Background: To identify the risk factors and changes of quality of life in the first occurrence of hip fracture in Taiwanese postmenopausal women.

Methods: In this case-control study, we enrolled 100 postmenopausal women with accidental first-incident hip fracture and 100 women without hip fracture. The control group was matched to the study group according to age. Evaluation consisted of a questionnaire, an interview to both assess quality of life via a 36-item Short Form Health Survey and document risk factors, a physical examination to record height and body weight, and bone mineral density (BMD) of the hip and spine using dual-energy X-ray absorptiometry (DXA).

Results: The mean age of the patients was 77.9 years old. Compared with the controls, the patients with first-incident hip fracture had a lower level of education, increased body height, higher parity, no experience of estrogen therapy, prior history of diabetes mellitus and rheumatoid arthritis, walking aid use, less weight-bearing exercise, and steroid use. Total hip BMD was a stronger predictor than BMD at different sites. Quality of life was significantly higher in the control group at the baseline and 4-month follow-up.

Conclusions: Quality of life was related to the first-incident hip fracture. The increased risk of falls, lower level of education, and total hip BMD are the strongest predictors of first-incident hip fracture in Asian elderly postmenopausal women.
At a glance commentary

Scientific background on the subject

Because hip fracture prevalence in Asian postmenopausal women is higher than that of their Western counterparts, Asian postmenopausal women may have certain risk factors for first-incident hip fractures that differ from those of Caucasian women. However, current knowledge regarding these risk factors for hip fractures among Asian women is limited.

What this study adds to the field

Besides risk factors related to fall and lower hip bone mineral density which are similar to those reported in Western women, awareness on osteoporosis prevention and quality of life should be the most important factor affecting the first-incident hip fracture in Asian elderly postmenopausal women.

It has been clearly established that because of estrogen deficiency, postmenopausal women have a higher incidence of osteoporosis and fracture than men. In postmenopausal women, the hip, spine and wrist are the areas most susceptible to fracture. Among these osteoporotic fractures, hip fractures are of greater concern, because they may result in personal disability and mortality and therefore, contribute a higher burden on family and society expenditure.

Although a declined age-adjusted hip fracture rate in most Western countries has been demonstrated over the past decades [1,2], the incidence of hip fracture has increased twofold to threefold in most Asian countries over the past 30 years [3]. Therefore, it is projected that by 2050, more than 50% of all osteoporotic hip fractures will occur in Asia [4]. In addition, patients with hip fracture have a two-fold relative risk of recurrent hip fracture [5]. Thus, preventing first-incident hip fracture should be the most critical issue, particularly in Asian countries.

Risk factor identification is critical for preventing first-incident hip fracture, averting subsequent fractures, and improving both outcome and quality of life after hip fracture. The potential risk factors for hip fracture have been evaluated in the white women and include low bone density, lower body weight, cigarette smoking, caffeine intake, use of long-acting sedatives, and inactivity etc. [6,7]. Because the prevalence of hip fracture in Asian postmenopausal women is higher than that in their Western counterparts, except for Northern Europe, Asian postmenopausal women may have some risk factors for first-incident hip fracture that are different from those of white women. However, current knowledge about the risk factors for hip fracture among Asian women is limited.

According to the recent systemic review, Taiwan not only represents the high-risk area for hip fracture worldwide, but also has the highest incidence of hip fracture as compared with other Asia countries [8]. Thus, determining the risk factors for hip fracture in Taiwanese postmenopausal women is crucial for identifying high-risk individuals in Asian countries, as well as for developing effective strategies for prevention. Therefore, the present study was designed as a case-control study to investigate the risk factors for hip fracture among postmenopausal women with first-incident hip fracture.

Materials and methods

Study design and subjects

In this case-control study, women with hip fracture (study group) were compared with women without hip fracture (control group) to determine whether the potential risk factors and bone mass differed between the two groups. This study was approved by the Medical Ethics Committee of Chang Gung Memorial Hospital. All participants provided an informed consent form.

This study enrolled patients who were admitted to Keelung Chang Gung Memorial Hospital for an accidental first-incident hip fracture from March 2014 to April 2016. Patients were excluded if they were (1) severely cognitively impaired and completely unable to follow orders, (2) terminally ill, or (3) refused to participate. A total of 100 postmenopausal women were included in the study group.

To obtain a control group with a similar background as the study group, 100 postmenopausal women (without hip fracture) undergoing general health evaluation were recruited from the Gynecology Outpatient Clinic of Keelung Chang Gung Memorial Hospital from March 2014 to April 2016. The control group was matched to the study group according to age.

Assessment of risk factors

Questionnaire and interview

All participants underwent in-person interviews: the study group during admission and the control group at the outpatient clinic. We determined their level of education, body height and weight, age at menopause, parity, history of fracture, parental history of fractures, current or previous therapy with estrogen within the past year, smoking habits, alcohol and coffee intake, calcium supplement, sun exposure more than 30 min per day, and weight-bearing exercise three or more times per week, as well as whether they underwent bilateral oophorectomy before the age of 45. We also examined whether the participants had physician-diagnosed fractures, hyperthyroidism, diabetes mellitus, chronic disease (including coronary heart disease, renal disease, epilepsy, Parkinsonism, and cancer), rheumatoid arthritis, stroke, cataracts or glaucoma, and visual impairment or using walking aids. Furthermore, we evaluated their current medication, including hormone therapy, steroid, psychological medication (such as tranquilizers, anti-anxiety medication, and anti-psychological medication), osteoporosis medication, and diuretics (including thiazide diuretic, and behyd).

Assessment of quality of life by using 36-item Short Form Health Survey (SF-36)

The 36-Item Short Form Health Survey (SF-36) is a general health-based survey of quality of life [9], which contains 36
items of self-reported aspects of health. In addition to a single-item measure of health transition (HT), the SF-36 comprises eight physical and mental dimensions of health namely: physical functioning (PF), role limitations due to physical health (RP), bodily pain (BP), general health perceptions (GH), vitality (VT), social functioning (SF), role limitations due to emotional problems (RE) and mental health (MH), which are also combined into physical and mental component summary scales (PCS and MCS, respectively). In this study, the Taiwanese version of the SF-36 questionnaire was used to calculate the summary scales [10], which was administered to the last 100 participants both in the study (50) and control (50) groups. The patients recalled their condition (SF-36) from the 4 weeks before fracture, and controls recalled their condition from the time preceding their inclusion. These data were used as baseline measures for both groups. The same data collection performed at the baseline was repeated after 4 months.

**Examination**

Body weight, height, and bone mineral density (BMD) were measured. Baseline lumbar spine and hip BMD were measured using a dual energy X-ray absorptiometry (DXA) instrument (GE-Lunar, iDAX, Madison, WI, USA) installed at Keelung Chang Gung Memorial Hospital.

**Statistical analyses**

Summary statistics for the study variables were calculated and compared between the study and control groups. Descriptive statistics were expressed as mean and standard deviation for continuous variables, and as frequency and percentage for categorical variables. Independent t tests were used to assess the differences in numerical variables between the two study groups, and chi-squared tests were used to examine the differences in categorical variables. Multiple logistic regression analysis was used to calculate multivariate-adjusted odds ratios (ORs) of the study variables associated with hip fracture. In multiple regression analyses, regression diagnostics, such as residual analysis, and multicollinearity were performed to ensure model robustness. Paired samples t tests were used to compare the SF-36 score between the baseline and 4-month follow-up in the patients and controls. All statistical analyses were performed using the Statistical Analysis System (SAS) software, version 9.1 (SAS Institute, Cary, North Carolina).

**Ethical approval**

This study was approved by Institutional Review Board of Chang Gung Medical Foundation (IRB:103-0582B; IRB:103-6635B, IRB: 201600490B0, and IRB: 201600772B0).

**Results**

**Comparison of clinical characteristics between patients with hip fractures and controls**

Table 1 presents the characteristics of the participants. The mean age of the participants was 77.9 years. Compared with the controls, the patients with first-incident hip fractures had a significantly lower level of education (p = 0.0000); increased body height (p = 0.0006); higher parity (p = 0.0387); no experience of estrogen therapy (p = 0.0082); prior history of diabetes mellitus (p = 0.0499) and rheumatoid arthritis (p = 0.0180); walking aid use (p = 0.0000); less weight-bearing exercise three times per week (p = 0.0008); and steroid use (p = 0.0323). Although there was no significant difference on bone mineral density (BMD), the correlation of total hip BMD with the risk of hip fracture was stronger than that of BMD at other sites (spine and femoral neck) [Table 2].

Compared with the study group, the control group had a significantly higher prevalence of chronic disease (p = 0.0333), including coronary heart disease, renal disease, epilepsy, Parkinsonism, and cancer, and a habit of daily coffee intake (p = 0.0169).

**Multivariate analysis**

The ORs and 95% confidence intervals (CIs) estimated using multivariate logistic regression analysis for all the predictor variables revealed that the level of education, walking aid use (OR $6.121; 95\%$ CI $2.548–14.700; p = 0.000$), total hip BMD (OR $1.190; 95\%$ CI $1.102–1.285; p = 0.000$) were the only significant risk factors for first-incident hip fractures [Table 3].

**Differences in health-related quality of life between patients and controls at baseline and 4-month follow-up**

At the baseline, the patients with first-incident hip fractures had significantly lower scores for the SF-36 domains, namely PF (p = 0.000), RP (p = 0.010), BP (p = 0.005) GH (p = 0.000), VT (p = 0.003), SF (p = 0.007), RE (p = 0.000), MH (p = 0.006), and HT (p = 0.049), as well as PCS (p = 0.000) and MCS (p = 0.012). At the 4-month follow-up, the patients still had significantly lower scores for all SF-36 domains (including PCS and MCS), except for RP, as compared with the controls [Fig. 1]. However, compared with the baseline, patients with hip fractures had significantly increased scores for PCS (p = 0.033) and decreased scores for MH (p = 0.047) at the 4-month follow-up.

**Discussion**

This study demonstrated that in addition to higher parity, no experience of estrogen therapy, prior history of diabetes mellitus and rheumatoid arthritis, less weight-bearing exercise three times per week, and steroid use, the risk factors considered to be the main determinants of first-incident hip fracture in Taiwanese postmenopausal women included walking aid use, higher body height, lower level of education, and total hip BMD. In addition, quality of life, including physical and mental components, played a crucial role in the occurrence of first-incident hip fracture.

The incidence of hip fracture is generally accepted to increase exponentially with age. This study further confirmed that most hip fractures occur in older postmenopausal women. More than 95% of hip fractures are caused by falling [11]. The present study revealed several significant risk
factors, particularly higher body height, history of rheumatoid arthritis, and walking aid use, that increase the likelihood of a fall. Because falls commonly result from a combination of risk factors \[12,13\], the variation in a person’s socio-demographic factors and the effectiveness of interventions should be considered. In the present study, the control group had a higher incidence of chronic diseases, hyperthyroidism and cataracts or glaucoma, most of which are also recognized as the risk factors for falls. However, the control group also had a higher average level of education, more regular exercise, and higher total hip BMD. It should be investigated whether the difference is due to the awareness of the patients and their family on how to prevent falling and subsequent hip fracture or other factors in the control group.

### Table 1 Characteristics of the study population.

| Variables                        | Patient group (N = 100) | Control group (N = 100) | p-value |
|----------------------------------|-------------------------|-------------------------|---------|
| Age                              | 78.7 ± 9.0              | 77.1 ± 6.1              | 0.1314  |
| Education level                  |                         |                         | 0.0000  |
| unschooled                       | 51 (52%)                | 21 (21%)                |         |
| primary school                   | 29 (30%)                | 53 (54%)                |         |
| Secondary or higher education    | 18 (18%)                | 24 (25%)                |         |
| Body Weight (kg)                 | 54.0 ± 9.2              | 52.7 ± 8.9              | 0.3295  |
| Body Height (cm)                 | 153.2 ± 6.1             | 150.1 ± 6.3             | 0.0006  |
| Body mass index (kg/m²)          | 23.1 ± 3.7              | 23.4 ± 3.5              | 0.6792  |
| Age at menopause                 | 48.7 ± 5.5              | 50.4 ± 7.7              | 0.0885  |
| Parity                           | 4.5 ± 2.1               | 3.9 ± 1.8               | 0.0387  |
| Bilateral oophorectomy prior to 45 y/o | 6 (6%)   | 7 (7%)                  | 0.7887  |
| Estrogen therapy                 | 9 (9%)                  | 23 (23%)                | 0.0082  |
| Prior history of fracture        | 37 (38%)                | 32 (33%)                | 0.4227  |
| Parental history of fracture     | 6 (6%)                  | 8 (8%)                  | 0.5927  |
| Prior history of hyperthyroidism | 5 (5%)                  | 12 (12%)                | 0.0832  |
| Prior history of diabetes mellitus | 33 (34%)             | 21 (21%)                | 0.0499  |
| Chronic diseases\[a\]            | 32 (33%)                | 47 (48%)                | 0.0333  |
| Rheumatoid arthritis             | 16 (17%)                | 6 (6%)                  | 0.0180  |
| Prior history of stroke          | 17 (17%)                | 9 (9%)                  | 0.0821  |
| Prior history of cataracts or glaucoma | 48 (50%) | 55 (55%)                | 0.4812  |
| Prior history of visual impairment | 23 (24%)             | 15 (15%)                | 0.1128  |
| walking aids                     | 50 (51%)                | 16 (16%)                | 0.0000  |
| Current smoking                  | 7 (7%)                  | 5 (5%)                  | 0.5275  |
| \(\geq 3\) alcoholic beverages/day | 0 (0%)               | 1 (1%)                  | 1.000   |
| Coffee intake every day          | 6 (6%)                  | 17 (17%)                | 0.0169  |
| Calcium supplement               | 25 (26%)                | 36 (36%)                | 0.1206  |
| Sun exposure over 30 min/day     | 41 (42%)                | 39 (39%)                | 0.6823  |
| Weight-bearing exercise \(\geq 3\) times/week | 22 (23%) | 45 (45%)                | 0.0008  |
| Steroid use \(\geq 3\) months and \(\geq 5\) mg/day | 7 (7%)     | 1 (1%)                  | 0.0323  |
| Psychological medication\[b\]    | 31 (32%)                | 25 (25%)                | 0.2790  |
| diuretics\[c\]                   | 16 (16%)                | 9 (9%)                  | 0.1141  |
| Bone mineral density             |                         |                         | 0.2900  |
| T-score \(\leq -2.5\)          | 69 (72%)                | 64 (66%)                |         |
| \(-2.5 < T-score < -1\)         | 24 (25%)                | 25 (26%)                |         |
| T-score \(\geq -1\)             | 3 (3%)                  | 8 (8%)                  |         |

\[a\] Chronic diseases include coronary heart disease, renal disease, epilepsy, parkinsonism, and cancer.
\[b\] Psychological medication includes tranquilizers, anti-anxiety medication, and anti-psychological medication.
\[c\] Diuretics include thiazide diuretic, and behyd.
\[d\] T-score: measure bone mineral density in the hip and spine by DEXA.

### Table 2 Association of bone mineral density with First Incident Hip Fractures.

| BMD site    | Patient group (N = 100) | Control group (N = 100) | p-value |
|-------------|-------------------------|-------------------------|---------|
| Lumbar spine| 0.84 ± 0.17             | 0.86 ± 0.20             | 0.987   |
| Total hip   | 0.65 ± 0.16             | 0.73 ± 0.14             | 0.000   |
| Femoral neck| 0.60 ± 0.19             | 0.63 ± 0.11             | 0.198   |
| Lumbar spine T-score | −2.08 ± 1.40         | −1.98 ± 1.53            | 0.602   |
| Total hip T-score | −2.47 ± 1.25          | −1.78 ± 1.11            | 0.000   |
| Femoral neck T-score | −2.61 ± 1.59          | −2.38 ± 0.92            | 0.212   |

### Table 3 Multivariate adjusted odds ratios for the major risk factors of first-incident hip fracture in postmenopausal women.

| Variables                        | Adjusted OR | 95% CI       | p-value |
|----------------------------------|-------------|--------------|---------|
| Education                        |             |              |         |
| primary school vs Unschooled     | 0.251       | 0.107–0.592  | 0.002   |
| Secondary or higher education vs unschooled | 0.338     | 0.128–0.891  | 0.028   |
| Walking aids                     | 6.257       | 2.708–14.457 | 0.000   |
| Total hip T-score                | 0.554       | 0.402–0.763  | 0.000   |
| Body height                      | 1.179       | 1.095–1.268  | 0.000   |
The correlation between the level of education and either bone mass or the risk of fractures remains controversial. Shaw [14] found no significant associations between BMD and the level of education in a cross-sectional study of healthy volunteers in Taiwan. By contrast, Ho et al. [15] demonstrated that a higher level of education was independently associated with improved BMD and a lower prevalence of osteoporosis among postmenopausal Chinese women. Colon-Emeric et al. [16] also observed a positive association between the level of educational and the risk of hip fracture among ambulatory non-Hispanic white men. Recent analysis demonstrated that low socioeconomic status was associated with an increased incidence of hip fracture [17,18]. The present study further demonstrated that the lower level of education is a significant main determinant of first-incident hip fracture. Awareness on osteoporosis and general health should be the most critical issue for preventing hip fracture.

It has been clearly established that low bone mass is associated with an increased risk of fracture. In a large meta-analysis of prospective cohort studies, the relative risk of hip fractures was assumed to be 2.6 per 1 standard deviation decrease in bone density [19]. In the present study, 97% patient group and 92% control group had low bone mass. However, after further analysis of BMD at different sites, only total hip BMD was found to be significantly related to first-incident hip fracture. Awareness on osteoporosis and general health should be the most critical issue for preventing hip fracture.

A meta-analysis of randomized controlled trials in older adults reported that the combination of weight-bearing exercise and progressive resistance training was the most effective method for preserving BMD and preventing bone loss at clinically relevant sites such as the hip and spine [18]. The present study also showed that women with less weight-bearing exercise three times per week had a higher incidence of hip fracture. Numerous lifestyle risk factors, disease, and medication, such as smoking, alcohol and coffee consumption, calcium supplement use, sun exposure more than 30 min per day, hyperthyroidism, diabetes mellitus, steroid, psychological medication, and diuretics, are believed to affect BMD and hip fracture. In this study, diabetes mellitus and steroid use increased the risk of first-incident hip fracture. Except for coffee consumption, other risk factors did not exert significant effects, which may be attributed to the cultural difference between Taiwan and Western countries, as well as to the limited sample size.

In addition to aging, the impact of menopause on the risk of hip fracture is recognized to be associated with the significant bone loss because of estrogen deficiency. Thus, factors related to menopause may affect the risk of hip fracture. Many studies, including the initial Women’s Health Initiative (WHI) trial [22], an observational study [23], and a meta-analysis of 22 clinical trials [24], have consistently reported a significant reduction in the risk of hip fracture among current or ever users of menopausal hormone therapy (MHT) compared with never users. In this study, we also found a similar effect of MHT on hip fracture. In addition, early menopause is widely believed to be a long-term risk factor for osteoporosis and fracture. However, in the present study, age at menopause and bilateral oophorectomy prior to 45 y/o was not significant risk factors for hip fracture, which is consistent with some reports [25]. The difference between this result and those
reported in other studies [6,26] may result from adjustment for age, which is one of the main determinants of hip fracture. Because pregnancy causes pronounced changes in the levels of sex steroids and other hormones involved in calcium homeostasis, many studies demonstrated that parity is associated with a reduced hip fracture risk [27]. However, the actual effect of parity on osteoporotic fracture risk is uncertain, because lifestyle factors and the socioeconomic condition during pregnancy may also play a crucial role. Similar to our previous study that showed an inverse relationship between parity and BMD in Taiwanese postmenopausal women [28], the present study also revealed increasing parity resulting in a higher incidence of first-incident hip fracture. The difference in the effects of parity between Eastern and Western countries may be associated with variability in the socioeconomic condition present decades ago.

The most significant implication of our findings is related to awareness on osteoporosis prevention and health care. This implication can be further confirmed by the difference on quality of life between the study and control groups. Rohde et al. also reported that the patients with hip fracture had lower global quality of life before fracture occurrence than did the controls [29]. Similar to other investigations using SF-36, our study also has some similar limitations and possible selective response shift, because the patients self-evaluated their “pre-fracture” SF-36 after the fracture had occurred. To minimize the recall problem, SF-36 assessments in the present study were performed with the shortest possible time lag during admission for the fracture event, which has been demonstrated to be crucial for a more accurate report of quality of life [30]. Although significant improvement of physical component summary after a 4-month follow-up in patient group may imply possible selective reporting bias, the general quality of life at the baseline and 4-month follow-up was still lower in the patient group than that in the control group. The surgery and rehabilitation may improve some of physical problems in patients with hip fracture, which still influenced the mental health as shown by the significant reduction of mental health score after 4-month follow-up in the study group.

In addition to the aforementioned recall problem, one limitation of this study is the limited sample size. The advantage of enrolling controls from a hospital in this study is that this enrollment afforded an improved assessment of the general condition and ensured the same source population as patients to reduce the possibility of selection bias. The strengths of the study are its prospective design, and that all participants were completely investigated using clearly defined methods.

In conclusion, many risk factors, particularly increased risk of falls and low hip BMD, for the first-incident hip fracture in Taiwanese postmenopausal women were identified in the present study, which are similar to reports in Western women [6,7]. However, the present study revealed that the level of awareness to health care should be considered as the main factor contributing to the difference in the risk of hip fracture between Western and Eastern countries. Thus, increasing awareness on osteoporosis prevention through education should be prioritized to prevent the first-incident hip fracture in Asian postmenopausal women.

Summary

This study demonstrated that in addition to higher parity, no experience of estrogen therapy, prior history of diabetes mellitus and rheumatoid arthritis, less weight-bearing exercise three times per week, and steroid use, the risk factors considered to be the main determinants of first-incident hip fracture in Taiwanese postmenopausal women included walking aid use, higher body height, lower level of education, and total hip BMD. In addition, quality of life, including physical and mental components, played a crucial role in the occurrence of first-incident hip fracture.

Conflicts of interest

All authors declare they have no conflicts of interest.

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References

[1] Leslie WD, O’Donnell S, Jean S, Lagacé C, Walsh P, Barcej C, et al. Trends in hip fracture rates in Canada. JAMA 2009;302:883–89.
[2] Ballane G, Cauley JA, Luckey MM, Fuleihan Gel-H. Secular trends in hip fractures worldwide: opposing trends East versus West. J Bone Miner Res 2014;29:1745–55.
[3] Dhingra V, Lau E. The Asian audit: epidemiology, costs and burden of osteoporosis in Asia. Nyon, Switzerland: International Osteoporosis Foundation; 2009. www.iofbonehealth.org/bonehealth/asian-audit [Accessed 22 July 2017].
[4] Gullberg B, Johnell O, Kanis JA. World-wide projections for hip fracture. Osteoporos Int 1997;7:407–13.
[5] Klotzbuecher CM, Ross PD, Landsman PB, Abbott 3rd TA, Berger M. Patients with prior fractures have an increased risk of future fractures: a summary of the literature and statistical synthesis. J Bone Miner Res 2000;15:721–39.
[6] Cummings SR, Nevitt MC, Browner WS, Stone K, Fox KM, Ensrud KE, et al. Risk factors for hip fracture in white women. Study of Osteoporotic Fractures Research Group. N Engl J Med 1995;332:767–73.
[7] Taylor BC, Schreiner PJ, Stone KL, Fink HA, Cummings SR, Nevitt MC, et al. Long-term prediction of incident hip fracture risk in elderly white women: study of osteoporotic fractures. J Am Geriatr Soc 2004;52:1479–86.
[8] Kanis JA, Oden A, McCloskey EV, Johansson H, Wahl DA, Cooper C. IOF Working Group on Epidemiology and Quality of Life. A systematic review of hip fracture incidence and probability of fracture worldwide. Osteoporos Int 2012;23:2239–56.
[9] Ware Jr JE, Sherbourne CD. The MOS 36-item short-form survey (SF-36). I. Conceptual framework and item selection. Med Care 1992;30:473–83.
[10] Fuh JL, Wang SJ, Lu SR, Juang KD, Lee SJ. Psychometric evaluation of a Chinese (Taiwanese) version of the SF-36 health survey amongst middle-aged women from a rural community. Qual Life Res 2000;9:675–83.

[11] Parkkari J, Kannus P, Palvanen M, Natri A, Vainio J, Aho H, et al. Majority of hip fractures occur as a result of a fall and impact on the greater trochanter of the femur: a prospective controlled hip fracture study with 206 consecutive patients. Calcif Tissue Int 1999;65:183–7.

[12] Rychnovskil M, Hawe P, Waters E, Barratt A, Frommer M. A glossary for evidence based public health. J Epidemiol Community Health 2004;58:538–45.

[13] Nelson M, Rejeski J, Blair S, Duncan P, Judge J, King A, et al. Physical activity and public health in older adults: recommendations from the american college of sports medicine and the American heart association. Med Sci Sports Exerc 2007;39:1435–45.

[14] Shaw CK. An epidemiologic study of osteoporosis in Taiwan. Ann Epidemiol 1993;3:264–71.

[15] Ho SC, Chen YM, Woo JL. Educational level and osteoporosis risk in postmenopausal Chinese women. Am J Epidemiol 2005;161:680–890.

[16] Colon-Emeric C, Biggs D, Schenck A, Lyles KW. Risk factors for hip fracture in skilled nursing facilities: who should be evaluated? Osteoporos Int 2003;14:484–9.

[17] Quah C, Boulton C, Moran C. The influence of socioeconomic status on the incidence, outcome and mortality of fractures of the hip. J Bone Jt Surg Br 2011;93:801–5.

[18] Guillely E, Herrmann F, Rapin CH, Hoffmeyer P, Rizzoli R, Chevalley T. Socioeconomic and living conditions are determinants of hip fracture incidence and age occurrence among community-dwelling elderly. Osteoporos Int 2011;22:647–53.

[19] Marshall D, Johnell O, Wedel H. Meta-analysis of how well measures of bone mineral density predict occurrence of osteoporotic fractures. BMJ 1996;312:1254–9.

[20] Stone KL, Seeley DG, Lui LY, Cauley JA, Ensrud K, Browner WS, et al., Osteoporotic Fractures Research Group. BMD at multiple sites and risk of fracture of multiple types: long-term results from the Study of Osteoporotic Fractures. J Bone Miner Res 2003;18:1947–54.

[21] Johnell O, Kanis JA, Oden A, Johansson H, De Laet C, Delmas P, et al. Predictive value of BMD for hip and other fractures. J Bone Miner Res 2005;20:1185–94.

[22] Cauley JA, Robbins J, Chen Z, Cummings SR, Jackson RD, LaCroix AZ, et al. Effects of estrogen plus progestin on risk of fracture and bone mineral density: the Women’s Health Initiative randomized trial. JAMA 2003;290:1729–38.

[23] Banks E, Beral V, Reeves G, Balkwill A, Barnes I. Fracture incidence in relation to the pattern of use of hormone therapy in postmenopausal women. JAMA 2004;291:2212–20.

[24] Torgerson DJ, Bell-Syer SE. Hormone replacement therapy and prevention of vertebral fractures: a meta-analysis of randomised trials. BMC Musculoskelet Disord 2001;2:7.

[25] Antoniucci D, Sellmeyer K, Cauley JA, Ensrud K, Schneider JL, Vesco KK, et al., Study of Osteoporotic Fractures Research Group. Postmenopausal bilateral oophorectomy is not associated with increased fracture risk in older women. J Bone Miner Res 2005;20:741–7.

[26] Johnell O, Gullberg B, Kanis JA, Allander E, Effors L, Dequeker J, et al. Risk factors for hip fracture in European women: the MEDOS study. Mediterranean osteoporosis study. J Bone Miner Res 1995;10:1802–15.

[27] Kauppi M, Heliovaara M, Impivaara O, Knekt P, Jula A. Parity and risk of hip fracture in postmenopausal women. Osteoporos Int 2011;22:1765–71.

[28] Chen FP, Teng LF, Soong YK. Factors that influence spinal bone mineral density in postmenopausal women. Taiwan J Obstet Gynecol 1997;36:117–24.

[29] Schmier JK, Halpern MT. Patient recall and recall bias of health state and health status. Pharmacoeconomics Outcome Res 2004;2:159–63.

[30] Rohde G, Haugeberg G, Mengshoel AM, Moum T, Wahl AK. Is global quality of life reduced before fracture in patients with low-energy wrist or hip fracture? A comparison with matched controls. Health Qual Life Outcome 2008;6:90.