Pulmonology clinic at the Aga Khan University Hospital (AKUH). AKUH is a privately owned, 500-bed tertiary level hospital, offering some of the most state-of-the-art diagnostic and therapeutic facilities in the country. It is conceivable that a relatively higher proportion of people visiting these clinics would belong to affluent and educated families. This is significant in the sense that according to the NHSP 1990-1994, illiteracy was associated with a higher prevalence of cigarette smoking.8 This is, however, unlikely to make a bearing on our findings vis-à-vis the relationship of CO levels to various putative factors including smoking status.

Moreover, our comparison of various groups among smokers on the basis of number of cigarettes smoked per day (Table-2) might lack an ideal validity due to a relatively limited number of smokers in the overall study sample. It follows that more extensive studies are needed to further examine this relationship.

We conclude that in spite of high air pollution levels, the exhaled breath CO level continues to provide a valid and real-time assessment of a subject's current smoking status. Larger studies are required in order to definitively establish the optimal cut-off values for predicting smoking status as well as for detecting violation of smoking cessation.

We also recommend additional studies to explore the relationship between occupational exposure and CO levels in this setting.

Acknowledgements
The authors gratefully acknowledge the contribution of Department of Medicine, Aga Khan University Hospital, for examining and approving the protocol of this study.

References

Review Article

Role of exercise in osteoporosis prevention - Current concepts
Mozaffar Rahim Hingorjo1, Sadiqa Syed2, Masood A.Qureshi3
Department. of Physiology1,2, Fatima Jinnah Dental College, Karachi, Department of Physiology3, Dow International Medical College, Dow University of Health Sciences, Karachi.

Abstract
Osteoporosis is a metabolic disorder of the bones due to loss of both bone mineral and bone matrix in equal proportions resulting in a bone that is weak and unable to support the body. This becomes a problem in the elderly who are then at risk of frequent fractures increasing the morbidity and mortality. Measures taken early in life in the form of calcium and exercise go far in preventing the development of this disorder. The primary purpose of this narrative review is to evaluate the current literature and to provide insight into the role of exercise relating to osteoporosis. Emphasis is given to the importance of the specific types of exercises needed to increase bone strength and muscle power, keeping in view the age and general physical condition of the person.

Introduction
OSTEOPOROSIS is defined by the NIH Consensus Development Panel on Osteoporosis as "a skeletal disorder characterized by compromised bone strength predisposing a person to an increased risk of fracture."1 The WHO Working Group has defined osteoporosis according to the measurement of bone mineral density (BMD) using dual-energy X-ray absorptiometry (DEXA). A T-score value of 2.5 standard deviation or more below the young adult mean is considered diagnostic for osteoporosis.2

Bone mineral density at any time in life depends upon the peak bone density achieved during the development and growth period (especially at the time of puberty) and the subsequent adult bone loss.
physical activity done during childhood increases the peak bone mass to its maximum as the human skeleton before puberty is quite sensitive to mechanical stimulation elicited by physical activity. A study revealed that weight bearing exercise for six months increased bone parameters by 5.5 % approximately around puberty. This fell to a maximum of 1.9 % in late puberty.³

High volumes of exercise are not required to achieve notable osteogenic effect, rather just three hours of participation in sports is enough.⁴ Girls who exercise athletically during years of peak bone acquisition have higher bone mass than their sedentary counterparts and this appears to have lasting benefits for lumbar spine and proximal femoral bone mass density later in life.⁵ Exercise done during late adulthood increases the bone mass minimally if at all, its main purpose being to maintain the bone mass. During old age the bone loss is rapid. This loss starts at around the age of 40 in both sexes and is initially 0.3 - 0.5% of the peak bone mass per year, gradually increasing as the age progresses, though some women may have a very rapid loss after the menopause, up to 5 or 6%, resulting in a rapid reduction in bone mass. Exercise done at this age decreases the rate of bone loss as well as improves muscle strength thereby providing balance, preventing falls and subsequent fractures.⁶ In view of the increase in life expectancy in our population and increased incidents of multiple fractures in middle aged and elderly subjects the effect of exercise on osteoporosis is reviewed.

Factors affecting Osteoporosis

Age related loss in bone mineral content occurs in both the compact and trabecular bones, however, the mass of trabecular bone does not change due to an overall enlargement of trabecular area as the age advances.⁷

Besides aging, several conditions can exaggerate the loss of mineral content which include nutritional, endocrinological, and exercise-related factors. The role for dietary calcium in influencing bone mineral content is well established especially in the first three decades of life, however, its intake decreases as a person grows older.⁸

In women, the most important determinant of bone mineral content is the presence of circulating estrogen. Any condition that reduces estrogen concentrations influences bone remodeling. After menopause the rate of trabecular mineral loss can increase up to 6% a year, with a greater loss in first 5 years. The rate of loss is large compared to the average loss before menopause of less than 1% a year. Hormone replacement therapy given at this time increases the BMD and affects bone remodeling but not as much as when it is combined with an exercise program.⁹

Classification of subjects according to BMD

The WHO Study Group¹⁰ has classified osteoporosis according to BMD as follows:

A. Normal: BMD within 1 standard deviation (SD) of the young adult reference mean.
B. Osteopenia: Mild bone loss - BMD more than 1 SD below the young adult mean but less than 2.5 SD below this value.
C. Osteoporosis: BMD 2.5 SD or more below the young adult mean.
D. Severe osteoporosis (or established osteoporosis): BMD 2.5 SD or more below the young adult mean in addition to one or more fragility fractures.

Exercise prescribed for a younger person with a normal BMD would not be suitable for a frail elderly with osteoporosis, having an imminent risk of fracture. And the goals for one group may not be achievable in another group.

How exercise effects bone mass

The stimulus for bone to maintain its structural and functional strength is the load exerted upon it on account of gravity and mechanical stress applied by the muscles. It has been observed that weight bearing activity stimulates bone remodeling whereas lack of mechanical stimulation as seen in space travelers or in paralyzed limbs can lead to osteoporosis. To evaluate the role of exercise in osteoporosis it is important to understand how mechanical signals are converted into biochemical response. Osteocytes are the primary bone mechanosensors embedded within the bone matrix that sense mechanical signals via 'stress-generated fluid flow' inside the bone. This is evident by the increase of both intra-cellular and extra-cellular chemical mediators after skeletal strain such as the formation of cyclooxygenase-2 (COX-2) and release of prostaglandins.¹¹,¹² However, the exact mechanism by which osteocytes and osteoblasts respond to fluid flow is not known.

Recently, it has been shown that the bones respond not only to increased magnitude of strain but to increased frequency of strain as well. This finding is particularly advantageous to frail population who are unable to do strenuous exercise due to the risk of fracture.¹³,¹⁴

What type of exercise should be advised?

Exercise strengthens muscles, increases flexibility, and improves coordination and balance. The importance of exercise in relation to bones is evident after disuse which results in a decrease in bone mineral density and thinning of cortical bone at the diaphysis. Bones being live tissue, respond to the stress placed by the environment. When that
motion against some kind of resistance. The resistance activities in which the body is moved through its range of fitness regimen.

influence on the heart, they should be part of a regular regards osteoporosis, however, due to their beneficial cycling do not have a significant effect on the bones as increases their chances of fall.

shown to increases BMD17 as other forms of exercises may exercise such as walking on level ground that has been similar sports, performing aerobics, tai chi and dancing. Persons having osteoporosis should start with a gentle exercise such as walking on level ground that has been shown to increases BMD17 as other forms of exercises may increase their chances of fall.

Weight-bearing exercises are those in which the muscles and bones bear the weight of the person and work against gravity. This includes any exercise in which the arms, feet and legs are bearing the weight, such as walking, jogging, stair climbing, playing tennis, volleyball and similar sports, performing aerobics, tai chi and dancing. Persons having osteoporosis should start with a gentle exercise such as walking on level ground that has been shown to increases BMD17 as other forms of exercises may increase their chances of fall.

Low impact aerobic exercises such as swimming and cycling do not have a significant effect on the bones as regards osteoporosis, however, due to their beneficial influence on the heart, they should be part of a regular fitness regimen.

Strength training or Resistance exercises are activities in which the body is moved through its range of motion against some kind of resistance. The resistance can be in the form of free weights, machines, tubing, or one's own body weight. Lifting weights, push-ups, and squats apply resistance against the bones by contracting the muscles and pulling upon the tendons. This has a direct effect upon bone formation and remodeling which is site specific and associated with high BMD in young and older individuals.18,19 Strengthening the muscles helps in daily tasks such as walking, standing from a sitting posture and helping improve balance thus preventing falls.20 Postural exercises that strengthen the back muscles prevent against the development of compression fractures of the spine.21

Persons with established osteoporosis have a fear of fall due to their lack of balance and coordination in their limbs and thus become more and more dependent on others. In this group, the above exercises will put a further strain on the bones and can lead to more fractures. The aim therefore should be for a targeted exercise programme that would improve their balance and increase muscle power. Exercises like yoga and tai chi are low impact weight bearing exercises involving slow, controlled movements that improve balance, muscle strength and help in alleviating the fear of falling.22

In old age, pain is a prominent factor, restricting activity of any kind. Hydrotherapy consists of exercises performed in warm water. The temperature of the water reduces the pain thus allowing patients to move their limbs. In addition, buoyancy relieves the body of its weight and allows certain movements that would not have been possible otherwise.23

Whole body vibrations is a new form of exercise consisting of vibrations of low amplitude and high frequency applied to the whole body while the subject is in a comfortable position. It has been shown to be a better alternative than walking in improving both bone mineral density and balance of elderly frail subjects.14

How much exercise is recommended?

A consensus on the optimal dimensions of exercise (type, frequency, duration and intensity) recommended for a person has still not reached as it would also depend on the age of the person and their bone health.24 However, an exercise programme that includes both weight bearing and resistance exercises done for 30 - 40 minutes daily, three to four times each week appears to achieve the purpose of increasing bone mass. Although the recommended intensity of training is between 70 and 80% of the functional capacity or maximal strength but this has yet to be decided.25 Extreme levels of exercise such as marathon running may in fact cause osteoporosis besides having other deleterious
effects on the health. Of course each person has to tailor the exercises according to his or her own capabilities, keeping in mind that some exercise is better than no exercise at all. It should be realized, however, that any skeletal benefit acquired during exercise will not be maintained if the person returns to his previous sedentary lifestyle.26

Conclusion

Osteoporosis is a public health issue that leads to increased morbidity and mortality. This is especially important in relation to post-menopausal women and the elderly. Lack of awareness about the disease process and its causative factors play a primary role in the progression of osteoporosis. In the present era of flood of information through television channels and media, and latest computer technology, the people have opted for a sedentary lifestyle in which case the importance of exercise cannot be overemphasized. Cross-sectional and interventional studies have shown a positive correlation between exercise and BMD, with high impact exercises having the greatest effect. Furthermore, the increase in bone mineral density is maximum when exercise is done at a younger age. Elderly population loses their bone mass rapidly and exercise slows down this process, as well as increasing muscle strength and coordination thus decreasing their chances of fall. New forms of exercises such as whole body vibration improve BMD and balance and may be a better alternative to walking in the elderly. In addition to exercise, a proper intake of calcium and if needed, hormone replacement therapy for women, play a cumulative role in preventing the development of osteoporosis. Apart from having an effect on the bones, exercise is beneficial for the cardio-respiratory system, improves diabetic control, reduces weight of a person and alleviates the mood, thus improving the quality of life and level of daily functioning. As it does not cost anything and if done properly, is free from side effects, exercise should be prescribed at all levels of bone health.

References

25. Chien MY, Wu YT, Hsu AT, Yang RS, Lai JS. Efficacy of a 24-week aerobic exercises according to his or her own capabilities, keeping in mind that some exercise is better than no exercise at all. It should be realized, however, that any skeletal benefit acquired during exercise will not be maintained if the person returns to his previous sedentary lifestyle.26