PHYSICAL ACTIVITY AND RISK FACTORS FOR HIP FRACTURES IN THAI MEN

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Abstract. To test the hypothesis that hip fracture is associated with physical activity in Thai elderly men, a case-control study was conducted in Bangkok, Thailand. A total of 187 men aged 51 years over, resident in Bangkok, admitted consecutively with a radiologically confirmed first hip fracture were studied. 177 age-matched community controls were randomly recruited from the same neighborhood of the cases. Physical activity was independently associated with reduced risk of hip fracture after controlling for confounding factors. Very active and active past physical activity markedly reduced risk of hip fracture in comparison to subjects with inactive past physical activity. Recent active physical activity was also protective against hip fracture. This prompts a need to identify strategy to promote physical activity among the elderly and at an early age.

INTRODUCTION

Physical activity has been shown by many studies as one of the promising, inexpensive preventive measure of hip fracture (Jaglal *et al*, 1993 ; Paganini *et al*, 1991; Joakimsen *et al*, 1997). Yet, most of the evidence has been derived from elderly western women. So far there have not been any studies demonstrating the relationship between hip fracture and physical activity in Thai men. This study aims to determine such a relationship in Thai elderly men using a case-control design.

MATERIALS AND METHODS

Subjects

In this case-control study, men with hip fractures (case patients) were compared with men without hip fractures (controls) to determine whether past and present physical activity were associated with a reduction of hip fracture, taking into account possible confounding factors. Fourteen hospitals in Bangkok and its vicinity participated in the study during August 1, 1997 - September 15, 1998.

Selection of cases

Cases included men aged 51 years or over, resident in Bangkok, admitted to the emergency rooms or orthopedics wards of the participating hospitals during the study period with the first episode of hip fracture (ICD - code 820.0, 820.2). The diagnosis was confirmed by X-ray reports. Exclusion criteria included patients with pathological hip fracture, fractures resulting from sufficient trauma or patients who were severely ill, unable to cooperate and had no proxy respondents.

Selection of controls

Since the population census was not complete in the study area, controls were therefore selected from men who lived in private homes

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within 20-minute walk clockwise from the houses of cases. Each control subject was matched by age (within a 5-year range, but not less than 51 years old) and had no history of hip fracture. Controls who were severely ill or unable to cooperate and had no proxy respondents were excluded.

Data collection

Trained interviewers used a structured questionnaire to ask the subjects about the study variables. Proxy respondents were interviewed when the subjects were medically incapacitated or cognitively impaired. Cases were interviewed in hospital. Controls were interviewed at home.

Measurement of study variables

Three types of past physical activity at three different ages (18-24, 25-50, and 51 years up) were assessed; housework, labor job in employment, and heavy sport exercises. Scores for each activity were calculated in the following manner: if the respondent did not participate in an activity, he received a score of 0. If he did participate, he received a score of 1,2 or 3 according to the frequency (hardly ever=1, sometimes=2, very often=3). These scores were then summed up and categorized as inactive, active and very active on the tertile of total score in controls.

Six types of recent physical activity performed during the last year before hip fracture were assessed: shopping, walking upstairs, walking uphill, lifting heavy object, doing housework and labor work. For each activity, frequency of 1, 2, and 3 or more times per week was scored as 1, 2, 3 respectively. The individual activity scores were summed to produce a total score that was categorized as inactive, active, or very active based on the tertile of total scores in controls

The activity before fracture was classified into 4 groups: not using gait aid (human or equipment) both indoor and outdoor activity, could go outdoor with gait aid, had to stay at home and walk with gait aid, and sitting on wheel chair or bedridden.

All subjects were asked whether their parents had Chinese race.

Alcohol consumption was assessed by the total amount, types of liquor and frequencies of drinking in one week. The subjects were classified as drinkers based on the tertile of total amount in controls. Since the amount of the first and the second tertiles equaled zero, reclassification was made using the median; if the alcohol consumption exceeded zero, he would be labeled as a drinker.

Number of packs (20 cigarettes/pack) and duration of smoking were recorded. The subjects were classified as smoker based on the tertile of total amount in controls. Since the amount of the first and the second tertiles equaled zero, reclassification was made using median; if the cigarette consumption exceeded zero, he would be labeled as a smoker.

Daily calcium intake was measured using a food frequency questionnaire with portion size estimation within one week period prior to the interview. Average daily calcium intakes of one-week of regular diet were calculated by multiplying the frequency of consumption of each food item by its calcium content (Department of Health, 1992) and summing over all foods.

Questions of the current use of the following drugs were included on the questionnaires: diuretics, steroids, sedatives, antihypertensives, anticonvulsants, antihistamines, thyroid and traditional medicine.

The underlying diseases included in the questionnaire were hypertension, diabetes mellitus, stroke, Parkinsonism, cancer, thyroid, renal and cardiac diseases.

All subjects were asked whether they experienced a fall in the past year before the interview and whether they had a physician-diagnosed fracture since the age of 40.

Height and weight were measured using standard techniques and body mass index (BMI) calculated (Wt in kg/m^2).

Statistical analysis

The data analysis was conducted using STATA (version 5.0; StataCorp. 1997. Stata Statistical Software: Release 5.0 College Station, TX: Stata Corporation). The univariate analysis was done using chi-squared tests, or exact tests where appropriate, to determine the association. Multiple logistic regression analysis was used to estimate the odds of hip fracture, which was affected by physical activity after controlling for confounding variables. Variables whose p-value were less than or equal 0.10 in the univariate analysis were included in the logistic model. Likelihood ratio tests were used to determine what confounding factors should be excluded from the model which already contained physical activity.

RESULTS

There were 364 men in this study: 187 cases and 177 controls. Proxy interviews were required in 33 cases and 14 controls. The mean age and standard deviation of cases and controls were 71.3 ± 9.8 and 69.8 ± 8.7 respectively. The types of hip fracture in all 187 patients were as follows: 114 intertrochanteric (60.6%), 69 cervical (36.7%) and 5 subcapital (2.7%).

Comparison of cases and community controls

Table 1 presents the associations between each study variable and hip fracture from univariate analysis. The factors associated with an increased risk included parental Chinese race; staying on the 2nd floor or higher; past and recent physical activity; alcohol use; underlying diseases such as stroke, hypertension, cancer and renal diseases; history of taking diuretics, sedative and antihistamines; history of fracture and past fall. No associations were detected for smoking, BMI and calcium intake. However, the multiple-variable adjusted odds ratio (OR) estimates from multiple logistic regression revealed seven risk factors and only one protective factor as depicted in Table 2. The only preventive factor found in this study was physical activity. Past physical activity markedly reduced the risk regardless of the level of activity (adjusted OR 0.09, 95% CI = 0.03 - 0.22 for very active and adjusted OR 0.33, 95% CI = 0.17 - 0.64 for moderately active, p for trend < 0.01). Recent moderately-active physical activity also preduced fracture liability to about one-third (adjusted OR 0.38, 95% CI = 0.19 - 0.75). The only underlying disease that predisposed to hip fracture was stroke which elevated the risk to sixteen-fold (adjusted OR 16.36, 95% CI = 3.62 - 73.94). Men living on the second floor or higher had an increased risk of almost six times (adjusted OR 5.76, 95% CI = 1.91 - 17.40). Men who had to stay at home and use gait aid had a four-fold increased risk (adjusted OR 4.22, 95% CI = 1.79 - 9.94). History of fracture, alcohol use and past fall increased the risk of hip fracture about four, three and two times respectively. Men with parental Chinese race had double the risk (adjusted OR 2.17, 95% CI = 1.17 - 4.02). Current medications and underlying diseases except for stroke were not significantly associated with hip fracture after adjustment by multivariate analysis. Possible interactions among independent variables were explored by adding interaction terms into the multiple-variable model, and none of the interactions achieved statistical significance ($p > 0.05$).

DISCUSSION

Our results showed evidence to support the hypothesis that physical activity had a protective effect for hip fractures in Thai men. Although data from proxy respondents were included in this study, this does not affect the results since similar findings were demonstrated regardless of sources of data as shown in Table 3. Previous human and animal studies have shown that physical activity can increase bone mass, density, and strength (Gutin and Kasper, 1992; Kannus *et al*, 1995). The bone mineral density is directly associated with hip fractures. One study estimated the relative risk for hip fractures of 2.9 per SD lower bone density at

Table 1
Percentage distribution of characteristics between cases and controls.

Factors			Group		p-value
			Case (n = 187)	Control (n = 177)	
Recent physical activities					
Very active			11.23	22.60	<0.001
Active			14.44	39.55	
Inactive			74.33	37.85	
Past physical activity					
Very active			4.81	29.94	<0.001
Active			16.58	33.33	
Inactive			78.61	36.73	
Race					
Father and mother Chinese			39.57	24.86	0.011
Father / Mother Chinese			5.35	6.78	
Father and mother Thai			55.08	68.36	
Type of Housing;	Building				
	High-rise building		29.95	22.60	0.112
	Low-rise building		70.05	77.40	
Live with :	Other peoples		3.21	1.13	0.357
	Alone		4.28	3.39	
	Relatives		92.51	95.48	
Floor :	Stay at the 2nd floor or higher		11.76	3.39	0.003
	Stay at the 1st floor		88.24	96.61	
Lift, Yes			4.28	2.82	0.455
Before fracture					
Go out with gait aid			15.51	5.08	<0.001
Home with gait aid			26.20	6.78	
Sit or bed ridden			1.07	1.69	
Normal			57.22	86.44	
Alcohol consumption, Yes			50.80	32.77	<0.001
median (range, mg/week)			33.1 (0-3,313.8)	(0-1,656.9)	<0.001[b]
Life span smoking (pack)	> 30		32.62	40.68	0.085
	1- 30		33.16	23.16	
	0		34.22	36.16	
median (range, pack)			11.03 (0-146.5)	14.75 (0-200)	0.538[b]
Underlying diseases:					
Hypertension, Yes			40.64	27.68	0.009
Diabetic mellitus, Yes			20.86	13.56	0.066
Stroke, Yes			19.52	1.69	<0.001
Thyroid, Yes			2.13	0	0.050[a]
Kidney, Yes			8.02	1.69	0.005
Parkinson, Yes			2.67	0	0.028[a]
Cancer, Yes			3.21	2.26	0.580
Absorption, Yes			6.38	2.26	0.053
Heart, Yes			6.91	3.95	0.214
Medication: Diuretics, Yes			11.73	2.29	0.001
Steroid, Yes			0.62	0	0.486[a]
Sedative, Yes			11.30	1.70	<0.001
Antihypertensive, Yes			25.41	20.45	0.265
Thyroid drugs, Yes			1.12	0	0.124[a]
Anticonvulsant, Yes			2.78	0	0.061[a]
Antihistamine, Yes			7.87	0.56	0.001
Traditional drugs, Yes			5.00	2.84	0.295
History of falling, Yes			30.48	14.12	<0.001
Number of falling, median (range)			2 (1-10)	2 (1-5)	0.172
History of fracture, Yes			10.70	4.52	0.027
BMI (kg/m^2)	≤ 20		30.48	33.33	0.589
	21 - 24		31.02	33.33	
	> 24		38.50	33.33	
Calcium intake (mg/day	≤ 152		31.55	33.33	0.715
	153 - 343		37.43	33.33	
	> 343		31.02	33.33	
mean (range, mg/day)			274.7 (0-3841.4)	299.7 (0-5,236.3)	0.909[b]

[a]Fisher's exact test, [b]Mann-Whitney test

Table 2
Relationship between hip fracture and predictor variables from multiple logistic regression model.

Factors	Adjusted odds ratio (OR)	95% CI of OR
Past physical activity		
Very active	0.09	0.03-0.22
Active	0.33	0.17-0.64
Inactive	1	
Recent physical activity		
Very active	0.48	0.21-1.11
Active	0.38	0.19-0.75
Inactive	1	
Race		
Father and mother Chinese	2.17	1.17-4.02
Father / Mother Chinese	1.93	0.62-5.99
Father and mother Thai	1	
Floor		
Stay at the 2nd floor or higher	5.76	1.91-17.40
Stay at the 1st floor	1	
Activity before fracture		
Go out with gait aid	2	0.73-5.51
Home with gait aid	4.22	1.79-9.94
Sit or bed ridden	0.25	0.01-5.58
Normal	1	
Stroke		
Yes	16.36	3.62-73.94
No	1	
History of fall		
Yes	2.08	1.01-4.27
No	1	
History of fracture		
Yes	3.95	1.41-11.08
No	1	
Alcohol drinking		
Yes	2.82	1.60-4.97
No	1	

95%CI = 95% confidence interval.

femoral neck (Nguyen *et al*,1996). Past and present physical activity including exercise can also improve gait, balance, coordination, and proprioception. These balancing mechanisms also decrease the propensity to fall. Jaglal *et al* (1993) conducted a case-control study on past and recent physical activity and risk of hip fracture. They found that past physical activity and moderately active recent activity reduced the risk in postmenopausal women. They also reported that occupational activity and leisure-time physical activity both independently associated with the risk of hip fracture. Our data demonstrated essentially the same results. Both studies also observed that a high level of recent physical activity was not protective. This may be explained by the fact that vigorous activity in old age may increase the predisposition to falls. Joakimsen *et al* (1997) reviewed seventeen case-control studies from USA, Australia, Asia and Europe. They concluded that physical activity seemed to reduce the risk of later hip fracture by up to 50%. Our result would probably showed the strongest association in term of protective factor, especially the high level of past physical activity with the odds ratio of 0.03 and a dose-response relationship, after adjusted for several significant risk factors. Thus, physical activity is a promising modifiable risk factor in preventing hip fracture in Thai men.

Regarding the activity before fracture, we found that men who could go out with gait aid did not have an increased risk of hip fracture but those who had to stay at home and used gait aid had a four-fold risk. We postulate that people who could go outside had more muscle strength, better neuromuscular function, stability and visual acuity. The activity before fracture was not related to the past activity but there were good correlations with frequencies of routine recent activity such as shopping, climbing stairs and weight bear, indicating minimal recall bias, if any. Observational studies have consistently found that physical inactivity in old age (recent physical activity) is associated with increased risk of hip fracture (Coupland *et al*, 1993; Paganini *et al*, 1991; Meyer *et al*, 1995). Therefore, both past and recent physical activity probably exerted independent effects on preventing hip fractures.

The strong association between underlying stroke and hip fracture in this study confirms the findings of earlier studies (Ramnemark *et al*, 2000). In addition, other risk factors were identified in this study namely history of fracture, alcohol consumption,

Table 3
Effects of past and recent physical activities on male hip fracture patients from multiple logistic regression analysis with and without proxy-respondents.

Factors	Adjusted OR (95% confidence intervals)	
	With proxy-respondent n=364	Without proxy-respondent n=317
Past physical activity		
Very active	0.09 (0.03-0.22)	0.09 (0.03-0.23)
Active	0.33 (0.17-0.64)	0.31 (0.16-0.63)
Inactive	1	1
Recent physical activity		
Very active	0.48 (0.21-1.11)	0.49 (0.21-1.17)
Active	0.38 (0.19-0.75)	0.36 (0.18-0.73)
Inactive	1	1
Race		
Father and mother Chinese	2.17 (1.17-4.02)	2.24 (1.17-4.31)
Father / Mother Chinese	1.93 (0.62-5.99)	1.81 (0.55-5.93)
Father and mother Thai	1	
Floor		
Stay at the 2nd floor or higher	5.76 (1.91-17.40)	6.97 (2.12-22.88)
Stay at the 1st floor	1	1
Activity before fracture		
Go out with gait aid	2 (0.73-5.51)	2.72 (0.80-9.32)
Home with gait aid	4.22 (1.79-9.94)	3.35 (1.30-8.66)
Sit or bed ridden	0.25 (0.01-5.58)	0.24 (0.01-13.25)
Normal	1	1
Stroke		
Yes	16.36 (3.62-73.94)	15.23 (2.76-84.07)
No	1	1
History of fall		
Yes	2.08 (10.1-4.27)	2.33 (1.06-5.09)
No	1	1
History of Fracture		
Yes	3.95 (1.41-11.08)	3.85 (1.36-10.90)
No	1	1
Alcohol drinking		
Yes	2.82 (1.60-4.97)	2.44 (1.35-4.43)
No	1	1

and history of past falls. These findings are in keeping with other studies (Felson *et al*, 1988; Owen *et al*, 1982; Cummings *et al*, 1995; Wolinsky and Fitzgerald, 1994).

One important risk factor encountered in our study not mentioned elsewhere was the Chinese parental race. Men who were born with Chinese father and mother were at twice the risk of acquiring hip fracture. It is well evident that there are variations in hip fracture incidence rates across race or ethnicity. Genetic factors play an important role in the pathogenesis of osteoporosis. Current evidence suggests that inheritance of bone mass is under polygenic control but the genes responsible are poory defined. Recently, Langdahl *et al* (1997) showed that a polymorphic Sp1 binding site in collagen type I alph1 (COLIA1) gene could

be of clinical value in identifying individuals at risk of osteoporotic fractures in both men and women. Future research on genetics epidemiology may clarify the hip fracture risk difference between the population of Chinese and non-Chinese parental racial background found in our study.

We found that calcium intake, cigarette smoking, many underlying diseases and current medications were not associated with hip fracture. The relatively low-calcium diet consumed by our subjects (less than 300 mg/day) would require much bigger sample size to detect such a small association. Similarly, very low proportion of subjects with underlying diseases or current use of medications might preclude detection of an association. Too healthy controls due to selection bias might also explain the findings. Yet, the prevalence of stroke detected in this study was similar to that (1.12%) from a multicenter community survey (Viriyavejakul *et al*, 1998).

In summary, our study provides evidence supporting the hypothesis that physical activity play a protective role against hip fracture in Thai men. The relationship between Chinese racial background and hip fracture in this study is a novel finding that warrants further exploration.

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APPENDIX

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