OSTEOPOROSIS FACT SHEET

What is osteoporosis?

Osteoporosis is where a person's bone mineral content is compared to, and has dropped a specified amount below, that of the average bone mineral density of 20 year olds of the same sex and ethnicity. This reduction in mineral content of the bones results in the bones being weaker. Due to the reduced bone strength, forces that usually cause no harm to bone (such as a fall from standing height) can result in a fracture, particularly to the spine, hips and wrist (IOF 2007). Early post-menopausal changes show a greater loss of trabecular bone (eg: in the vertebrae and hip) compared to cortical bone (eg: long leg and arm bones) (Forwood and Burr, 1993).

Osteoporosis affects approximately one in three women and one in five men over the age of 50 years. For the elderly who survive a hip fracture, only one in three returns to their previous level of independence (IOF, 2007).

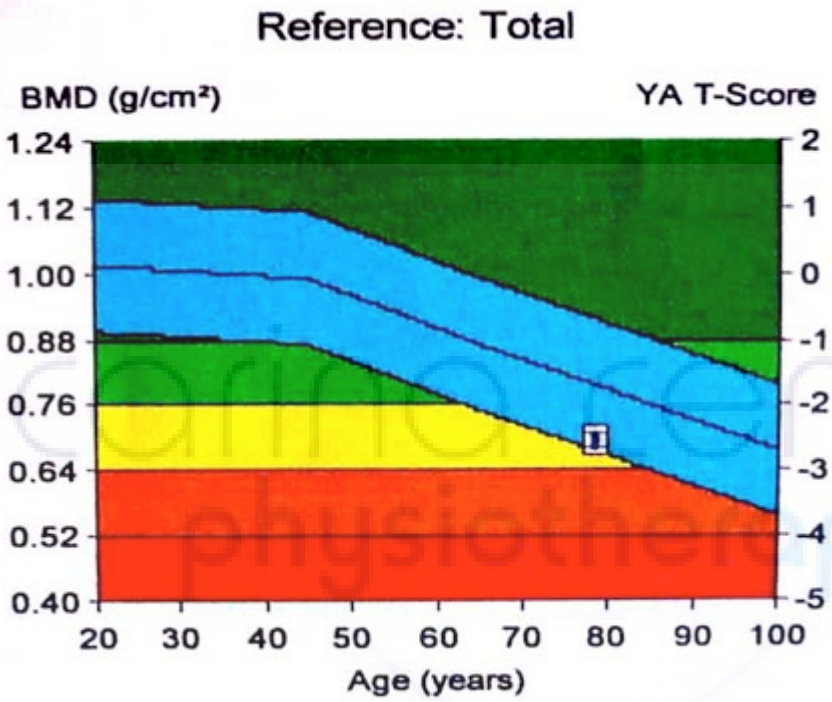
Bone is a dynamic tissue. Inside bone there are two types of cells, one lays down new mineral (osteoblasts) and the other removes old mineral (osteoclasts) (IOF, 2007). Bone is in a constant state of "remodelling and repair" in response to the forces placed upon it and to maintain body serum levels of calcium.

Our ability to form bone is greatest in the first 20 or so years of our life, with peak bone mass being achieved in our early twenties to thirty years of age. Following this, there is a gradual loss of bone mineral that continues for the rest of one's life, particularly after menopause in women (IOF, 2007). Oestrogen is an important hormone in females as it supports osteoblast survival (IOF, 2007). The higher the peak bone mass that is achieved by the early 20's, then the greater the likelihood of withstanding the effects of normal age related bone loss. A 10% increase in peak bone mass is predicted to delay the onset of osteoporosis by 13 years (Ebeling et al, 2013).

There are strategies that can be taken to reduce the rate of bone mineral loss and even improve it. These strategies will be discussed further on in this fact sheet.

Osteoporosis can be diagnosed by a DEXA (Dual Energy X-ray Absorptiometry) scan which gives a measure of the mineral content in bone (mainly calcium). A person's bone mineral density is compared to the average bone mineral density of 20 year olds of the same gender and ethnicity (T score), and to people of the same age, ethnicity and gender (Z score) (Monash University, 2010). If your bone mineral density falls a certain amount below that of young, gender matched people, then you may be diagnosed with having either osteoporosis or osteopaenia.

A **T score** which is positive (+ve) or only minus (-) one standard deviation (up to one step below normal) from the normal bone mineral density of a 20 year old is regarded as being a normal bone mineral density, for the site that it is measured at. If the T Score is - 1.0 to - 2.5 standard deviations below the normal bone mineral density of a 20 year old, this indicates the presence of osteopaenia. If the T score is greater than - 2.5 standard deviations below the normal bone mineral density of a 20 year old, this indicates the presence of osteoporosis (Monash University, 2010).



Values in the dark green band are considered of normal bone density. Osteopaenia would be diagnosed in values coinciding with the light green and yellow bands, whereas osteoporosis would be values falling within the yellow and red bands.

Image taken from: River Radiology (riverradiology.com)

Figure 1.

What is Osteopaenia?

Osteopaenia is not osteoporosis. It represents a stage when the bones have lost some mineral strength and are weaker, however not as weak as in osteoporosis. It can be regarded as the phase before the occurrence of osteoporosis. People diagnosed with Osteopaenia have a reduced bone density that is -1.0 to - 2.5 standard deviations below the normal bone density of a 20 year old (Monash University, 2010).

Some people attribute their aches and pains to their diagnosis of osteoporosis/osteopaenia. In themselves, these conditions are not painful. The loss of bone occurs progressively over many years and usually without symptoms, hence referred to as the "silent epidemic" (IOF, 2007). Often the first sign of osteoporosis is a fracture, which can be a source of pain.

Why would I have low bone density?

Factors contributing towards reduced bone density include, however are not limited to, the following:

1. Reduced calcium intake
2. Poor vitamin D intake (can't absorb the calcium)
3. Inadequate exercise
4. Smoking
5. Increased alcohol intake
6. Low sex hormone levels (oestrogen and testosterone)

Alcohol intake above 2 units per day is associated with an increased risk of fracture (Kanis et al, 2005) which is due to the negative effects that prolonged moderate alcohol intake has on bone building activity (Laitinen et al, 1991). Vitamin D metabolism does not appear to be impaired by prolonged, moderate alcohol consumption (Laitinen et al, 1991).

There is strong evidence showing that smoking reduces bone mineral density and increases the risk of fracture (Jutberger et al, 2010 and Kanis et al 2005).

Women who sit for 9 hrs a day or more are at a 43% greater risk of obtaining a hip fracture than those who sit less than 6 hrs a day (Pfeifer et al, 2004).

An increased incidence of fracture rates has occurred in recent decades due to reduced activity and dairy consumption and increased body fat (increased weight = increased force with fall).

Calcium

How much calcium do I need?

1000-1300mg of calcium is recommended per day (Osteoporosis Australia, 2013). This can be achieved by **consuming 3-5 servings of dairy** a day, one of which at least should be fortified (Ebeling et al; 2013). A few examples of a serving of dairy would include one cup (250ml) of milk, 2 slices of cheese (40g) or 1 tub of yoghurt (200g). Consuming dairy products is the easiest way to obtain your dietary calcium needs. Nuts and leafy green vegetables are also sources of calcium however greater quantities are required to equal one

serve eg: 6.5 cups of shredded cabbage, 32 brussel sprouts, 1 cup of almonds. Tinned fish, containing the bones, is a good source of calcium eg: sardines, salmon.

Female athletes may require greater than 1500mg of calcium per day to reduce their risk of fractures.

Individuals who dislike or are intolerant of dairy products and wish to achieve their required calcium intake from their diet will need to have more serves of other high-calcium-containing foods (eg, specific vegetables, fish, nuts) or calcium fortified foods such as soy milk (Ebeling et al; 2013).

A "calcium calculator" is available at www.iofbonehealth.org. It can help determine the amount of calcium contained in a person's diet (IOF, 2007).

Foods	**Calcium Content mg/serve**
Milk, cheese and yoghurt	300-400
Tinned salmon and sardines (bones)	220-400
Calcium-set tofu	150
Nuts and tahini	65-110
Selected green vegetables	18-43

Source: from Ebeling et al; 2013

Table 1.

Australian Recommended Daily Intake (RDI) of Calcium

1-3 yrs	500 mg/day
4-8 yrs	700 mg/day
9-13 yrs	1000-1300 mg/day
14-18 yrs	1300 mg/day
Mothers aged 14-18 yrs	1300 mg/day
Mothers aged 19-50 yrs	1000 mg/day
19-50 yrs	Females and males 1000 mg/day
Female athletes	1500 mg/day
51-70 yrs	Females 1300 mg/day males 1000 mg/day
> 70 yrs	Females and Males 1300 mg/day

(RDI's taken from IOF, 2007 and Ebeling et al; 2013)

Table 2.

For 9-11 yr old children who have physically matured earlier, the recommended daily intakes for 12-18 yr olds may be more appropriate (Ebeling et al; 2013).

Calcium Supplements

Ideally, calcium needs should be obtained from calcium rich foods in the diet. If a person cannot consume their recommended amount of daily calcium, then supplements are recommended, especially if a low bone density has been diagnosed.

Calcium is optimally absorbed at doses of 500mg or less. Limit your calcium supplements to 500-600mg/day and take with meals to aid absorption (Osteoporosis Australia, 2013). The evidence of calcium supplements increasing your risk of heart disease is conflicting and these risks can be discussed with your doctor (Osteoporosis Australia, 2013). Calcium supplements are not usually recommended for children. If you believe your child would benefit from taking calcium supplements, then it is advised you discuss this issue with your general practitioner (Ebeling et al; 2013). There are medications on the market used to facilitate the improvement of a person's bone mineral density. These medications may not be suitable for some people and your general practitioner should also be consulted regarding this (Ebeling et al; 2013).

Why is calcium important?

Calcium is not just important for bone health and strength. Ionised calcium is contained in our plasma (blood serum) and is also important for our nerves and muscles. If insufficient serum calcium is available, the body produces more parathyroid hormone which results in bone resorption to boost serum calcium levels (Heaney, R.P., 2002; Boonen et al, 2006; IOF, 2007). In other words, our skeletal system acts as a calcium storage reserve that will be utilised to make sure we maintain adequate serum (plasma) levels (Ebeling et al; 2013).

What type of exercise will improve my bone density?

If your goal is to reduce the risk of sustaining a fracture due to the effects of age-associated bone mineral density loss, then the type of exercise you engage in will be determined by your age and the quality/density of your bones.

An exercise must *overload* bone in order to stimulate it to "lay down" more bone. To promote bone gains, an exercise programme must include activities that impose bone loads substantially greater than those experienced during activities of normal daily living (Beck and Snow, 2003). Consequently, walking alone is not an effective strategy for the prevention of osteoporosis in postmenopausal women. *A bone-density evaluation is recommended for older and at-risk individuals before initiating a programme of impact or high-force exercise, as such activity may be injurious to the osteoporotic skeleton* (Beck and Snow, 2003).

The ages of 13-18 years are very important bone building years during which 40% of peak bone mass is acquired. Growing bones have a greater ability to adapt to weight-bearing exercise than mature bone (Forwood and Burr, 1993). Moderate to high impact exercise has the greatest benefit during our pre-pubertal years. Jumping exercises, involving loads in multiple directions, achieve the largest gains eg: basketball and gymnastics (Warden and Fuchs, 2009). There appears to be a gender difference in the responsiveness of bone strength to exercise around puberty, with boys showing a greater response than girls (Weeks and Beck, 2010). It is recommended that children participate in 10-45 min of high impact activity 3-7 times a week in order to build up adequate bone strength and reserves during their important bone development years.

Which Activities Improve Bone Density?

Highly Osteogenic	Moderately Osteogenic	Low Osteogenic	Non-osteogenic
Basket/netball	Running, jogging	Leisure walking	Swimming
Impact aerobics	Brisk or hill walking	Lawn Bowls	Cycling
Dance, gymnastics	Resistance training	Yoga	
Tennis	Stairs	Pilates	
Skip rope, jumping		Tai Chi	

Table taken from Ebeling et al; 2013

Table 3.

The mature skeleton maintains some ability to respond to the loads placed upon it, albeit not to the degree of growing bones, with small gains in bone mass being achievable. The objective of exercise during adulthood shifts towards preserving bone quantity so as to enter late adulthood with maximal bone stock (Warden and Fuchs, 2009).

Healthy young and middle adulthood individuals should pursue activities that overload the skeleton eg: running and jumping. Stepping or jumping (even just 8cm off the ground) for 2 min per day can be considered a high impact activity. *Pre-menopausal women* can improve their bone density by 1% per year by participating in moderate to high resistance training and/or high impact and aerobic exercise compared to sedentary controls.

Perimenopausal women who exercise will maintain their bone mineral density at loaded sites to a greater extent than those who do not (Beck and Snow, 2003). From a practical perspective, jumping exercises (as mentioned above) would be feasible for nonathletic women and can be completed in 2 minutes per day (Ebeling et al; 2013). The recommended number of jumps required to induce a bone remodelling effect varies between 50 and 100 (Bone Health in Sport Symposium, 2014). Activities of low intensity, such as walking, impart very low bone loads.

The ability of mature bone to improve its bone mineral density appears to be dependent on a persons' initial bone mass. Those with extremely low initial bone mass seem to make greater gains by initiating an exercise programme compared to those with moderately reduced bone mass (Forwood and Burr, 1993). At the very least, exercise will help preserve bone mass and inhibit further loss as occurs in sedentary people. If training is discontinued, bone mass levels return to baseline and continue their age-related decline (Forwood and Burr, 1993).

For the elderly, the focus of exercise swings from the enhancement of bone health to the protection of the skeleton from potentially damaging loads eg: falls, poor posture. Falls are one of the greatest causes of fractures in the elderly. Reducing the risk of falling will substantially reduce the risk of fracture, even in those with a low bone density. Exercises that help reduce the risk of falling would involve muscle strengthening, general conditioning and balance exercises, which can be included alongside the "bone building" exercises (Beck and Snow, 2003; Warden and Fuchs, 2009).

As a general rule, resistance training is more favourable for older individuals. Exercises to avoid, if you have osteoporosis, would be high impact jumping or those that involve loaded or repetitive flexion/bending of the spine (eg: sit-ups, lawn bowls, some yoga positions) as this can result in compression fractures of the spine (Ebeling et al; 2013).

In females with low bone mass, there is evidence of a possible positive bone mass response to brief daily bouts of standing on a high frequency, vibrating platform (Beck et al; 2006). These platforms may be found at certain physiotherapy or other health care practices. There are Whole Body Vibration platforms available on the market to purchase, however only a few produce the results quoted from scientific research. It is beyond the scope of this information sheet to state which brands and devices are proven and reliable for a positive effect on bone health.

For those diagnosed with osteoporosis, high impact exercises may result in a fracture. It would be recommended to discuss an appropriate exercise programme with a health practitioner who has an interest in exercise regimes for people with osteoporosis. Exercises can then be tailored to the individual and slowly progressed over time. For those with osteopenia, jogging and step ups may initially be appropriate however high impact jumping may not. A new programme should begin slowly and under supervision, with careful attention to form and appropriate progression.

How often should I exercise to improve my bone health?

Recommendations on the requisite duration and frequency of exercise sessions are broad: 10–45minute bouts occurring 3–7 days per week (Ebeling et al; 2013). Daily exercise of one hour duration is recommended for our general health. To improve our bone strength, 30

min of osteogenic (bone building) activity is recommended 3-5 x week. Muscle strengthening of moderate to high intensity (60-80% peak capacity) is recommended at least 2 x week and should be progressed when required. Increased strength and lean muscle mass, along with reduced body fat results in a decreased risk of fracture (Ebeling et al; 2013).

Vitamin D

Why is vitamin D important?

Vitamin D, along with our parathyroid glands and hormones, regulates the calcium, phosphorous and magnesium levels in our blood and bones. Vitamin D forms in the skin as a result of UVB exposure (The Australian and New Zealand Bone and Mineral Society, Osteoporosis Australia, The Australasian College of Dermatologists and the Cancer Council Australia, 2007). Some studies have indicated that our ability to synthesise vitamin D diminishes as we age, therefore reducing our ability to maintain adequate bone mineral density (Hollick, Matsuoka and Wortsman, 1989).

Your vitamin D levels should be measured if you have been diagnosed with osteoporosis or have sustained a fracture through minimal trauma. A reading of 50 nmol/L is recommended however 75nmol/L may be required to maintain optimal bone health (Osteoporosis Australia, 2013; The Australian and New Zealand Bone and Mineral Society et al, 2007).

Who is at risk of being vitamin D deficient?

- Older adults who may be housebound or institutionalised
- Those with dark skin
- Concealing clothing eg: religious purposes
- Babies and infants whose mothers are vitamin D deficient
- Those at high risk of developing skin cancer (who avoid the sun)

(The Australian and New Zealand Bone and Mineral Society et al, 2007)

Vitamin D metabolism is also affected by obesity and end stage renal or liver disease.

Sources of vitamin D

Sunlight is the best source of vitamin D, with food sources providing only 5-15% of our daily needs. Food sources would include liver, eggs and fatty/oily fish (Osteoporosis Australia, 2013).

How much sun exposure is enough to obtain my vitamin D needs?

This is difficult to accurately prescribe as variables include time of day, time of year, latitude and skin colour. A general guide for a fair skinned person would be exposure of the face,

arms and hands for 6-7 min (up to 30 min in winter) during the mid-morning or afternoon most days of the week. A dark skinned person would require 3-6 x longer exposure. In southern parts of Australia during winter, a person may require 2-3 hrs of exposure a day (Osteoporosis Australia, 2013; The Australian and New Zealand Bone and Mineral Society, Osteoporosis Australia, The Australasian College of Dermatologists and the Cancer Council Australia, 2007).

General Recommended Sun Exposure Requirements to Meet Adequate Vitamin D Levels

	Summer	**Winter**
Fair Skin	Expose arms 6-7 min most days	Expose as much bare skin as practical 7-40 min most days
When?	10am-2pm (standard time) 11am-3pm (daylight saving) **avoid peak UV times**	Midday
Dark Skin	Expose arms 18-42 min most days	Expose as much bare skin as practical for 21min to 4 hrs
When?	10am-2pm (standard time) 11am-3pm (daylight saving) **avoid peak UV times**	Midday

Taken from Ebeling et al; 2013

Table 4.

When is it safe to be outside without skin protection?

When UV index ratings are below 3, it is safe to be outside without skin protection. **Brisbane's peak UV levels** are higher than cities in the southern states, so the recommended times of day for sun exposure stated in Table 4 may not be appropriate if they coincide with Brisbane's peak UV levels. Safer times for unprotected exposure in Brisbane are more likely to be early morning and late afternoon.

The following table indicates the peak UV levels averaged over the days for each month in the city of Brisbane (The Australian and New Zealand Bone and Mineral Society et al, 2007).

January 11	May 4	September 7
February 10	June 3	October 8
March 9	July 3	November 10
April 6	August 5	December 11

Table 5.

Vitamin D Supplements

20-50 ug/day has been found to reduce the risk of fractures in people greater than 50 years old.

In those with a moderate to severe vitamin D deficiency, 75-125 ug/day is recommended for 6-12 weeks with a maintenance dose of 25-50 ug/day thereafter.

Energy Demands

In both females and males, hormone production is influenced by the balance between dietary intake and the energy demands of the body. This can be referred to as "energy availability" (Bone Health in Sport Symposium, 2014). Oestrogen and testosterone production can be diminished if the energy demands of the body exceed energy intake. This can occur in people with eating disorders such as anorexia nervosa and bulimia or in athletes that expend large amounts of energy with inadequate dietary intake. In population studies, fracture risk is increased in females with low BMI (Body Mass Index) and body fat, especially if body weight is sufficiently low to impair sex hormone production (Ebeling et al; 2013).

In females, oestrogen deficiency can result in the loss of menses (amenorrhoea) or irregular menses (oligomenorrhoea) which has similar effects on bone metabolism as is seen in post-menopausal women. At a time when bone mass is supposed to be accruing, a loss of bone mass, or inability to increase bone mass, will be detrimental to the bone health of the person. Low testosterone levels in men are also linked with lower bone density levels (IOF, 2007 and Bone Health in Sport Symposium, 2014).

Conclusion

Many people are unaware that bone health is affected by the dietary and exercise habits chosen throughout their lives. Improved education and awareness will hopefully reduce the incidence of osteoporosis related fractures in older populations. Ideally, regular high impact exercise and adequate calcium intake in our younger years will build bone strength sufficiently to reduce the risk of fracture as we age. For those of us who have reached our later years, and discovered that our life habits were not sufficient to attain adequate bone strength, steps can be taken to improve or maintain our bone mineral density. These steps/habits must be continued in order to preserve any benefits that are achieved.

REFERENCES

The Australian and New Zealand Bone and Mineral Society, Osteoporosis Australia, The Australasian College of Dermatologists and the Cancer Council Australia – Risks and Benefits of Sun Exposure Position Statement, (2007).

Beck BR. And Snow CM. (2003) Bone health Across the Lifespan – exercising our options *Exercise and Sport Sciences Reviews Vol. 31 (3) pp 117-122*.

Beck B., Kent K., Holloway L. and Marcus R. (2006) Novel, High Frequency, Low Strain Mechanical Loading for Pre-menapausal Women with Low Bone Mass: early findings *Journal of Bone and Mineral Metabolism Vol. 24 pp 505-507*

Bone Health in Sport Symposium (2014) Australian Institute of Sport, February 1st and 2nd.

Boonen S, Vanderschueren D, Haentjens P and Lips P (2006). Calcium and Vitamin D in the Prevention and Treatment of Osteoporosis. *Journal of Internal Medicine Vol. 259(6) pp 539-52*.

Ebeling PR, Daly RM, Kerr DA and Kimlin MG (2013) Building Healthy Bones Throughout Life – An evidence informed strategy to prevent osteoporosis in Australia *Medical Journal of Australia Vol. 2 supplement 1 pp 1-9*

Forewood MR and Burr DB (1993) Physical Activity and Bone Mass; exercises in futility? *Bone and Mineral Vol. 21 (2) pp 89-112*

Heaney RP (2002) The Importance of calcium Intake for Lifelong Skeletal Health *Calcified Tissue International Vol. 70 pp 70-73*

Holick MF., Matsuoka LY. and Wortsman J. (1989) Age, Vitamin D and Solar Ultra-violet *The Lancet November 4 pp 1104-1105*

International Osteoporosis Foundation (2007) Invest in Your Bones – Beat the Break. Written on behalf of the IOF Committee of Scientific Advisors by Cyrus Cooper, FMedSci, Professor of Rheumatology and Director, MRC Epidemiology Resource centre, University of Southampton, Southampton, UK.

Jutberger H, Lorentzon M, Barrett-Connor E, Johansson H, Kanis JA, Ljunggren O, Karlsson MK, Rosengren BE, Redlund-Johnell I, Orwoll E, Ohlsson C and Mellström D (2010) Smoking

Predicts Incident Fractures in Elderly Men *Journal of Bone and Mineral Research Vol. 25 (5) pp 1010 -1016*

Kanis JA, Johansson H, Johnell O, Oden A, De Laet C, Eisman JA, Pols H and Tenehouse A (2005) Alcohol Intake as a Risk Factor for Fracture *Osteoporosis International Vol. 16 (7) pp 737 -742*

Kanis JA, JohnellO, Oden A, Johansson H, De Laet C, Eisman JA, Fujiwara S, Kroger H, Mc Closkey EV, Mellström D, Melton LJ, Pols H, Reeve J, Silman A and Tenehouse A (2005) Smoking and Fracture Risk – a meta-analysis *Osteoporosis International Vol. 16 (2) pp 155-162*

Laitinen K, Lamberg-Allardt C, Tunninen R, Karonen SL, Ylikahri R and Välimäki M (1991) Effects of 3 Weeks' Moderate Alcohol Intake on Bone and Mineral Metabolism in Normal Men *Bone and Mineral Vol. 13 (2) pp 139-151*

Monash University (2010) Definition, Diagnosis and Causes of Osteoporosis *Medicine, Nursing and health Science Women's Health Programme*

Osteoporosis Australia (2013) Vitamin D Position Statement www.osteoporosis.org.au

Osteoporosis Australia (2013) Statement on Calcium Supplements www.osteoporosis.org.au

Pfeifer M, Sinaki M, Geusens P, Boonen S, Preisinger E and Minne HW (2004) Musculoskeletal Rehabilitation in osteoporosis – a review *Journal of Bone and Mineral Research Vol. 19 (8) pp 1208-1214*

Warden SJ and Fuchs RK (2009) Exercise and Bone Health: optimising bone structure during growth is key, but all is not in vain during ageing *British Journal of Sports Medicine Vol. 43 (12) pp 885-887*

Weeks B. and Beck B. (2010) The Relatiponship Between Physical Activity and Bone During Adolescence Differs According to Sex and Biological Maturity *Journal of Osteoporosis Article ID 546593 pp 1-9.*