Associations between Floor Activities and Knee Osteoarthritis in Thai Buddhist Monks: The Songkhla Study

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Objective: *Whether floor activity, a common daily activity among Buddhist monks, is a risk factor for knee osteoarthritis remains controversial. The objective of the present study was to search for any association between floor activities and knee osteoarthritis.*
Material and Method: *This population-based survey involved 261 monks, 40 years of age or older from Songkhla province in the southern part of Thailand. Histories were taken on lifetime floor activities in four common positions, squatting, lotus, side-knee bending, and kneeling. Radiographic investigations included antero-posterior and skyline views of both knees. Diagnosis of osteoarthritis in each compartment was based on Kellgren & Lawrence grade 2 or more. Logistic regression analysis adjusted for age, body mass index and smoking status was used to identify the associations between lifetime floor activity and knee osteoarthritis.*
Results: *The mean age (SD) of monks in the present study was 60.4 (12.7) with mean age at ordination 44.4 (17.6) years. The lotus and side-knee bending positions were the two most common practices. Using the lowest tertile of exposure to lotus position as a reference, the third tertile had an odds ratio of 1.0 (95%CI; 0.5-2.2) associated with radiographic knee osteoarthritis. The corresponding odds ratio for side-knee bending was 0.8 (95%CI; 0.3-1.7), for squatting 2.1 (95%CI; 0.9-4.5), and for kneeling 0.7 (95%CI; 0.3-1.5).There was no significant association between the average daily lifetime floor activity in any positions and symptomatic radiographic knee osteoarthritis.*
Conclusion: *Floor activities involving squatting, lotus, side-knee bending and kneeling do not increase the risk of knee osteoarthritis in Thai Buddhist monks.*

Keywords: *Floor activity, Knee osteoarthritis*

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Knee osteoarthritis is a major public health problem all over the world, especially in the elderly[1-3]. A mechanical role has been proposed as a key risk factor associated with this condition[4,5].One such mechanical effect advanced for such associations, floor activities, a common a daily among Asians, might account for the relatively higher prevalence of knee osteoarthritis in Asians than in Western populations[6-8]. Thailand, with over 90% of the population being Buddhist, has approximately 300,000 monks. One large group perceived as being at risk in Thailand is Buddhist monks, who spend a large amount of time daily in floor activities, mainly using the lotus, side-knee bending and kneeling, with simple squatting less frequent. Most previous studies exploring the association between knee bending activities and knee osteoarthritis have been done in Western populations without any conclusive results[9-11].Since the nature and type of floor activity of monks, and the amount of

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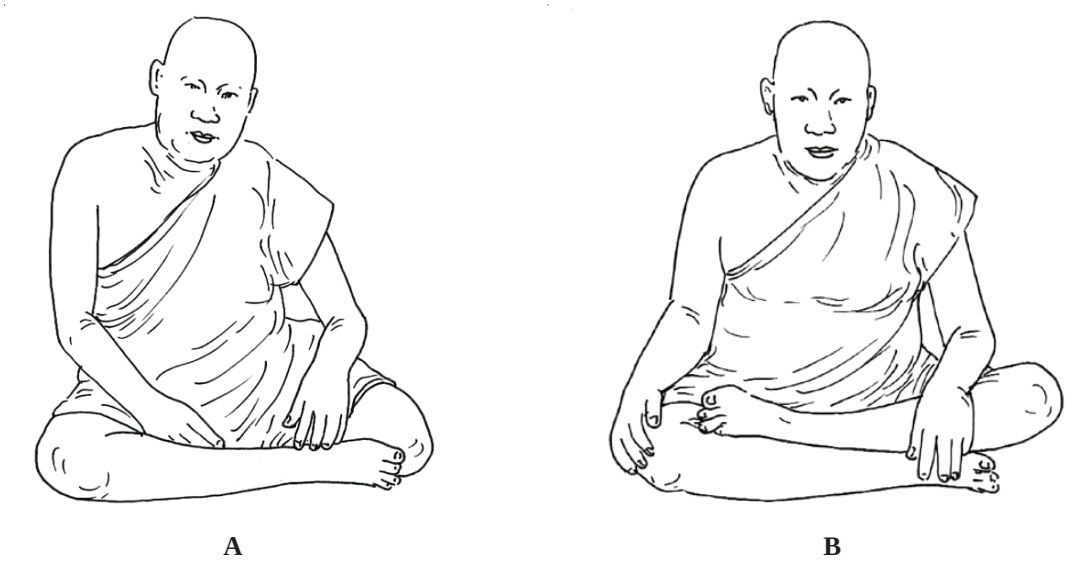
time they spend doing such activities, are different from Western populations, it was felt it would be useful to examine whether floor activities such as lotus, side-knee bending, squatting and kneeling are risk factors of knee osteoarthritis. This information is important for public education. The objective of the present study was to document the association between floor activities and knee osteoarthritis in Thai Buddhist monks.

Material and Method

This was a population-based survey of monks in Songkhla province, southern part of Thailand. Informed consent was obtained from all participants before the study began. The study protocol was approved by the Ethics Committee of Faculty of Medicine, Prince of Songkla University. Among 313 temples in the province, eighty-five temples located within 30 kilometer from the authors' research centre were chosen. Monks aged 40 years or older without other rheumatic conditions such as gout or rheumatoid arthritis were invited to participate. Monks who agreed to participate were taken to a private radiological clinic for history taking, physical examination and radiographic investigation. Face-to-face interview was done by one well-trained nurse to obtain the demographic data including age, history of previous knee injuries if any, family history of osteoarthritis, beginning age and duration of ordainment, history of knee pain, and floor activity exposure. Floor activity exposure was categorized into four positions: squatting, kneeling, lotus and side-knee bending (Fig. 1). Height and body weight were measured for calculation of body mass index. Frequency and duration of each type of floor activity per day in each 10-year-interval since the age of 25 were recalled, summed and average for daily exposure in minutes. Radiographic images, including weight-bearing anterior-posterior, and skylines using the method by the Devies method[12],were taken of both knees by one musculoskeletal imaging technician. Interview concerning floor activity exposure was done prior to radiography.

To calibrate the reliability of the radiographic evaluations, thirty existing knee radiographs available in the present study with different severities were randomly selected and independently evaluated by two musculoskeletal radiologists, blinded to clinical results, twice, one month apart. The reliability (kappa statistic) of the radiographic evaluations was at a good to excellent level of agreement in both intra-rater (0.74-0.86) and inter-rater reliability tests (0.62-0.85) for each site of involvement.

Osteoarthritis was established if the radiographic result was grade 2 or more using Kellgren & Lawrence classifications[18] (definite osteophyte with questionable joint space narrowing) in each side and specific compartment, medial and lateral tibiofemoral. For evaluation of patellofemoral involvement, skyline radiographs were graded from 0 to 3 (0: normal, 1: osteophyte without joint space narrowing, 2: moderate



A **B**

Fig. 1 Common floor activities in Thai Buddhist monks: side-knee bending (A) and lotus (B)

joint space narrowing and 3: marked joint space narrowing). Grade 1 or more was classified as patellofemoral involvement.

Statistical analysis

The average daily exposure in each 10-year interval were summed into lifetime cumulative exposure and subsequently cut into tertiles. Chi-square test was used to find out the relationship between normal and knee osteoarthritis according to risk factors. The associations between lifetime floor activity exposure and radiographic and symptomatic knee osteoarthritis were analyzed by logistic regression and presented it with odds ratio and 95% confidence interval (95%CI). The data were analyzed using STATA software (version 7.0, STATA Corporation, 2001). A p-value of less than 0.05 was considered statistical significance.

Results

Of 280 eligible monks, 261 agreed to participate in the present study. Non-participating monks were mostly abbots who were not available due to several administrative commitments. The mean (SD) age of the participants was 60.4 (12.7) with mean age at ordainment of 44.4 years. The mean duration of ordainment was 16.9, while the mean (SD) body mass index was 23.2 (4.5) kg/m^2. Current smoking was found in 38.1%. The distribution of average daily exposure in minutes (SD) in each position was lotus 69.0 (87.7), side-knee bending 37.1 (62.8), squatting 23.1 (16.8) and kneeling 21.0 (58.3). The total average time of daily floor activity was about 150 minutes.

The overall prevalence of radiographic and symptomatic radiographic knee osteoarthritis in the present study was 59.2% and 29.6%, respectively, with 32.9% categorized as a combined pattern and 18.7% and 7.6% categorized as isolated patellofemoral and isolated tiofemoral pattern. The prevalence of radiographic knee osteoarthritis among each pattern was broken down by potential risk and summarized in Table 1.These variables showed significant crude association with osteoarthritis.

There was no association between lifetime floor activity exposure in any position and radiographic knee osteoarthritis. Monks who were exposed to the highest tertile of floor activities in any position did not show an increased risk of knee osteoarthritis compared to those exposed to the lowest tertile (Table 2).

Among subjects with radiographically-indicated knee osteoarthritis, subjects in the highest tertile of time spent in squatting, lotus, kneeling and side-knee bending did not show an increased risk of developing knee pain compared to those in the lowest tertile of floor activity (Table 3).

Table 1. Distribution of radiographic knee osteoarthritis according to potential risk factors

Risk Factors	Normal (%) (n = 117)	Osteoarthritis (%) (n = 144)	p-value*
Age group (yrs)			<0.001
- Less than 60 (125)	77 (61.6)	48 (38.4)	
- Equal to or more than 60 (136)	40 (29.4)	96 (70.6)	
Body mass index (kg/m^2)			0.117
- Less than 20 (62)	35 (58.4)	27 (43.5)	
- 20-24.9 (123)	52 (42.2)	71 (57.7)	
- 25-29.9 (58)	25 (43.1)	33 (56.9)	
- Equal to or more than 30 (18)	5 (27.8)	13 (72.2)	
Smoking status			0.819
- Never (60)	27(45.6)	33 (55.0)	
- Former (101)	43 (42.6)	58 (57.4)	
- Current (100)	47 (47.0)	53 (53.0)	
Previous knee injury			0.070
- No (250)	115 (46.0)	135 (54.0)	
- Yes (10)	2 (18.2)	9 (81.8)	
Family history of osteoarthritis			0.861
- No (231)	104 (45.0)	127 (54.9)	
- Yes (30)	3 (10.0)	17 (56.8)	

* Chi-squared test

Table 2. Relationship of floor activity exposure and radiographic knee osteoarthritis

Lifetime Floor Activity Exposure	Radiographic Knee Osteoarthritis	
	Crude OR (95%CI)	Adjusted OR (95%CI)
Squatting		
- First tertile	1	1
- Second tertile	1.6 (0.9-3.0)	1.3 (0.6-2.5)
- Third tertile	2.1 (1.1-3.9)	1.7 (0.9-3.4)
Lotus		
- First tertile	1	1
- Second tertile	0.8 (0.5-1.5)	0.9 (0.5-1.8)
- Third tertile	1.1 (0.6-1.9)	1.2 (0.6-2.3)
Side-knee bending		
- First tertile	1	1
- Second tertile	0.6 (0.4-1.2)	0.8 (0.4-1.6)
- Third tertile	0.7 (0.4-1.3)	0.5 (0.3-1.2)
Kneeling		
- First tertile	1	1
- Second tertile	1.0 (0.6-1.8)	1.1 (0.6-2.2)
- Third tertile	0.6 (0.3-1.2)	0.6 (0.3-1.4)
Total floor activity		
- First tertile	1	1
- Second tertile	0.7 (0.4-1.3)	0.7 (0.3-1.3)
- Third tertile	0.7 (0.4-1.3)	0.7 (0.3-1.4)

Table 3. Relationship of floor activity exposure and symptom of pain in knee osteoarthritis

Lifetime Floor Activity Exposure	Symptomatic Radiographic Osteoarthritis	
	Crude OR (95%CI)	Adjusted OR (95%CI)
Squatting		
- First tertile	1	1
- Second tertile	1.7 (0.6-4.5)	2.6 (0.8-8.1)
- Third tertile	1.7 (0.6-4.3)	2.4 (0.8-7.2)
Lotus		
- First tertile	1	1
- Second tertile	1.3 (0.5-3.2)	1.8 (0.6-5.3)
- Third tertile	1.3 (0.6-3.2)	1.3 (0.4-3.6)
Side-knee bending		
- First tertile	1	1
- Second tertile	0.9 (0.4-2.1)	0.7 (0.3-1.9)
- Third tertile	1.6 (0.6-3.9)	1.1 (0.4-3.2)
Kneeling		
- First tertile	1	1
- Second tertile	0.4 (0.2-1.0)	0.4 (0.2-1.2)
- Third tertile	2.6 (0.9-7.9)	2.4 (0.6-9.1)
Total floor activity		
- First tertile	1	1
- Second tertile	1.8 (0.7-4.5)	2.2 (0.7-6.1)
- Third tertile	1.6 (0.6-3.8)	1.4 (0.5-4.1)

Discussion

The authors found that floor activities using lotus, side-knee bending, kneeling or squatting did not increase the risk of knee osteoarthritis in Thai Buddhist monks. In addition, floor activities did not increase the risk of knee pain in patients having radiographically-indicated knee osteoarthritis.

Repetitive knee bending activity has been previously reported as an occupation hazard for knee osteoarthritis[8-10]. This is in contrast to the present results. The explanation for this discrepancy might be explained by the differences in patterns, intensity of exposure and the demography of the populations. Most of the previous reports have been done in Western populations that are less likely to have habitual floor activities as do most Asians, and where most knee bending activities are job-related. Additionally, the intensity, duration, and loading characteristics on the knee are probably different. In addition, the body mass index in monks, again as in most Asians, is relatively lower than in Western populations, which would also lead to lower load transfer across the knee during knee bending activities. Furthermore, daily and regular floor activity, especially beginning at a younger age, might be related to the soft tissue adaptation resulting in decreased loads across the knee joint in Asian populations[14,15]. There may also be some other known and unknown factors related to the pathogenesis of knee osteoarthritis such as the effect of meditation on the biology of cartilage and cartilage healing which need further exploration.

The two common floor activities among Thai Buddhist monks are lotus and side-knee bending. Both positions require knee bending beyond 120 degrees. In lotus or Buddhist position, both hips are adducted and internally rotated. Lotus position has been used for more than 2500 years, since Lord Buddha indicated that it was appropriate for Buddhists to sit in this way[16]. Buddhist monks use this position during meditation and some religious ceremonies. In side-knee bending position, one hip is abducted and externally rotated while the other is adducted and internally rotated. This knee position is frequently used during prayer by Buddhist monks in Thailand and Sri Lanka. Both the lotus and side-knee bending positions require soft tissue elasticity around the knee. However, the present study demonstrated that 50% of monks with knee osteoarthritis reported pain especially during these floor activities.

The association between squatting and knee osteoarthritis remain unsolved. The present results showed that squatting was not a risk factor. This discordant result may be associated with the fact that the amount of exposure of both knees to squatting is actually quite small; mainly, most monks squat only in the toilet or for a few minutes during some forms of prayer. A previous study done in Beijing[17], among people spending prolonged time squatting reported the risk of knee osteoarthritis to be about 1.7 times compared to that having lower exposure.

Most of the previous reports showed that kneeling increased the risk of knee osteoarthritis[18-20]. They found that men with jobs that required both carrying and kneeling in mid-life had an increased risk of knee osteoarthritis. The present results might be explained by noting that the exposure pattern and duration of kneeling in monks is lower, since they kneel only for a short period during prayer and furthermore they do not carry heavy loads like workmen, so the kneeling would be less likely to have the same effect.

The prevalence of knee osteoarthritis in Thai Buddhist monks from the present study is high compared with other studies[1,3,6,7]. This might be explained by first, the authors used skyline view which has a better diagnostic accuracy to detect patellofemoral arthritis instead of lateral view. Second, most of the monks included in the present study were elderly, which is an independent risk factor of knee osteoarthritis.

The diagnostic criteria of knee osteoarthritis remain unsettled. Most epidemiological studies have been based on the results of standard radiographs with or without symptoms, rather than clinical features[21]. Radiographic criteria were proposed by Kellgren and Lawrence[13] focuses mainly on osteophyte formation. In their system, grade 2 or more is the point at which a diagnosis of osteoarthritis is indicated. Another radiographic classification scheme commonly used in clinical practice is the Ahlback system, which focuses on joint space narrowing as an indirect sign of cartilage loss. An Ahlback grading equal to or greater than grade one is considered to indicate osteoarthritis[22]. The American Rheumatism Association (ARA) developed a classification system with a set of criteria for reporting osteoarthritis of the knee[23]. The criteria consist of both clinical and radiographic findings, which are age over 50, crepitus, bony enlargement, morning stiffness of less than 30 minutes and presence of an osteophyte. However, these criteria cannot be used for people aged less than 50 and the scheme focuses on only the tibiofemoral joint and ignores the patellofemoral joint. Furthermore, knee pain without radiographic change

may not be diagnosed as knee osteoarthritis by this classification.

The present study has some strength. First, the authors used skyline view radiographs, which have better diagnostic accuracy in detecting patellofemoral involvement than the lateral view, ensuring that the authors accurately assessed the prevalence of knee osteoarthritis, especially in the patellofemoral compartment. In addition, the authors measured lifetime exposure rather than simply the average intensity at a single time point, which should be more representative of the exposure to floor activity. The present study also had some limitations. First, recall bias cannot be obviated because subjects having knee osteoarthritis may perceive that floor activity caused knee osteoarthritis and thus report more floor activity. Second, the "healthy worker effect" may have diluted the association, as monks who have retired due to the problems related to knee osteoarthritis were not included in a study such as this, and such monks may have had high floor activity exposure. In addition, monks with knee osteoarthritis and knee symptoms may not be able to do floor activity, thus biasing the relationship toward a null or negative association. Finally, since Thai Buddhist monks have a special lifestyle and different demographics compared to non-monks, these results cannot readily be generalized to other groups.

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ความสัมพันธ์ระหว่างการนั่งกับพื้นกับการเกิดโรคข้อเข่าเสื่อมในพระภิกษุไทย: การศึกษาในจังหวัดสงขลา

บุญสิน ตั้งตระกูลวนิช, วีระศักดิ์ จงสู่วิวัฒน์วงศ์, อลัน กีเตอร์

วัตถุประสงค์*: การนั่งกับพื้นเป็นกิจกรรมซึ่งพระภิกษุในพุทธศาสนากระทำอยู่เป็นนิจในกิจวัตรประจำวัน อาจเป็นปัจจัยเสี่ยงของการเกิดโรคข้อเข่าเสื่อม การศึกษานี้มีจุดประสงค์เพื่อหาความสัมพันธ์ระหว่างการนั่งกับพื้นกับการเกิดโรคข้อเข่าเสื่อมในพระภิกษุไทย*

วัสดุและวิธีการ*: เป็นการศึกษาโดยวิธีสำรวจในพระภิกษุจำนวน 261 รูปที่มีอายุ 40 ปีหรือมากกว่า ในจังหวัดสงขลา พระทุกรูปได้รับการซักประวัติเกี่ยวกับการนั่งกับพื้นในท่าต่าง ๆ 4 ท่า ได้แก่ ท่านั่งยอง ท่าขัดสมาธิ ท่าคุกเข่า และท่าพับเพียบ และได้รับการถ่ายภาพรังสีบริเวณเข่าทั้ง 2 ข้าง การวินิจฉัยโรคใช้เกณฑ์จากภาพถ่ายรังสี โดยยึดตามการแบ่งความรุนแรงของรอยโรคตาม Kellgren และ Lawrence ที่เกรดมากกว่าหรือเท่ากับ 2 การวิเคราะห์หาความสัมพันธ์ระหว่างปัจจัยการนั่งกับพื้นกับการเกิดโรคข้อเข่าเสื่อม ใช้ Logistic regression ที่ปรับเทียบกับอายุ ดัชนีมวลกาย และประวัติการสูบบุหรี่*

ผลการศึกษา*: อายุเฉลี่ยของพระภิกษุที่ศึกษาเท่ากับ 60.4 ปี (12.7) โดยอายุเฉลี่ยที่เริ่มบวชคือ 44.4 ปี (17.6) ท่านั่งขัดสมาธิและท่าพับเพียบเป็นท่านั่งที่นั่งนานและบ่อยที่สุด อย่างไรก็ดีไม่พบความสัมพันธ์ระหว่างการเกิดโรคข้อเข่าเสื่อมกับระยะเวลาการนั่งในทุกท่า (ท่าพับเพียบ OR = 1.0 (95%CI; 0.5-2.2), ท่าขัดสมาธิ OR = 0.8 (95%CI; 0.3-1.5), ท่านั่งยอง OR = 2.1 (95%CI; 0.9-4.5) และท่าคุกเข่า OR = 0.7 (95%CI; 0.3-1.5) และไม่พบความสัมพันธ์ระหว่างระยะเวลาการนั่งกับพื้นกับการเกิดอาการปวดเข่า*

สรุป*: การนั่งกับพื้นในท่านั่งยอง ท่าคุกเข่า ท่าขัดสมาธิหรือท่าพับเพียบไม่เพิ่มความเสี่ยงต่อการเกิดโรคข้อเข่าเสื่อมในพระภิกษุไทย*