ORIGINAL ARTICLE

Osteoporosis and its Associated Factors Revisited: Case Control Study

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ABSTRACT

Background: Osteporosis is increasingly observed as a major public health concern as it leads to poor quality of life, pain and often disability for those effected. Especially in the developing countries, its prevalence in alarming in the face of poor awareness and management.

Objective: To assess the risk factors for osteoporosis in females coming to a tertiary care hospital of Karachi.

Methods: This was hospital based case control study conducted in a private tertiary healthcare facility of Karachi. It was carried out in 2012. 57 cases and 60 controls were selected through WHO Sample size calculator. Matching among cases and controls was based on gender, socioeconomic status and age group. Data was collected through questionnaire based personal interviews. Data entry and analysis was done using Epi Info. Association between categorical variables was found using chi square. Odds ratio was calculated for finding association between different risk factors and osteoporosis. The study was cleared through the Ethical review board.

Results: One hundred and seventeen cases and controls were taken in this study with the age range of 45+ years (mean age 56.8 ± 11.8). Statistically significant difference was found in under 50 age group where cases were only n=8 (14%) as compared to controls n=25(42%). Parsi ethnicity showed strong

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association with osteoporosis (OR 2.23). Strong association was observed between smoking and osteoporosis with an Odds Ratio of 4.0. Strong association was observed with Rheumatoid arthritis (OR 2.8, CI at 95% 1.2-6.3) and Calcium deficiency (OR 2.2, CI at 95% 1.1-4.7).

Conclusion: The study revealed specific to Parsi ethnicity, family history, smoking, rheumatoid arthritis and Vitamin D deficiency were found to be potent risk factors. Therefore as reaffirmed from our study also, risk factors except from the non modifiable ones should be tackled well in advance through health education and interventions.

KEY WORDS: *Osteoporosis, Rheumatoid Arthritis, Bone Density.*

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INTRODUCTION

Osteoporosis is a major and growing public health problem.[1,2] Globally 200 million women suffer from osteoporosis. Across the globe, an osteoporotic fracture is estimated to occur every 3 seconds.[3] It is a major cause of fractures in elderly, resulting in pain, disability, costly rehabilitation, poor quality of life, and premature death.[4] Osteoporosis stands as a common feature in most races including Blacks, Hispanics but especially Whites and Asians. Osteoporosis poses gender predilection with females more prone to develop as compared to males.[5] About 30%-50% of women suffer from osteoporosis-related fractures in their lifetime[6] with escalated risk as age advances.[7] Osteoporosis endorses a wide gamut of risk factors including female gender, Asian or Caucasian race, family history of menopause, age of menarche and menopause, early menopause, diet low in calcium and Vitamin D, smoking, sedentary lifestyle, excessive alcohol and caffeine consumption, low Body mass index, prolonged amenorrhea use of glucocorticoids, anticoagulants, anticonvulsants, thyroid hormones along with lifestyle factors comprising of exercise and activity levels.[8,9,10]

Developing countries continue to be ill-equipped to handle burden of the disease. This coupled with poor literacy rates and lack of awareness on the risk factors and symptoms results in poor outcomes.[11] Comparing people suffering from osteoporosis Pakistan stands at 5th position across the world.[12] Osteoporosis in elderly females is a significant public health problem in Pakistan.[5] Studies in Pakistan have demonstrated that 75.3% of post-menopausal women are predisposed to osteoporosis with 55% within the age of 45-55 years.[13] It has been suggested that South Asian diets, coupled with reduced exposure to sunlight, may compromise calcium and vitamin D status.[14]

According to a survey in Pakistan 72% of people lead a sedentary lifestyle and vitamin D deficiency among Pakistani women has been reported to be as high as 83%.[15,16] Moreover, the Pakistani diet has been found to be deficient in calcium.[17] The prevalence of smoking has been reported to be 22%-40% in most recent population-based studies.[18,19] To the knowledge of the researchers, the prevalence of osteoporosis and its risk factors among Pakistani women are hitherto unknown. There is a paucity of data regarding ethnic predilection of osteoporosis among Pakistani females. Through the study researchers aimed to revisit the risk factors of osteoporosis and uncover any novel association missed so far.

METHODOLOGY

This was hospital based case control study conducted in a private tertiary healthcare facility of Karachi. It was carried out in 2012. Sample size was calculated through the WHO sample size calculator. The calculations were based on the assumption that anticipated probability of exposure in the non diseased group is around 25% and at a power of 80% and confidence level of 95%, 69 cases and 69 controls were inducted in the study. After editing and non response there were 57 cases and 60 controls. The cases were selected from the Orthopedic OPD and were all females while the controls

were selected from gynecology department after excluding the presence of osteoporosis from the non diseased group. Matching among cases and controls was based on gender, socioeconomic status and age group. The inclusion criterion for the cases was females above 45 years of age who were diagnosed with Osteoporosis by consulting doctor. Females above 45 were included as it has been shown that bone mass reaches the peak in the third decade and then declines in both sexes, in women accelerating after the menopause.[20,21]

Subjects speaking language other than English or Urdu were excluded from the study. Those who failed to give consent were also not taken for this study. The questionnaire was in English with Urdu translation. Age identification was performed by using National Identification Cards. Subjects without their NIC were excluded from the study. Questionnaire was reviewed by a physician and an orthopedic surgeon. Data was collected by the primary investigators themselves. Patients were diagnosed based on X rays and CT scan and osteoporosis was defined as

For purpose of analysis categorization of variables was performed as follows. Age range was categorized as between 45-50, 50-59 and those above 60 years of age. Ethnicity was categorized as Urdu speaking, Punjabi, Pathan, Sindhi, Balochi, Parsi and others. Moreover, 30 minute or more work against gravity (like walking, stair climbing and weight training) per day was considered in exercise doing by subjects

A written consent was taken from the hospital and informed verbal consent was taken from participants Data was entered on Epi Info. Before analysis, data was cleaned for possible data entry errors. Association between categorical variables was found using chi square. Odds ratio was calculated for finding association between different risk factors and osteoporosis. The study was cleared through the Ethical review board.

RESULTS

One hundred and seventeen cases and controls were taken in this study with the age range of 45+ years (mean age 56.8 ± 11.8). Majority of participants were greater than 60 years of age. Statistically significant difference was found in under 50 age group where cases were only n=8 (14%) as compared to controls n=25(42%). Most of them belonged to Urdu speaking ethnicity (Table 1). Though the Parsi ethnicity were only n=9 in the sample yet this ethnicity showed a strong association with osteoporosis (OR 2.23, CI at 95% 1-9.4). Family history of osteoporosis was present in n=24 (42%) cases and n=16 (27%) controls with an Odds ratio of 2 (CI at 95% 0.9-4.4). Smoking as a habit was observed in a total of 13 participants, n=10 (18%) from cases and n=3 (5%) from controls. Strong association was observed between smoking and osteoporosis with an Odds Ratio of 4.0 ((CI at 95% 1.05-15.5).

Table 1: General Characteristics of Patients

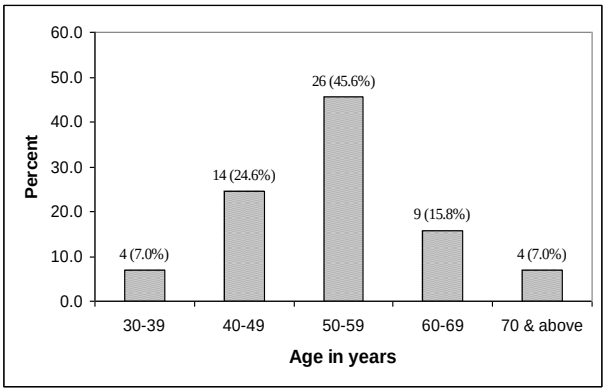
	osteoporosis				
	Cases (n=57)		**Controls** (n=60)		
Age grouping	n	%	n	%	**P-Value**
Under 50	8	14.0	25	41.7	0.001 **
50-59	21	36.8	20	33.3	0.690
60 & above	28	49.2	15	25.0	0.006 **
Mean ± S.D	59.6 ± 10.7		54.7 ± 12.3		0.015 *
Level of Education ©					
Illiterate	10	22.7	7	20.0	0.769
Matriculation	13	29.5	12	34.3	0.653
Intermediate	6	13.6	3	8.6	0.738
Graduate	8	18.2	7	20.0	0.837
Postgraduate	7	15.9	6	17.1	0.883
Ethnicity					
Urdu Speaking	22	38.6	25	41.7	0.734
Punjabi	9	15.8	10	16.7	0.897
Pathan	10	17.5	7	11.7	0.367
Sindhi	5	8.8	8	13.3	0.432
Balochi	1	1.8	2	3.3	0.999
Parsi	6	10.5	3	5.0	0.440
Others	4	7.0	5	8.3	0.999
Marital status					
Married	54	94.7	55	91.7	0.775
Unmarried	3	5.3	5	8.3	

© Education known in 44 cases and 35 controls
Statistically significant * p<0.05, ** p<0.01

When association between protein and calcium rich foods and osteoporosis was assessed through application of Odds Ratio, occasional consumption of eggs was found to be 1.32 times more likely to be a habit of known cases of osteoporosis (CI at 95% 0.5-3.4).Similar results were observed with occasional consumption of yogurt (OR 1.2, CI at 95% 0-4-3.2). (Table 2 shows association through application of Chi square test).

When association of different co-morbid conditions was assessed with osteoporosis, strong association was observed with Rheumatoid arthritis (OR 2.8, CI at 95% 1.2-6.3) and Calcium deficiency (OR 2.2, CI at 95% 1.1-4.7). . Though asthma had an Odds Ratio of 2.3 yet the CI at 95% was 0.64-8.0. Similarly Vitamin D deficient individuals had 1.9 the odds of suffering from osteoporosis yet CI at 95% was 0.9-4.1).

Figure 1: Age at the Time of Diagnosis



Maximum (46%) cases diagnosed at the age of 50-59 years, 7% diagnosed under 40 years of age.

Table 2: Use of Dietary Items (for Calcium and Protein) and Exercise

	osteoporosis				
	Cases (n=57)		Controls (n=60)		
	n.	%	n.	%	P-Value
Drink milk					
Daily	32	56.1	32	53.3	0.760
Quantity of milk One glass	25	43.9	30	50.0	0.148
Two glass	7	12.3	2	3.3	
Eat yogurt					
Daily	17	29.8	26	43.3	0.129
Alternative days	13	22.8	7	11.7	0.109
Once a week	16	28.1	13	21.7	0.422
Occasionally	11	19.3	14	23.3	0.594
Eat egg					
Daily	13	22.8	22	36.7	0.101
Alternate days	3	5.3	3	5.0	0.999
Thrice a week	13	22.8	6	10.0	0.060
Once a week	19	33.3	20	33.3	1.000
No	9	15.8	9	15.0	0.905
Exercise					
Daily	24	42.1	17	28.3	0.118
Alternate Days	6	10.5	4	6.7	0.678
Occasionally	10	17.5	14	23.3	0.438
No	17	29.8	25	41.7	0.182

What form of exercise					
Walking	30	52.6	28	46.7	0.518
Others	10	17.5	7	11.7	

Table 3: Associated Disease and Medicine Supplement Used

	osteoporosis				P-Value
	Cases(n=57)		Controls (n=60)		
	n	%	n	%	
Associated disease					
Hypothyroidism	3	5.3	0	0.0	-
Insulin-dependent DM	8	14.0	11	18.3	0.528
Rheumatoid arthritis	25	43.9	13	21.7	0.010
Asthma	8	14.0	4	6.7	0.314
Have you ever been diagnosed?					
Calcium deficiency	31	54.4	21	35.0	0.034
Vitamin D deficiency	22	38.6	15	25.0	0.114
Take calcium supplements	36	63.2	20	33.3	0.001
Doctor prescribed Glucocorticoid (cortisone)					
for longer period	4	7.0	5	8.3	0.999

DISCUSSION

As the saying goes 'In Hollywood you play a mom and instantly you've got osteoporosis' (Gabrielle Union) similar situation can be observed in Pakistan also as the proportion of elderly and post menopausal females is increasing along with escalating risk factors for osteoporosis.[8,15] We conducted this study on ages above 45 years. This was based on the findings of survey conducted by International Osteoporotic Foundation in 2009 where age range was 45-70 years.[22] The study findings indicated that majority cases were diagnosed between 50-59 years of age. This was in accordance to previous findings where Osteoporosis after menopause manifested approximately in 10 years[23] as research has indicated that bone mass peaks in third decade but declines after menopause.[24] The results were further validated by another study in this regard conducted in Newyork that made the same inference that men and premenopausal women have higher BMD as compared to post menopausal women.[25]

Studies conducted elsewhere has strongly demonstrated an association between different races and BMD where Caucasians and in general Asians have been shown to have a low Bone Mass Density at all ages.[26,27,28] The study specifically demonstrated Parsi ethnicity to be at high risk for Osteoporosis although the sample size was small.

Regarding the educational background, the sample had a preponderance of illiterate or having low literacy and having no significant association with the disease in question. This

was again confirmed by previous studies where no difference of risk was detected for osteoporosis by education[29] but surveys on Chinese have elucidated that better educated females know more about the disease in contrast to less educated females.[30] Though we did not take into account the socioeconomic status but studies conducted elsewhere have inveterate the universal truth that with money we can buy anything and that includes good health.[29]

Genetic factors take preponderance over environmental, nutritional and lifestyle risks against osteoporosis as established by a number of systematic reviews published.[31] When we assessed two important genetic associations, family history of osteoporosis and fractures, the results demonstrated that females with family history of osteoporosis had a significant odds ratio this was supported by previous studies where females have been shown to have a genetic predisposition.[32] Though no significant association between fractures and osteoporosis was assessed in the study yet It is estimated that by the year 2050, 50% of all hip fractures in Asia will be a consequence of Osteoporosis.[22] Poignant but a reality another study demonstrated that 48.5% postmenopausal females in Asia even after suffering fractures were not informed about osteoporosis.[33]

Smoking among females is considered to be a taboo in Pakistani society[34] hence smoking prevalence is lower in Pakistani females[35], as was the case in the current, study however significant odds ratio was demonstrated among smokers as indicated by previous studies.[36] In a study conducted in Quetta showed 19.8% smoking prevalence in females[36]; another study in Pakistan showed 11.7%[34] similar to the current study where 11.1% participants were smokers. We excluded Pan, gutka and huqqa consumers and those with family history of tobacco intake to nullify this confounder as has been shown by previous studies.[35]

When diet was evaluated as a risk factor low intake of protein in the form of egg consumption and calcium in the form of yogurt were specifically associated with high risk of osteoporosis. Ample research has purported the dietary phenomena in decreasing osteoporosis risk. Calcium rich food especially dairy products on daily basis have been shown to shield from osteoporosis whereas reduced intake enhances the risk.[37] Calcium deficiency displayed a high odds ratio in the study. Another study showed that calcium supplementation was low among Pakistani females probably due to improper counseling although its protective effects are eminent.[37] Vitamin D deficiency was found to have an association with osteoporosis in the study. A Systematic review conducted on similar associations has also demonstrated fair evidence on the association of Vitamin D deficiency and low BMD in old age.[38]

The current study showed that 50% of cases performed exercise which is contrary to a similar study conducted in Pakistan that showed 95% of Pakistani women do not exercise.[37] However lack of exercise has been revealed by studies as prominent risk for low bone mass and osteoporosis.[36] Regular exercise has been shown to decrease and delay physiological reduction in bone mass density.[39]

Association of Osteoporosis has been shown with chronic pulmonary diseases and people using high dose corticosteroids for inflammatory conditions like Rheumatoid arthritis asthma[40] similar findings were validated by the study where Rheumatoid arthritis and asthma both had strong association with osteoporosis. Although in both the studies it is difficult to ascertain the role of chronic diseases as a confounder or a risk factor.

There were few limitations observed for the study. First the sample size was limited and data was collected from a single tertiary care hospital. Hence the need to perform a population based study remains. DEXA scan is the recommended investigation to determine bone mineral density however because of relatively high cost a case finding strategy was used as recommended by previous studies.[41] The strengths of the study included proper age identification techniques, diagnosis approved by consultants, data collection by primary investigators themselves and removal of confounders. All major risk factors for osteoporosis as approved by recent studies were taken into account.

There is evidence that knowledge on osteoporosis leads to preventive behavior.[42,43] Prevention programs have the potential to delay or prevent this dilemma.[44] Some studies have displayed that prevention programs for elderly were effective in health promotion, knowledge

and behavior.[45] The situation turns tragic as osteoporosis is avoidable, prevention diagnosis and treatment is simple and inexpensive.[46] Hence the main goal should be to evaluate modifiable risk factors and implement primary prevention to minimize burden of this silent killer. Events as World Osteoporosis Day (20th October) in liaison with organizations such as Pakistan Endocrine Society, Osteoporosis Society of Pakistan should be organized. Simple messages on timely detection and prevention should be spread. Key practical implication of the current study pertains to setting primary healthcare programs for osteoporosis in Pakistani women as has been recommended for females in Taiwan[47], Hispanics and African Americans.[48]

CONCLUSION

Osteoporosis a silent stalker especially for females is capable of creating more mayhem than can be perceived. In the study Parsi ethnicity, family history, smoking, rheumatoid arthritis and Vitamin D deficiency were found to be potent risk factors. Therefore, as reaffirmed from the study, risk factors except from the non modifiable ones should be tackled well in advance through health education and interventions and since we belong to that geographical location where we are more at risk proper intervention programs are the need of the day.

REFERENCES

[1] Spencer SJ. Lack of knowledge of osteoporosis: a multi-centre, observational study. Scott Med J 2007; 52:13-6.

[2] Khuwaja AK, Nasir A, Mithani Y. Preventing Osteoporosis epidemic by exercise interventions. Med Today 2005; 3:140-2

3 Osteoporosis facts and statistics. (Online) (Cited 2012 September 20). Available from URL: http://www.iofbonehealth.org/facts-and-statistics.

[4] Górski R, Chmielewski D, Zgoda M. The evaluation of social awareness of osteoporosis: based on the aimed questionnaire. Ortop Traumatol Rehabil 2006; 8:627-632

[5] National Osteoporotic Foundation, 1996 and 2015 osteoporosis prevalence figures: state-by-state report. January 1997. Women's Health Matters 1998; 2:1.

[6] Fatima M, Nawaz H, Kassi M, Rehman R, Kasi P M, Kassi M, etal.Determining the risk factors and prevalence of osteoporosis using quantitative ultrasonography in Pakistani adult women. Singapore Med Journal 2009; 50(1):20

[7] J. Usman, H. Siddiqui. Osteoporosis in Family Practice. JPMA (Journal of Pakistan Medical Association) Vol 53, No. 9, Sep 2003

[8] Sultan A, Khan DA, Mushtaq M, Hassan M. Frequency of Osteoporosis and its associated risk factors in postmenopausal women in clinical practice at Rawalpindi. Pakistan J Pathol 2006; 17:115-118.

[9] Habiba U, Ahmad S, Hassan L. Predisposition to Osteoporosis in Postmenopausal Women. J Coll Physicians Surg Pak 2002; 12:297-301.

[10] National Institute of Health. Osteoporosis prevention, diagnosis, and therapy. NIH Consensus Statements 2000; 17:1-45

[11] National Health Survey of Pakistan 1990-1994. Pakistan Medical Research Council 1998.

[12] Statistics by Country for Osteoporosis. (Online) . Available from URL: http://www.cureresearch.com/o/osteoporosis/stats-country.htm

[13] Nicola M. Lowe, Basma Ellahi, Qudsia Bano, Sonia Ali Bangash, Soma R. Mitra, and Mukhtiar Zaman. Dietary Calcium Intake, Vitamin D Status, and Bone Health in Postmenopausal Women in Rural Pakistan. INTERNATIONAL CENTRE FOR DIARRHOEAL DISEASE RESEARCH, BANGLADESH. J Health Popul Nutr. 2011 October; 29(5): 465–470.

[14] Jaleel MA, Nooreen R, Parveen A, etal. Comparison of population survey of Multan about cigarette smoking with survey of Abbottabad. J Ayub Med Coll Abbottabad 2002; 14:16-19.

[15] Iqbal SP, Dodani S, Qureshi R, Risk factors and behaviours for coronary artery disease (CAD) among ambulatory Pakistanis. J Pak Med Assoc 2004; 54:261-266.

[16] Brunvand L, Henriksen C, Haug E. [Vitamin D deficiency among pregnant women from Pakistan. How best to prevent it?] Tidsskr Nor Laegeforen 1996; 116:1585-7. Norwegian.

[17] Akhter P, Baloch NZ, Mohammad D, Orfi SD, Ahmad N. Assessment of strontium and calcium levels in Pakistani diet. J Environ Radioact 2004; 73:247-256.

[18] Alam SE, Prevalence and pattern of smoking in Pakistan. J Pak Med Assoc 1998; 48:64-6.

[19] Jaleel MA, Nooreen R, Parveen A, etal. Comparison of population survey of Multan about cigarette smoking with survey of Abbottabad. J Ayub Med Coll Abbottabad 2002; 14:16-9.

[20] Collier JD, Ninkovic M, Compston JE. Guidelines on the management of osteoporosis associated with chronic liver disease. Gut 2002;50:11-19.

[21] Tresolni CP, Gold DT, Lee LS (eds). Working with patents to prevent, treat and manage osteoporosis: a curriculum guide for health professionals. 2nd ed.San Francisco: National Fund for Medical Education, 1998.

[22] The Asian Audit: Epidemiology, costs and burden of Osteoporosis in Asia 2009 by International Osteoporosis foundation.

[23] Jack SD. Mineral and Metabolic Bone Disease. Washington Manual of Medical Therapeutics. 1998. 29th ed.Philadelphia: Lippincot - Raven 1998, pp. 450-451.

[24] Collier JD, Ninkovic M, Compston JE. Guidelines on the management of osteoporosis associated with chronic liver disease. Gut 2002; 50:11-19.

[25] Shen W,Chen J, Gantz M, Punyanitya M, Heymsfield SB, Gallagher D, et.al;. 'Ethnic and sex differences in bone marrow adipose tissue and bone mineral density relationship. Osteoporos Int.2012; 23: 2293–2301.

[26] Shih TT, Chang CJ, Hsu CY, Wei SY, Su KC, Chung HW. Correlation of bone marrow lipid water content with bone mineral density on the lumbar spine. Spine. 2004; 29:2844–2850.[PubMed:15599288]

[27] Griffith JF, Yeung DK, Antonio GE, Lee FK, Hong AW, Wong SY, Lau EM, Leung PC. Vertebral bone mineral density, marrow perfusion, and fat content in healthy men and men with osteoporosis: dynamic contrast-enhanced MR imaging and MR spectroscopy. Radiology. 2005; 236:945–951. [Pub Med: 16055699]

[28] Shen W, Chen J, Punyanitya M, Shapses S, Heshka S, Heymsfield SB. MRI-measured bone marrow adipose tissue is inversely related to DXA-measured bone mineral in Caucasian women. Osteoporos Int. 2007; 18:641–647. [Pub Med: 17139464]

[29] Riaz M, Abid N, Patel J, Tariq M, Khan MS, Zuberi L. Knowledge about osteoporosis among healthy women attending a tertiary care hospital. J Pak Med Assoc April 2008; 58:190-4

[30] Saw SM, Hong CY, Lee J, Wong ML, Chan MF, Cheng A, et al. Awareness and health beliefs of women towards osteoporosis. Osteoporos Int 2003; 14:595-601.

[31] Cohen AJ, Roe FJ. Review of risk factors for osteoporosis with particular reference to a possible etiological role of dietary salt. Food Chem Toxicol. 2000 Feb-Mar; 38(2-3):237-53

[32] Werner P, Otchouslay D, Ertan - Gelaki H. First degree relatives of persons suffering from osteoporosis beliefs, knowledge and health related behavior. Osteoporos Int 2003; 14:306-11.

[33] Factors influencing diagnosis and treatment of osteoporosis after a fragility fracture among postmenopausal women in Asian countries: a retrospective study

[34] Mamji M.F., Hasan J.A. and Sabri M.S., Risk Factors for Osteoporosis in Post-Menopausal Women with Hip Fractures, J. of Surgery Pak., 15(2), (2010)

[35] Ahlborg H G , Rosengren B E1 , Järvinen T L N ,Rogmark C , Jan-Åke Nilsson J A , Ingemar Sernbo I and Karlsson M K. Prevalence of Osteoporosis and incidence of hip fracture in women - secular trends over 30 years2010 BMC Musculoskeletal Disorders, 11:48doi:10.1186/1471-2474-11-48

[36] Fatima M, Nawaz H, Kassi M, et al. Determining risk factors and prevalence of osteoporosis using quantitative ultrasonography in Pakistani adult women. Sing Med J 2009;50:20-8

[37] Prevalence Of Osteoporosis And Osteopenia Among Pakistani Pre And Post Menopausal Women

[38] Cranney A, Horsley T, O'Donnell S,Weiler H, Puil L,Ooi D, et.al,. Effectiveness and Safety of Vitamin D in Relation to Bone Health. AHRQ Evidence Reports.2007

[39] Henderson NK, White CP, Eisman JA. The role of exercise and fall risk reduction in the prevention of osteoporosis. Endocrinol Metab Clin North Am 1998; 27:369-87

[40] Bourjeily G, Rochester CL. Exercise training in chronic obstructive pulmonarydisease. Clin Chest Med 2000; 21:763-81.

[41] Koh LK, Ng DC: Osteoporosis risk factor assessment and bone densitometry-current status and future trends. Ann Acad Med Singapore 2002, 31:37–42.

[42] Blalock SJ, Currey SS, DeVellis RF, DeVellis BM, Giorgino KB, Anderson JJ, et al. Effects of educational materials concerning osteoporosis on women's knowledge, beliefs, and behavior. Am J Health Promot 2000; 14:161-9.

[43] Phillipov G, Phillips PJ, Leach G, Taylor AW. Public perceptions and self-reported prevalence of osteoporosis in South Australia. Osteoporos Int 1998; 8:552-6.

[44] Bailey DA, Faulker RA, McKay HA. Growth, physical activity, and bone mineral acquisition. In: Hollosky JO. Exercise and sport sciences reviews. Baltimore (MD): Williams and Wilkins, 1996; pp 233-66

[45] Huang LH, Chen SW, Yu YP, Chen PR, Lin YC. The effectiveness of health promotion education programs for community elderly. J Nurs Res 2002; 10:261-70.

[46] Kanis J. Diagnosis of osteoporosis and assessment of fracture risk. Lancet 2002; 359: 1929-36

[47] Yu S, Huang YC. Knowledge of attitudes toward, and activity to prevent osteoporosis among middle-aged and elderly women. J Nurs Res. 2003; 11:65-72

[48] Geller SE, Derman R. Knowledge, beliefs, and risk factors for osteoporosis among African-American and Hispanic women. J Natl Med Assoc 2001; 93:13-21