

# Osteoporosis—is it really preventable?

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**Osteoporosis is a major public health problem in Hong Kong. For instance, in 1995, a total of 3783 hip fractures occurred, with an associated acute care cost of HK\$150 million. Thirty percent of elderly women in Hong Kong are known to have one or more vertebral fractures. The main risk factors for osteoporotic fracture in the Hong Kong Chinese population include a low dietary calcium intake, an inactive lifestyle, smoking, and frequent falls. Prevention for high-risk individuals involves bone mineral density measurement, followed by drug treatment. In a population-based approach, the entire population is targeted for the removal of risk factors. Osteoporosis in Hong Kong is potentially preventable, provided that the medical profession and the public can be motivated to participate, and adequate resources allocated for its prevention and treatment.**

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## Introduction

Osteoporosis is a major cause of mortality and morbidity in the elderly. Many individuals die after a hip fracture and most survivors lose their functional independence. The 'compression of morbidity' model was proposed by Fries<sup>1</sup> in the 1980s. He advocated that the objective of preventive health care should be to raise the average age at first infirmity, so that the morbidity curve becomes more rectangular. Research in the field of cardiovascular diseases has shown that infirmity may be preventable. In this article, the feasibility of reducing mortality and morbidity due to osteoporosis will be examined.

## How big is the problem?

Osteoporosis is a significant problem among the elderly in Hong Kong. The number of patients sustaining hip fractures increased by 200% between 1966 and 1995.<sup>2,3</sup> In 1995, a total of 3783 hip fractures occurred, and 11 of 1000 women and 5 of 1000 men who were 70 years and older fractured their hip. The cost for the acute care of hip fracture totalled HK\$150 million in 1995. The projected number of hip fractures

for the year 2010 is 7642 and the health care cost for treating these fractures will be HK\$960 million.

Vertebral fracture is another major complication of osteoporosis. A 1995 study found that 30% of women and 17% of men who were aged 70 to 79 years had experienced one or more vertebral fractures.<sup>4</sup> Such fractures can cause considerable pain and a reduced quality of life. The prevention of osteoporosis is a major challenge for the public health sector and medical profession in Hong Kong.

## The cause: nature or nurture?

### *Genetic factors*

Both genetic and environmental factors contribute to osteoporosis. From twin and family studies, it has been estimated that genetic factors contribute to approximately 80% of the total variance in peak bone density.<sup>5-8</sup> Scientists have found, however, that physical fitness and muscle strength may explain up to 40% of the variance found in adult bone density.<sup>9</sup> Dietary calcium intake has also been found to contribute to 40% of the variance in bone density in men.<sup>10</sup> These varying findings seem to suggest that both environmental and genetic effects are important. Physical activity, nutrition, and hormonal balance probably play a major role in allowing for the full expression of an individual's bone mineral density genotype.

### *Lifestyle factors*

Several large-scale, cohort studies on osteoporosis have been completed in Caucasians in the past 30 years and

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these have enabled us to understand what the risk factors for osteoporosis are.

In an American study investigating osteoporotic fractures, 9704 women were followed up for 5 years.<sup>11</sup> Women with multiple risk factors and low bone density were found to have a high risk for hip fracture. In this context, maintaining body weight, walking for exercise, avoiding taking long-acting benzodiazepines, maximising calcium intake, and treating impaired visual acuity were recommended as important for the prevention of hip fracture.<sup>11</sup> In Australia, the Dubbo Study provided further evidence of the importance of lifestyle factors on bone loss in the elderly.<sup>12</sup> In this study, 1800 elderly Australian men and women were assessed. A low dietary calcium intake, poor muscle strength (a surrogate measurement for a sedentary lifestyle), and cigarette smoking were found to be very important determinants of bone loss. For instance, the bone mineral density (BMD) of a smoker was 5% lower than that of a non-smoker, and subjects in the highest quintile for quadriceps strength and calcium intake had 5% greater BMDs than the rest. These study results provide good evidence as to why public health programmes to prevent osteoporosis should be commenced.

### Which factors are important for prevention?

Local studies have identified the relative importance of various risk factors. In two case-control studies, we found that a low dietary calcium intake is an important risk factor for the development of osteoporosis in elderly men and women. The relative risk (RR) of hip fracture was 1.9 (95% confidence interval [CI], 1.0-3.7) for women whose dietary calcium intake was in the lowest quintile<sup>13</sup>; similar observations were made for vertebral fracture.<sup>14</sup> For men and women who did not perform load-bearing activity, the RR of hip fracture was 1.7 (95% CI, 1.2-4.0). The risk of hip fracture was 1.6 (95% CI, 1.1-2.3) for smokers and 4.0 (95% CI, 1.9-6.7) for men and women who were heavy drinkers.<sup>13</sup>

But RRs per se can be misleading. As the late Geoffrey Rose said: "A small but widespread risk may create a public health disaster."<sup>15</sup> He discussed the issue in the context of serum cholesterol level and the risk of coronary heart disease. Although the RR of coronary heart disease is high for those whose serum cholesterol level is in the highest centiles, many more cases of coronary heart disease occur in people with only moderately high cholesterol levels. This is due to the greater prevalence of individuals with 'moderately raised' cholesterol levels. A fairly good indication of the relative importance of risk factors is the population-attributable risk, which depends on both the RR and the prevalence of risk factors in a population.

The population-attributable risk for various risk factors for hip fracture is shown in the Table. Preventing smoking, increasing dietary calcium intake, and maintaining physical activity can greatly reduce the risk of hip fracture.<sup>16</sup>

### Should the individual or the entire population be targeted?

There are two basic approaches to disease prevention: the high-risk strategy and the population-based strategy. Both approaches have their merits and problems.

#### *The high-risk strategy*

##### **Possible approaches**

In the high-risk strategy, subjects undergo screening for risk factors and receive treatment if found to be abnormal. To implement the high-risk strategy, a sensitive (and preferably specific) screening test should be available and effective treatment should exist. If this approach is adopted for osteoporosis, the BMD of postmenopausal women will be measured, and women who are osteoporotic will be given treatment such as hormonal replacement therapy. Measurements of BMD do identify those likely to sustain a fracture. For instance, in the trial by the Study of Osteoporotic Fractures Research Group, women whose BMD values

**Table. The relative risk, prevalence, and population-attributable risk of various risk factors for hip fracture in the Hong Kong Chinese population, 1989<sup>16</sup>**

Factor	Relative risk	Prevalence in control subjects (%)	Population-attributable risk (%)
No regular load-bearing activity	1.7	22	13
Calcium intake in the lowest quartile	1.9	26	19
Smoking in the past or present	1.6	40	19
A history of falls	1.8	12	9
Heavy alcohol consumption (Five drinks or more per day)	4.0	3	8

were in the lowest quartile had an 8.5-fold greater risk of hip fracture than those with measurements in the higher quartiles.<sup>17</sup> There is also little doubt that hormonal replacement therapy, if taken, will prevent bone loss in postmenopausal women.<sup>18</sup> Moreover, hormonal replacement therapy has added benefits for the cardiovascular system.<sup>19</sup>

Despite the proven benefits, there is little evidence that Chinese women will take hormonal replacement therapy on a long-term basis. Reasons for non-compliance are partly cultural, but may be due to a fear of the treatment causing cancer and not wanting the return of menstruation. If a measurement of BMD at menopause is not followed by appropriate therapy, there is little justification for such measurements. The high-risk approach may prove to be expensive and ineffective.

#### **Methods for measuring bone mineral density**

The method of choice for measuring BMD is by dual X-ray densitometry (DEXA).<sup>20</sup> Using population-specific normal ranges for the Hong Kong Chinese population,<sup>21</sup> osteoporosis can be diagnosed when a BMD is 2.5 standard deviations or more below the BMD of the normal young adult population. Dual X-ray densitometers are available in some public and private hospitals in Hong Kong. For financial reasons, the measurement of BMD of patients in public hospitals have been mainly to monitor treatment rather than screen for osteoporosis.

Quantitative ultrasonography measures bone stiffness at the calcaneus and is quicker, cheaper, and more flexible than the DEXA method.<sup>22</sup> It has recently been approved by the Food and Drug Administration of the United States as a technique for the monitoring of treatment effects in osteoporotic patients. It is anticipated that quantitative ultrasonography will be widely adopted by general practitioners and specialists in Hong Kong to measure bone mass. As mentioned earlier, doctors should consider the likelihood of compliance to secondary preventive treatment before embarking on measuring bone mass in the healthy population.

#### **Drugs used to prevent osteoporosis**

The importance of maintaining an adequate calcium intake (of 1 g/d) and performing regular load-bearing activities have been discussed previously. For patients with established osteoporosis, such measures may not be adequate, and drug treatments may be needed.

The bisphosphonates have recently been approved

by the United States Food and Drug Administration for use in the prevention of bone loss in osteoporotic patients. The bisphosphonates are stable carbon-substituted analogues of pyrophosphate that appear to bind selectively to the hydroxyapatite crystals of bone resorption surfaces and inhibit osteoclast activity. The intermittent administration of low doses of disodium etidronate has been shown to increase bone density and reduce the vertebral fracture rate in women with established spinal osteoporosis.<sup>23,24</sup> The results of recent, large-scale clinical trials indicate that 10 mg of alendronate sodium given daily to osteoporotic subjects results in increased bone mass at all sites.<sup>25</sup> Furthermore, giving alendronate to women with vertebral fractures results in a 57% reduction in painful spinal fracture, a 44% reduction in wrist fracture, and a 50% reduction in hip fracture.<sup>26</sup>

Future study results as to the long-term efficacy of alendronate are particularly important for Hong Kong, as many people may be eligible for treatment. Cost-effectiveness may have to be demonstrated for the Health Authorities to begin large-scale prevention programmes.

The problem of non-compliance to hormonal replacement therapy has been discussed elsewhere. However, recent findings from research on selective estrogen receptor modulators (SERM), are encouraging.<sup>27</sup> The results of a recent clinical trial using SERM at a dose of 60 mg/d showed that the BMD in the treatment group increased by an average of 2.4% (standard error, 0.4%). In addition, serum concentrations of total cholesterol and low-density lipoprotein cholesterol decreased significantly in the treatment group. There was no evidence of endometrial stimulation by raloxifene and previous evidence has shown that the drug may protect post-menopausal women against breast cancer.

The availability of effective agents for preventing bone loss, such as alendronate and SERM, strengthen the argument for a 'screen and treat' approach to osteoporosis.

#### **Screening to find those likely to fall**

In contrast, screening for and treating any risk factors for falls in the elderly may be more effective in preventing hip fractures. Falls in the elderly are an independent and important determinant of hip fracture. The results of prospective studies show that falls can be attributed to reversible factors such as poor eyesight, muscle weakness, postural hypotension, and the use of sedatives.<sup>28</sup>

More recent studies indicate that a multifactorial intervention<sup>29</sup> is effective in preventing falls. An individual programme of strength and balance retraining exercise improved physical function and reduced falls and injuries in elderly women.<sup>29,30</sup> Falls prevention may prove to be extremely effective in the prevention of hip fractures and should be an important part of health services for the elderly.

### ***The population-based strategy***

The idea of increasing the dietary calcium intake and physical activity, and preventing cigarette smoking and alcoholism in the general population is an attractive one. To quote from Rose,<sup>15</sup> "Personal life-style is socially conditioned. Smokers are more likely to give up the habit if smoking brings disapproval within their section of society. Individuals are unlikely to eat very differently from the rest of their family and social circle, and the housewife buys what is readily available and attractively priced, or what is most strongly advertised. It makes little sense to expect individuals to behave differently from their peers; it is more appropriate to seek a general change in behavioural norms and in the circumstances which facilitate their adoption".

In the United Kingdom and the United States, nearly all recent improvements in national health have been due to prevention, mostly from changes at the population level. There are no reasons to believe that things will be otherwise for Hong Kong. However, the best approach to changing mass behaviour remains to be defined. History has told us that health education may help but only up to a certain point. It may be useful to educate the public about the risk factors for osteoporosis but it would be naive to assume that individuals will change their behaviour dramatically as a result of health education. The main determinants of behavioural changes are perhaps economic and political. Possibly the only way whereby calcium intake can be increased in Hong Kong is by food fortification. Increases in the cigarette and alcohol tariffs may be the most effective ways of changing behaviour. Finally, the promotion of physical activity in children depends on changes in school policies; and in the elderly, it depends on the provision of facilities.

### **Conclusion**

Osteoporosis is a major public health problem for the ageing population of Hong Kong. The medical profession has a role to play in the prevention of this condition:

- (1) Professional societies in Hong Kong should establish guidelines on screening, treatment, and

prevention, for their members to follow.

- (2) General practitioners are in a good position to educate patients and their family members about the importance of maintaining a healthy lifestyle. They should also be alert to and ready to intervene in removing avoidable causes of osteoporosis.
- (3) Specialists encounter many patients with the complications of osteoporosis in their daily practice. Adequate drug therapy and professional advice should be provided to prevent further bone loss.
- (4) The Health Authorities should make the prevention of hip fracture a top priority. Such services as the School Health Service, the Well-Woman Service, and the Elderly Service should be targeted to help maintain bone health in the community.

The Hospital Authority should ensure that bone density measurements are available for patients at high risk for osteoporotic fracture. Bone density measurement should be followed by adequate drug treatment as indicated. Death and disability are not inevitable consequences of ageing; osteoporosis is preventable.

### **Editorial note**

*The Working Group for Formulating Clinical Management Guidelines for Osteoporosis in Hong Kong* has published guidelines for the clinical management of osteoporosis in Hong Kong on page 423 of this issue.

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