Fall Risk Prediction in Community Dwelling Hong Kong Elderly Chinese Based on their 12-Month Prospective Fall History, Longest Pre-Retirement Occupation and Bone Mineral Density

Kwok AWL[1,2]*, Leung J[2], Kwok T[2] and Leung PC[2]

[1]School of Medical and Health Science, Tung Wah College, Hong Kong

[2]The Chinese University of Hong Kong Jockey Club Centre for Osteoporosis Care and Control, Hong Kong

*Corresponding author: Anthony WL Kwok, School of Medical and Health Science, Tung Wah College, Hong Kong, Email: anthonykwok@twc.edu.hk

Abstract

Background: Falls are common among older adults worldwide. This study aimed to investigate and predict fall risk based on the fall incidence, longest pre-retirement occupation and bone mineral density in community dwelling Hong Kong Chinese elderly.

Methods: 3,983 subjects consisting of 2,000 men (aged 72.39±5.01) and 1,983 women (aged 72.58±5.4) of community dwelling Hong Kong Chinese at age 65 or above were recruited. The subjects' fall history in a 12-month prospective cohort, longest pre-retirement occupations, bone mineral density (BMD) level, and physical capability by the Physical Activity Scale for the Elderly Questionnaire were evaluated with their fall history four-monthly by telephone contacts.

Results: Fall incidence per 1,000 person-years in women and men was 245.75 and 158.60 in osteoporosis, 246.99 and 152.98 in osteopenia, and 252.35 and 182.57 in normal BMD respectively (p<0.001). Women had higher fall incidence than in men (p<0.001). Older age (73.3± 5.2) had 2 or more falls than no fall in younger age (72.1± 4.8) [RR (95% CI) 1.21 (1.14, 1.28) per 5 years increase]. PASE scores were 92.0±48.8 in older age and 98.4±49.9 in younger age [RR (95% CI): 0.93 (0.87, 0.99) per 50-unit increase]. Pre-retired longest occupation in Building/Maintenance jobs showed the lowest fall risk [RR (95% CI): 0.58 (0.37, 0.90)], followed by Business/Finance [RR (95% CI): 0.80 (0.68, 0.95)] and Art/Design/Office [RR (95% CI): 0.81 (0.68, 0.97)] as compared to Management jobs as a standard reference.

Conclusion: Women had a higher fall risk than men due to their decreasing physical capability with increasing age in Hong Kong Chinese. Longest pre-retired occupation with physically demanding jobs showed the lowest fall risk.

Keywords: Bone Mineral Density; Fall Incidence; Prospective Cohort; Osteoporosis; Osteopenia

Abbreviations: BMD: Bone Mineral Density; CVA: Cardiovascular Accidents; ADL: Aids Daily Living; BMI: Body Mass Index; PASE: Physical Activity Scale for the Elderly Questionnaire.

Introduction

Falls have been public health concerns among the elderlies since 1940 [1,2]. In advancing age with reduced bone mineral density (BMD), the consequence of fall is

Fall Risk Prediction in Community Dwelling Hong Kong Elderly Chinese Based on their 12-Month Prospective Fall History, Longest Pre-Retirement Occupation and Bone Mineral Density

Ann Physiother Occup Ther

fragility fracture or even fatality [3]. The US experience tells that one-third of people aged 65 or above experience "falls" at least once every year and are the main source of patients seeking emergency medical services [4-7]. Comparing with US, people in Hong Kong are living in a densely occupied condition with the longest life expectation [8]. Previous studies show that 18% of the community dwelling elderly fell at least once a year, and 40% of fallers had multiple falls. Fall caused fractures in more women (8.5%) than men (4.6%) attending the emergency medical services, with 17.4% of fallers needed hospitalization. Subsequent follow up for 9 months and found that 21.8% elderly fell again [9-11].

Older adults with poor self-perceived health, dizziness, presence of cardiovascular accidents (CVA), difficulties in aids daily living (ADL), body mass index (BMI) of between 20 to 24 (i.e., normal to slightly obese), slow gait velocity, and non-practice of morning walk, frequent use of analgesics balms or plasters, and previous white-collar employment were the common reasons of falls [11-14]. This study aimed to investigate and predict the fall risk based on the fall incidence, longest pre-retirement occupation and bone mineral density in community dwelling Hong Kong Chinese elderly.

Methods

3,983 men and women community-dwelling ambulatory Hong Kong Chinese of age older than 65 were randomly recruited from 18 different community districts throughout Hong Kong territory using the cluster sampling through advertisement via community senior citizens clubs and neighborhood elderly houses. Their fall history and frequency in a 12-month prospective cohort were collected, and the association with their longest pre-retirement occupations and bone mineral density were evaluated.

Subjects' inclusion criteria were Community dwelling elderly males or females of age 65 or above, able to walk without assistance to the research center for the assessment, understanding and signing the consent form. Exclusion criteria were bilateral hip replacement or spine surgery done, known malignancy and unable to attend the research center for receiving assessment and giving consent.

Sample size calculation is based on the results of the similar community lifestyle and risk factors study [15]. The sample size of 2,000 men and 2,000 women in this study should be adequate to attain 90% power. The data were from part of the Mr and Ms OS Study. Ethic approval was granted from The Chinese University of Hong Kong Ethics Committee (CREC-2003.102). Written informed consent was obtained from all subjects.

Subjects' bone mineral density (BMD) was measured by QDR-4500W Hologic Densitometer to group under the categories of Normal, Osteopenia and Osteoporosis using the World Health Organization criteria. Demographic data including subjects' profile, fall history and longest pre-retirement occupation were collected. Physical Activity Scale for the Elderly Questionnaire (PASE) was used to evaluate their physical mobility. Fall frequency telephone survey was conducted at every four-month interval for twelve prospective months to all subjects.

SAS, Version 9.4 was used for statistical data analysis. Subjects' profiles were compared in separate genders. Two sample independent t-tests were used for continuous variables while Chi-square tests for categorical variables. The incidence of falls was calculated per 1,000 person-years. All statistical tests were two-sided. A α-level of 5% was used as the level of significance.

Results

Subjects recruited from 18 districts throughout Hong Kong were 1,983 women (aged 72.58±5.4) and 2,000 men (aged 72.39±5.01). Both males and females were of similar age and similar number for comparison and analysis.

Males	Osteoporosis (T-score < -2.5) n=244	Osteopenia (-2.5 ≤ T-score < -1) n=922	Normal (-1 ≤ T-score) n=834	P-value
Age at baseline				0.0004[a]
65-69	27.05%	32.00%	36.33%	
70-74	36.07%	34.71%	35.97%	
75 or above	36.89%	33.30%	27.70%	
Incidence of fall (per 1,000 person-years)	158.6	152.98	182.57	0.0187[b]

a = p-value of chi-square test for trend, b = p-value of Poisson Regression,
*p-value <0.001, Poisson Regression comparing female with male
Table 1: Incidence of fall (males).

Fall incidence per 1,000 person-years in women (Table 2) and men (Table 1) was 245.75 and 158.60 in osteoporosis, 246.99 and 152.98 in osteopenia, and 252.35 and 182.57 in normal BMD (p<0.001). Women had higher fall incidence than in men (p<0.001). Older age (73.3± 5.2) had 2 or more falls than no fall in younger age (72.1± 4.8) [RR (95% CI) 1.21 (1.14, 1.28) per 5 years increase]. PASE scores were 92.0±48.8 in older age and 98.4±49.9 in younger age [RR (95% CI): 0.93 (0.87, 0.99) per 50-unit increase].

Pre-retired longest occupation in Building/Maintenance jobs showed the lowest fall risk [RR (95% CI): 0.58 (0.37, 0.90)], followed by Business/Finance [RR (95% CI): 0.80 (0.68, 0.95)] and Art/Design/Office [RR (95% CI): 0.81 (0.68, 0.97)] as compared to Management jobs as a standard reference.

Females	Osteoporosis (T-score < -2.5) n=921	Osteopenia (-2.5 ≤ T-score < -1) n=801	Normal (-1 ≤ T-score) n=261	P-value
Age at baseline				<.0001[a]
65-69	29.06%	37.38%	36.88%	
70-74	31.97%	32.55%	39.92%	
75 or above	38.97%	30.07%	23.19%	
Incidence of fall (per 1,000 person-years)	245.75*	246.99*	252.35*	0.9492[b]

a = p-value of chi-square test for trend, b = p-value of Poisson Regression,
*p-value <0.001, Poisson Regression comparing female with male

Table 2: Incidence of fall (Females).

Discussion

In elderly men, the incidence of falls was higher in the normal BMD group than in the reduced BMD group (p≤0.01). In elderly women, the incidence of falls did not show a relationship with reduced BMD (≤0.01). Although the incidence of falls was higher in the Normal BMD Group in Hong Kong Chinese elderly men, it was similar among the Normal Group, Osteopenia Group, and Osteoporosis Group in Hong Kong Chinese elderly women. Collectively, the results of this study show that in Hong Kong Chinese older adults, women had a higher fall risk than men in advancing age.

Building or maintenance job retirees show the lowest fall risk [RR (95% CI): 0.58 (0.37, 0.90)] probably due to their job requirements for a good physique in an outdoor environment, and a regular physical work with better balance. The combination helps to prevent osteoporosis and falls as weight-bearing exercise and vitamin D from the sunlight are the known factors to prevent osteoporosis. The lowest relative risk gives a reasonable prediction for their subsequent fall risk except if there is a deterioration of their physical and medical health (Table 3).

Variable	No. of falls, Freq (%)/ Mean (SD)			Relative risk (95% CI)
	0	1	2 or more	
Age (per 5 unit increase)	72.1(4.8)	73.0(5.5)	73.3(5.2)	1.21 (1.14, 1.28)
PASE (per 50 unit increase)	98.4(49.9)	97.0(53.4)	92.0(48.8)	0.93 (0.87, 0.99)
Longest occupation before retirement				
Management	67.00%	18.00%	15.00%	1
Business/ finance	71.40%	16.30%	12.30%	0.80 (0.68, 0.95)
Art/ design/ office	71.60%	16.40%	11.90%	0.81 (0.68, 0.97)
Protective service/ transportation	69.60%	18.20%	12.20%	0.82 (0.67, 1.01)
Building/ maintenance	79.00%	14.50%	6.50%	0.58 (0.37, 0.90)
Food preparation	63.60%	18.70%	17.80%	1.01 (0.78, 1.31)

Table 3: Analysis of Fall Risks.

Kwok AWL, et al. Fall Risk Prediction in Community Dwelling Hong Kong Elderly Chinese Based on their 12-Month Prospective Fall History, Longest Pre-Retirement Occupation and Bone Mineral Density. Ann Physiother Occup Ther 2024, 7(1): 000258.

Copyright© Kwok AWL, et al.

The relative risk of Business/Finance retirees [RR (95% CI): 0.80 (0.68, 0.95)] and Art/Design/Office retirees [RR (95% CI): 0.81 (0.68, 0.97)] are of the medium fall risk. Business and finance retirees and Art/Design/Office retirees mainly worked indoors and in sedentary work nature. The risk of developing osteoporosis is higher if they do not have adequate calcium and vitamin D, and lack of physical weight-bearing exercises. If business and finance retirees, mainly white-collar workers, have osteoporosis and sustained a fall, their risk of vertebral fracture is also likely [12,13].

Food preparation retirees show the highest frequency of falls of 2 or more (17.8%) and highest relative risk of fall of [RR (95% CI): 1.01 (078, 1.31)]. As food preparation retirees stay in the static position doing their job, the lack of body displacement in prolonged static positions may impair balance and proprioception capability, making them prone to fall, as frequent physical activity improves balance and reaction time [16-20].

Bone Health and Osteoporosis Foundation predicts one in every two osteoporosis sufferers will eventually sustain a fracture [21]. Literature on fall risk reports one in five elderly individuals aged 65 or above falls annually, with 24.8% of fallers experiencing fractures, and 72.2% having life-threatening conditions such as head injuries [10,11,18,19].

In people with reduced BMD, the consequence of a fall could be fragility fracture or even fatality. Health education and promotion are effective ways to raise public awareness and improve individuals' knowledge of osteoporosis care and control within a short time [12,13,19,20,22]. Health care professionals should collaborate with local television networks, radio stations, and newspapers, to educate and promote osteoporosis, fragility fracture and fall prevention to the public [12-14].

Limitations of this Study

All subjects were ambulatory older adults without bilateral hip replacement to attend the research center for assessments. The sampling may have only included older adults with better balance skills and less falls in this study compared to frail and fragile osteoporotic older adults with poor balance and higher fall risks, leading to an underestimation of fall risks.

Conclusion

All subjects were ambulatory community-dwelling individuals recruited locally through community activities and community advertising. The results are representative. In Hong Kong Chinese women, falls are common once they reach the age of 65, regardless of their BMD status. People with reduced BMD are at risk of sustaining fragility fractures when they fall. Health education and promotion are extremely important. Recognizing the longest re-retirement jobs could have impact on the fall risk help to give indication and guideline for early fall risk detection and prevention. Retirees in the food preparation area have a high fall risk. The data of this study provides useful and functional information on fall risk identification, detection, and prevention. Strategies to minimize falls and prevent the first fracture should be examined in further detail.

Acknowledgement

Conflicts of Interest: None to declare.

References

1. Speechley M (2011) Unintentional Falls in Older Adults: A Methodological Historical Review. Can J Aging 30(1): 21-32.

2. World Health Organization (2007) WHO Global Report on Falls Prevention in Older Age.

3. Kwok A, Law SW, Leung J, Hung LK, Leung PC (2014) Fall risk with Reducing Bone Mineral Density in Hong Kong Chinese Elderly. 34th Annaul Congress of Hong Kong Orthopaedics Association, Hong Kong.

4. Pfortmueller C, Kunz M, Lindner G, Zisakis A, Puig S, et al. (2014) Fall-Related Emergency Department Admission: Fall Environment and Settings and Related Injury Patterns in 6357 Patients with Special Emphasis on the Elderly. Scientific World Journal 2014(256519): 1-6.

5. Pfortmuller C, Lindner G, Exadaktylos A (2014) Reducing fall risk in the elderly: risk factors and fall prevention, a systematic review. Minerva Med 105(4): 275-281.

6. Bergen G, Stevens M, Burns E (2016) Falls and Fall Injuries among Adults Aged ≥65Years -United States. MMWR Morb Mortal Wkly Rep 65(37): 993-998.

7. Nikolaos S, Thierry C, Dimitrios S, Gabriel G (2010) Older Patients in the Emergency Department: A Review. Ann Emerg Med 56(3): 261-269.

8. The United Nations (2010) Population ageing and development 2009.

9. Bergland A (2012) Fall risk factors in community-

Kwok AWL, et al. Fall Risk Prediction in Community Dwelling Hong Kong Elderly Chinese Based on their 12-Month Prospective Fall History, Longest Pre-Retirement Occupation and Bone Mineral Density. Ann Physiother Occup Ther 2024, 7(1): 000258.

Copyright© Kwok AWL, et al.

dwelling elderly people. Norsk Epidemiologi 22(2): 151-164

10. Chan TJ, Leung KS (2005) Effectiveness of a 1-year Fal Prevention Community Model Programme in Hong Kong. 25th Annaul Congress of Hong Kong Orthopaedics Association, Hong Kong.

11. Ho SS (2005) Epidemiology of falls and fracture in elderly in Hong Kong. International Symposium of Fall and Fracture Prevention for the Elderly, Hong Kong.

12. Kwok AWL (2009) Exercise prescription for osteoporosis. SMART Convention, Hong Kong.

13. Kwok A, Leung J, Law SW, Hung LK, Leung PC (2014) Prevalence and Risk Factors of Vertebral Fracture in Asian Elderly. 34th Annaul Congress of Hong Kong Orthopaedics Association, Hong Kong.

14. Kwok AWL, Leung JCS, Chan AYH, Au BSK, Lau EMC, et al. (2012) Prevalence of vertebral fracture in Asian men and women: Comparison between Hong Kong, Thailand, Indonesia and Japan. Public Health 126(6): 523-531.

15. Nguyen TV, Eisman JA, Kelley PJ, Sambrook P (1996) Risk factors for osteoporotic fractures in elderly men. Am J Epi 144(3): 255-263.

16. Gregg EW, Cauley JA, Seeley DG, Ensrud KE, Bauer DC (1998) Physical activity and osteoporotic fracture risk in older women. Study of osteoporotic fractures research group. Ann Intern Med 129(2): 81-88.

17. Xu L, Cummings SR, Qin M, Zhao X, Chen X, et al. (2000) Vertebral fractures in Beijing, China: The Beijing Osteoporosis Project. J Bone Miner Res 15(10): 2019-2025.

18. Callis N (2015) Falls prevention: Identification of predictive fall risk factors. Applied Nursing Research 29: 53-58.

19. Chu WM, Kristiani E, Wang YC, Lin YR, Lin SY, et al. (2022) A model for predicting fall risks of hospitalized elderly in Taiwan-A machine learning approach based on both electronic health records and comprehensive geriatric assessment Front Med 9: 937216

20. Appeadu MK, Bordoni B (2023) Falls and Fall Prevention in Older Adults, StatPearls Publishing, St. Petersburg, Florida, United States.

21. Bone Health and Osteoporosis Foundation (2023) Protect your ability to live your best life.

22. Jockey Club Centre for Osteoporosis Care and Control (2012) Health Education and Promotion. Annual Report 2011, The Chinese University of Hong Kong, pp: 13.

Kwok AWL, et al. Fall Risk Prediction in Community Dwelling Hong Kong Elderly Chinese Based on their 12-Month Prospective Fall History, Longest Pre-Retirement Occupation and Bone Mineral Density. Ann Physiother Occup Ther 2024, 7(1): 000258.

Copyright© Kwok AWL, et al.