age- and BMI-adjusted odds ratios (ORs) (and 95% confidence intervals (CIs)) for the association of knee pain with occupation

Variables	Men			Women		
	With pain n+	Without pain n+	OR (95% CI)	With pain n+	Without pain n+	OR (95% CI)
Kind of work						
White-collar	3	57	1.00	1	25	1.00
Blue-collar	45	269	1.31 (0.36-4.72)	71	276	2.29 (0.28-18.71)
Frequency of handling and lifting heavy objects on the job						
Rare	8	113	1.00	30	155	1.00
Occasional	18	130	1.55 (0.75-3.23)	20	113	1.30 (0.69-2.43)
Frequent	12	56	3.03 (1.24-7.41)*	14	20	5.75 (2.43-13.61)**
Frequency of standing on the job						
Rare	5	58	1.00	9	48	1.00
Occasional or more	32	237	0.95 (0.49-1.85)	59	250	1.09 (0.64-1.84)
Frequency of walking on the job						
Rare	12	70	1.00	13	73	1.00
Occasional	23	140	1.07 (0.53-2.02)	30	152	0.85 (0.48-1.53)
Frequent	8	88	0.74 (0.30-1.83)	27	77	1.70 (0.90-3.21)

*p<0.05, **p<0.01. Odds ratios were adjusted for age and BMI.
+The subjects were restricted to those who worked regularly (385 men and 391 women), but answers to specific questions were missing for 53 men and 39 women.

Table 4 Age- and BMI-adjusted odds ratios (ORs) (and 95% confidence intervals (CIs)) for the association of knee pain with living conditions

Variables	Men			Women		
	With pain n+	Without pain n+	OR (95% CI)	With pain n+	Without pain n+	OR (95% CI)
Slopes around residence						
Level ground	10	109	1.00	33	116	1.00
Gentle slopes	21	151	1.54 (0.68-3.53)	31	152	0.66 (0.37-1.18)
Steep slopes	19	86	2.74 (1.18-6.32)*	31	86	1.20 (0.64-2.25)
Habitually sitting on chairs or Japanese tatami mats						
Chairs	2	52	1.00	6	43	1.00
Chairs & tatami	10	106	2.38 (1.23-4.62)*	36	117	1.54 (0.63-3.78)
Tatami	41	183	5.68 (1.51-7.41)*	54	200	1.42 (0.60-3.39)
Kind of toilet						
Western style	18	114	1.00	34	129	1.00
Japanese style	32	234	0.89 (0.46-1.71)	64	234	1.25 (0.75-2.10)

*p<0.05, **p<0.01. Odds ratios were adjusted for age and BMI.
+Answers to specific questions were missing for 11 men and 17 women.

Table 5 Adjusted odds ratios (ORs) (and 95% confidence intervals (CIs)) for knee pain

Variables	Men	Women
	OR (95% CI)	OR (95% CI)
Age (per 10-year increase)	1.74 (1.27-2.38)**	2.14 (1.64-2.79)**
Body mass index (per 5-unit increase)	0.51 (0.21-1.20)	1.97 (1.08-3.60)*
Frequency of heavy lifting (frequent/rare)	4.08 (1.41-11.79)**	3.86 (1.59-9.40)**
Slopes around residence (steep slopes/level ground)	2.91 (1.00-8.45)*	1.05 (0.48-2.32)
Sitting on chairs or tatami mats (tatami mats/chairs)	3.35 (0.87-12.84)	1.28 (0.52-3.15)

*p<0.05, **p<0.01. Odds ratios were adjusted for all other variables in the table by multiple logistic regression analysis. The subjects were restricted to those who worked regularly, and answers were missing for 71 men and 53 women; the subjects in this analysis were 314 men and 338 women.

toilet (Japanese or Western) was not associated with knee pain.

Table 5 shows the adjusted ORs for knee pain by multiple logistic regression analysis, taking account of all significant factors such as age, BMI, frequency of heavy lifting, slopes aroud the residence, and habitually sitting on chairs or tatami mats. The analysis was done for the subjects who worked regularly because the question on the frequency of heavy lifting during work was expected to be answered by them. After controlling for all these factors, age, heavy lifting, and residence on steep slopes were significant factors related to knee pain in men, whereas age, BMI, and heavy lifting were such factors in women.

Discussion

The present survey adopted a definition of knee pain similar to the HANES study; [13] knee pain was inquired about by the question: "Have you had pain in the knee joints which lasted for more than one month in the past year?" A similar definition was employed by other studies as well. [5, 7, 9, 10, 14] Owing to the definition, knee pain in the present study was thought to include pain resulting not only from knee OA but also from other causes, although injuries and accidents related to knee pain and rheumatoid arthritis were excluded. However, Tecumseh Study data have indicated that knee pain according to this definition is likely to be a predictor of the status of knee OA in spite of some discrepancies. [9]

The present study showed that the prevalence of knee pain increased with age, particularly after 50 in women, and that it was significantly higher in women than in men. These findings were in accordance with previous studies on knee OA demonstrating that radiologic knee OA increases progressively with age and that it is more prevalent in women. [2, 7, 15-17] On the other hand, previous results on knee pain were inconsistent: some studies demonstrated a positive correlation with age, [2, 5] whereas some did not. [11, 18] Dacre et al. [19] have shown that women and the elderly have smaller knee joint spaces, and surmised that they may be more susceptible to knee pain.

The present survey was conducted in a rural area of Japan, where about 60% of respondents were farmers, a group shown to have a higher-than-average prevalence of knee pain. [20] Hence, the present findings are considered to rather reflect the farmers' knee pain. The farmers' conditions may contribute to the relatively high prevalence of knee pain in the present study, though a more than 30% prevalence of knee pain has been reported in previous studies as well. [5, 6, 9, 10]

Obesity is known to be a significant risk factor for knee OA; a relation stronger in women than in men. [2, 16, 21-24] The present study demonstrated a positive relationship between knee pain and BMI in women, but not in men. As for the association between knee pain and obesity, previous studies have shown the same positive relation between them as did the present study. [2, 9] But some studies in which the relation was analyzed in light of radiographic changes have indicated no such association. [17, 21, 25] Since the present survey did not examine radiographs of the knee joints, we could not properly determine the contribution of obesity to knee pain independently of knee OA.

The association between BMI and knee pain was found only in women. Obesity is presumed to increase mechanical stress on the knee and lead to knee pain. Because of the smaller knee joint space in women than men, [19] women may be more likely to be affected by obesity. Additionally, obese women can also be influenced via increased production of condrodestructive, endogenous estrogens from adipose tissue, which are shown to be correlated with obesity. [26] These factors may explain the stronger relationship between BMI and knee pain in women.

The present study revealed that frequent handling and lifting of heavy objects in the workplace was significantly associated with knee pain in both sexes. Previous studies have shown that heavy physical labor is related to knee OA and knee pain. [20, 23, 27-32] But they have mostly defined heavy physical labor by the type of job, though some of the types of jobs are expected to involve heavy lifting. The present study was partly compatible with a previous study which showed a relation between knee OA and heavy lifting together with jobs that entailed kneeling or squatting. [32] It is known that mechanical stress on the knee plays an important role in the development of knee OA. [33-35] Handling and lifting of heavy objects increase such stress and can be risk factors for knee pain as well. The present multiple logistic regression analysis has suggested that heavy lifting is an independent major factor for knee pain in both sexes. Job-related mechanical stress on the knee may be an important risk factor for knee pain. The category of frequency of heavy lifting in this survey was based on the self-reporting of workers in many occupations. More precise studies will be required on this matter.

In the present study, residence on rather steep mountain slopes and habitually sitting on Japanese tatami mats were significantly related to knee pain in men. Walking up and down steep slopes puts mechanical stress on the knee, and may lead to the higher risk for knee pain in residents on the steep slopes. Sitting on tatami mats requires knee bending, which might possibly contribute to knee pain, since some studies have suggested that prolonged bending of the knee is associated with knee OA. [23, 31, 32] Thus, these factors can be risks for knee pain. However, the multiple logistic regression analysis did not show a significant relationship to habitually sitting on tatami mats even in men. Moreover, the association between these factors and knee pain

was not found in women. It is, therefore, considered that the results are only suggestive, and require more studies to draw a conclusion about these relationships.

The present survey was a cross-sectional study, so that the results could be affected if persons with knee pain changed their life style due to the pain. In this case, they might lose weight, avoid lifting heavy objects or prolonged walking, and prefer a chair or Western style toilet. These changes all could lead to underestimation of the risks for knee pain under study. Nevertheless, the present results indicated significant relationships to obesity, heavy lifting and sitting on tatami mats in men and/or women in addition to age and sex. Therefore, these factors are expected to have some importance as risks for knee pain. However, since these factors were, as a result, similar to those for knee OA, the question still remains whether they are associated with knee pain as well as knee OA, or whether they are linked only to knee OA from which some knee pain usually results. One study has indicated that knee pain is an important determinant of functional impairment in elderly subjects more than severity of knee OA.[36] Knee pain can be a troublesome problem in the elderly. Further studies are needed to evaluate the risk factors for knee pain.

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