Causes for increase in bone related problems in India

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ABSTRACT

Bone is a homeostatic and metabolically active organ receiving about 10 per cent of the cardiac output. Despite of plenty of sunshine, vitamin D rich animal products and availability of milk and other Calcium rich plant foods throughout year; bone related problems are more than expected in India. Such figures are further increasing at high pace. The common bone related problems prevalent in India are osteoporosis, osteopenia, neck pain, backache, joint pain, wrist pain. The problems occur in both sexes (male and female) but more frequently in females and become more prevalent with advancing age. Even toddlers were also reported to have weak bone health. The present study is an effort to put several factors like nutritional deficiency, inadequate exposure to sun, menopause in women, excessive consumption of tea or coffee and sedentary lifestyle to a common platform to view their effect on bone related problems. We found a strong connection of these factors with musculoskeletal problems among Indian population.

KEYWORDS: Osteoporosis, vitamin D, calcium, bone density, menopause

INTRODUCTION

Bone related disorders, either because of malformation of the bones or imbalance of their mineral density, are prevalent in India. Different disorders have diverse characteristics and diagnostic features. Osteoporosis is characterized by weak and porous bones (i.e., bone density is much lower than the normal value) that cannot maintain normal bone functions. In most of cases, the disease cannot be detected until bones get extremely weak and fracture easily causing pain and discomfort. A study (Melton 3rd, 2001) suggested that after the age of 50 years, almost 20% individuals are affected with moderate osteoporosis. Further, if bone density is lower than normal peak density but not low enough to be classified as osteoporosis then it is termed as osteopenia. Bone density is a measurement of how dense and strong the bones are. Paget disease of bone is another common musculoskeletal problem which is characterized by high growth potential of bones. After enlargement the bones become weak and more prone to fractures. Disease shows excessive bone resorption with abnormal bone formation that replaces the marrow with fibrous and vascular tissue (Roodman and Windle, 2005). Osteomalacia (in adults) and Rickets (in children) is an acquired condition in most cases caused by *deficiency of vitamin D.* Moderate to severe deficiency of Vitamin D disturbs the bone building process and thus lead to soft and weak bones *(*Holick, 2006*).* When fibrous tissue (a type of scar tissue) replaces the normal bone, the disorder is referred to as fibrous dysplasia. Other common problems are neck pain, backache, cervical spondylosis and musculoskeletal problems.

"Bone and Joint Decade" was an international collaborative movement from 2000 - 2010 to raise awareness on the impact of bone and joint conditions on the society and to raise global funding for research on cost effective prevention and treatment of musculosketal problems (Weinstein, 2000). Indian Orthopedic Association is celebrating Bone and Joint day on 4th August since 2012. The slogan for that day is- "Stronger bones Stronger India – because we believe healthier the bones, healthier the society and stronger the nation" (Jain and Kumar, 2013). Bone and Joint day is not only a day but an opportunity to aware people about the increase in musculoskeletal conditions and to suggest cost-effective prevention and treatment.

The present article is an effort to put all possible causes of various bone related problems together so that the most common bone diseases and risk factors can be avoided where we can. This article discusses some common causes of bone problems, which are the main culprit but has not been given that much attention so far.

Nutritional deficiency

Osteomalacia occurs when bones do not get the required nutrients and building blocks when they are developing. Most common cause is Vitamin D deficiency. Vitamin D is an important nutrient that enables the body to absorb calcium; and maintain calcium and phosphate levels for proper bone formation. There are two kinds of Vitamin D. Vitamin D_2 (Ergocalciferol) is found in food items and Vitamin D_3 (cholecalciferol) is made by body in the presence of sunlight. When the body lacks vitamin D, it affects bone formation resulting in defective, soft and ill formed bone that is extremely prone to fractures. The typical function of vitamin D is to regulate calcium absorption and homeostasis. It promotes calcium absorption from the gut, enables mineralization of newly formed osteoid tissue in bone and plays an important role in muscle function (NOS 2013). Prolonged vitamin D deficiency is

damaging to the skeleton, resulting in rickets in children and osteomalacia in adults (Thacher and Clarke, 2011).

Prevention of the well-described vitamin D deficiency disorders like rickets and osteomalacia is important, but there may also be an implication of low vitamin D status in bone loss, muscle weakness and falls and fragility fractures in older people, and these are highly significant public health issues in terms of morbidity, quality of life and costs to health services in Europe (Spiro and Buttriss, 2014). Also, studies from northern India have shown vitamin D deficiency (< 20 ng/ml) in pregnant women and their new born (Goswami et al., 2000; Sachan et al., 2005; Bhalala et al., 2007 & Sahu et al., 2009). Few studies (Agarwal et al., 2002; Tiwari et al., 2004), have shown that a small group of toddlers had higher vitamin D status compared to their counter parts with low dietary calcium and poor exposure to sunlight living in the location and environment. Higher vitamin D status in this group was attributed to education on nutrition and sunlight exposure in this community.

Calcium is an important mineral that helps to keep bones strong. Calcium intake through diet also affects bone health. Bones are constantly remodeling themselves i.e., the body takes small amounts of calcium from the bones and replaces it with new calcium. Therefore, it is essential to have enough calcium so that the body doesn't decrease bone density in this remodeling process. Though calcium is necessary for ensuring bone health, the actual benefits of calcium intake do not exist after consumption passes a certain threshold. Consuming more than required (approximately 600 milligrams per day) does not improve bone integrity (Feskanich et al., 2003).

Low calcium intakes at young age not only predispose to osteoporosis, but make bones more fragile in childhood and adolescence as well (Teotia and Teotia, 2008). The beneficial effects of Ca intake were evident, as the females with adequate intake entered the osteoporosis and the fracture zones at about 10 yr later than those with inadequate intake (Teotia et al., 2004). It is possible to decrease the risk of osteoporosis by reducing sodium intake in the diet (Reid and New 1997; Lin et al., 2001), increasing intake of fruits and vegetables (Lin et al., 2001; Tucker et al., 1999) and ensuring adequate calcium intake from plant foods. Individuals drink milk in order to obtain calcium in their diets, unaware that without vitamin D, only 10-15 percent of dietary calcium is absorbed (Holick et al., 2006).

Inadequate exposure to sun

Indian subcontinent range between 8.4° and 37.6°N latitude and majority of the population living here experience plenty of sunlight throughout the year; and thus should get adequate vitamin D through this sun exposure and its deficiency is uncommon in India (Hodgkin et al., 1973). However from the researches (Harinarayan et al., 2005; Marwaha et al., 2008; Harinarayan et al., 2009) it was found that Vitamin D deficiency is very common in India in all the age groups and both sexes across the country. May be, fear of getting darker skin pigmentation (tanning) and recent modernization of India resulted working indoor (reducing outdoor activity) have caused limited sun exposure. Now a days, one of the main causes of vitamin D deficiency is Indoor activities: It is most likely that working from morning to evening in air-conditioned offices have starved the body for vitamin D.

The women from Indian subcontinent who have migrated to western countries are at increased risk of accelerated age-related bone loss or osteoporosis when compared to their counterparts living in the same geographic region due to their darker skin, conservative dressing such as "Burqa," "Sari," and

"Salwar kameez," and their genetic pattern (Mitra et al., 2006). Osteoporosis has various medical implications and a huge socioeconomic impact. So it is matter of concern to spread awareness and treatment of bone related disorders.

A study on osteomalacia (Teotia et al., 2002) showed that the women residing in the northern parts of India were affected more than those living south to Mumbai and Kolkota in India. This difference in the occurrence of osteomalacia is due to North-South gradient of the solar ultraviolet radiations (UVR-B 219- 315 nm) which are required for the cutaneous synthesis of vitamin D_3. Synthesis of vitamin D_3 in the skin is reduced by residing at northern latitudes distant from the equator (Teotia et al., 2008; Hollick and Garabedian, 2006).

The best natural source of vitamin D is sunlight. Five to 15 minutes of sun exposure to the arms and legs or the hands, face, and arms can be enough to meet the body's requirements for vitamin D, depending on the individual's skin tone (Holick, 2005). Darker skin requires longer exposure to the sun in order to obtain adequate levels of vitamin D. In colder climates during the winter months the sun may not be able to provide adequate vitamin D. During this time the diet must be able to provide vitamin D.

Menopause in women

Osteoporosis is slowly occurring disease with symptoms like joint pain, fracture of bones after minor injury, continuous back pain, and problem in sitting straight. Women are at a high risk of osteoporosis during their menopause time, as the estrogen levels will be decreased during this time. Disturbance in hormones is also one of the major causes of osteoporosis like variations in level of estrogen in women and level of androgen in men (Manolagas et al., 2013). Thyroid problem is also one of the causes of osteoporosis (Dhanwal, 2011; Tárraga López et al., 2011).

In India, the precise figures on the prevalence of osteoporosis are not available at present. However, it is estimated that more than 61 million Indians have osteoporosis; out of these, 80% patients are females (Joshi et al., 1998; Rao et al., 2003). There has been a great interest in conducting epidemiologic surveys on the occurrence of osteoporosis and related risk factors in communities (Inanici-Ersöz et al., 2002). In large community-based studies, the prevalence of osteoporosis was comparatively lower in western countries when compared to Asian population. A study from India, has shown that the mean Indian Bone Mineral Density is about 2 standard deviations lower than the western BMD (Patni et al., 2010).

In pre-menopausal Dutch women, the prevalence of osteopenia was 27.3%, and 4.1% of the women were osteoporotic; and in Canadian women, the prevalence of osteoporosis was 20% (Smeets-Goevaers et al., 1998; Tenenhouse et al., 2000). In Vietnamese adult women, osteoporosis was found to be relatively higher in comparison to nearby countries. High osteoporosis in the age group 50–70 years was comparable to Japanese women and this was postulated to be due to pre–World War exposure and poor nutrition at that time (Vu et al., 2005). In this study, the prevalence was thought to be less among rural premenopausal women as compared to urban due to high outdoor physical activity in this population. Another study, Aggarwal et al., 2011, revealed that almost half of the study women in peri- and postmenopausal age group were found to have low Bone Mineral Density.

Excessive consumption of tea and coffee

Coffee and tea are drunk all over the world by both young and old. In India tea is something that people swear about they cannot live without. Despite the many health benefits from high antioxidant content of tea it can negatively affect body's ability to use a variety of minerals; Specially if consumed just after or with meal (which has now became a common practice among Indians). Prime among these is calcium, the most common and most required mineral in body. All varieties of tea contain compounds that can reduce calcium levels. Caffeine affects calcium absorption in two ways. First, body excretes greater amounts of calcium as your caffeine intake increases. Secondly, body's ability to absorb calcium decreases when caffeine is present in body.

In concern to bone metabolism, increased coffee consumption caused a negative shift in overall calcium balance, but was not related to bone recovery in postmenopausal women with fracture osteoporosis (Hasling et al.,1992). A coffee intake in excess (1000 mL) could induce an extra calcium loss of 1.6 mmol calcium/day, while intake of 1-2 cups of coffee per day would have little impact on calcium balance (Hasling et al., 1992). Some studies (Hannan et al., 2000), however concluded no association between caffeine intake on bone metabolism. Further, caffeine was observed to interact with the TT genetic variant of vitamin D receptor (Rapuri et al., 2001). Furthermore, excessive consumption of brewed tea has also been found to lead skeletal fluorosis and increased bone mineral density (Izuora et al., 2011).

According to a study (Heaney, 2002), the negative effect of caffeine on calcium absorption is so small that it can be fully compensated by 1–2 tablespoons of milk. The study (Heaney, 2002) claimed that there is no evidence that caffeine has any harmful effect on bone status or on the calcium level in individuals who ingest the recommended daily requirements of calcium. Although, there is scarcity of information with regards to tea consumption and its effects on vitamin D and on skeletal system; still drinking tea and coffee must be avoided by person who take calcium supplements.

Sedentary lifestyle

A sedentary lifestyle is with little or no physical activity. A person living a sedentary lifestyle is often sitting or lying, while reading, socializing, watching television, playing video games, or using a mobile phone/computer for much of the day. This type of lifestyle has been significantly increased among Indian population and is still increasing. As computers have become integral part at workplace, the ill-effects of long hour sitting are evident leading to a host of postural ailments. An increasingly sedentary lifestyle has been suggested as a significant contributing factor for the increased prevalence of osteoporosis (McGraw and Riggs, 1994).

A large number of people under the age of 40 are suffering from cervical spondylosis because they don't exercise enough; spend too much time in front of their computer screens and bending their head down to smart phones. Most people experience some degree of neck pain in their lifetime (Makela et al., 1991; Cote et al., 1998). According to a recent study (Shah and Patel, 2015), Prevalence of neck pain due to work related habits was found to be 47%. The use of mobiles has been found associated with non-specific symptoms of ill-health and musculoskeletal complaints (Berolo et al., 2011).

A survey conducted on Indian population aged between 20-30 years showed (Aggarwal and Reza, 2013) an increase in prevalence of neck pain with age and computer usage; it was found 81% for

men and 91% for women. Further, a recent review study (Xie et al., 2017), has demonstrated that occurrence of musculoskeletal complaints among mobile users ranged from 1% to 67.8% and neck complaints had the highest prevalence rate from 17.3% to 67.8%. However, a previous study (Green, 2008) has demonstrated no clear cause for the work related musculoskeletal problems.

The bone related problems have grasped major population of India. Best schemes and resources must be deployed by Indian government to break this web. Besides proper nutrition and basking in sunshine; exercise is also one of the most effective ways to increase bone density and decrease the risk of osteoporosis (Prince et al. 1995; Going et al. 2003) and other bone related problems; its benefits have been observed in studies of both children and adults (Prince et al. 1995; Lunt et al. 2001; Llyod et al. 2002). Government programmes should be launched to educate people about nutrition, sunlight exposure, proper body posture and importance of exercise to maintain good bone health and to prevent the dire consequences of ignorance of skeletal problems.

REFERENCES

Agarwal KS, Mughal MZ, Upadhyay P, Berry JL, Mawer EB, Puliyel JM. The impact of atmospheric pollution on vitamin D status of infants and toddlers in Delhi, India. Arch Dis Child 2002; 87: 111-113.

Aggarwal N, Raveendran A, Khandelwal N, Sen RK, Thakur JS, Dhaliwal LK, *et al*. Prevalence and related risk factors of osteoporosis in peri- and postmenopausal Indian women. J Midlife Health. 2011; 2(2): 81–85.

Aggarwal P, Reza, M Kashif. Impact of Computer use on Prevalence of Neck Pain and Consequent Disability. Indian Journal of Physiotherapy and Occupational Therapy; New Delhi. 2013; 7(4): 102-106.

Berolo S, Wells RP, Amick BC 3rd. Musculoskeletal symptoms among mobile hand-held device users and their relationship to device use: A preliminary study in a Canadian university population. Appl Ergon. 2011; 42(2): 371-378.

Bhalala U, Desai M, Parekh P, Mokal R, Chheda B. Subclinical hypovitaminosis D among exclusively breastfed young infants. Indian Pediatr. 2007; 44: 897-901.

Cote P Cassidy JD, Carroll L. The Saskatchewan health and back pain survey. The prevalence of neck pain and related disability in Saskatchewan adults. Spine. 1998; 23: 1689–1698.

Dhanwal DK. Thyroid disorders and bone mineral metabolism. Indian Journal of Endocrinology and Metabolism. 2011; 15(2): S107-S112.

Feskanich D, Willett WC, Colditz GA. Calcium, vitamin D, milk consumption, and hip fractures: a prospective study among postmenopausal women. Am J Clin Nutr. 2003; 77: 504–511.

Going S, Lohman T, Houtkooper L, et al. Effects of exercise on bone mineral density in calcium-replete postmenopausal women with and without hormone replacement therapy. Osteoporos Int. 2003; 14: 637–643.

Goswami R, Gupta N, Goswami D, Marwaha RK, Tandon N, Kochupillai N. Prevalence and significance of low 25-hydroxyvitamin D concentrations in healthy subjects in Delhi. Am J Clin Nutr. 2000; 72: 472-475.

Green BN. A literature review of neck pain associated with computer use: public health implications. J Can Chiropr Assoc. 2008; 52(3): 161-167.

Hannan MT, Felson DT, Dawson-Hughes B, Tucker TL, Cupples LA, Wilson PW, Kiel DP. Risk factors for longitudinal bone loss in elderly men and women: the Framingham Osteoporosis Study. J Bone Miner Res. 2000; 15: 710–720.

Harinarayan CV, Joshi SR. Vitamin D status in India-Its implications and Remedial Measures. J Assoc Physicians India 2009; 57: 40-48.

Harinarayan CV. Prevalence of vitamin D insufficiency in postmenopausal South Indian women. Osteoporos Int 2005; 16: 397- 402.

Hasling C, Sondergaard K, Charles P, Mosekilde L. Calcium metabolism in postmenopausal osteoporotic women is determined by dietary calcium and coffee intake. J Nutr. 1992; 122: 1119–1126.

Heaney RP. Effects of caffeine on bone and the calcium economy. Food and Chemical Toxicology, 2002; 40 (9): 1263–1270.

Hodgkin P, Kay GH, Hine PM, et al. Vitamin D deficiency in Asians at home and in Britain. Lancet 1973; 2: 167-171.

Holick M. The vitamin D epidemic and its health consequences. J Nutr. 2005; 135: 2739S–2748S.

Holick MF, Garabedian M. Vitamin D: photobiology, metabolism, mechanism of action, and clinical applications. In: Favus MJ, ed. Primer on the Metabolic Bone Diseases and Disorders of Mineral Metabolism. 6th ed. Washington, DC: American Society for Bone and Mineral Research; 2006; 129-137.

Holick MF. High prevalence of vitamin D inadequacy and implications for health. In Mayo Clinic Proceedings. 2006; 81 (3); 353-373.

Hollick MF, Garabedian M. Vitamin D. Photobiology, metabolic mechanism of action, and clinical applications. In: Favus MS ed. Primer on the Metabolic bone diseases and disorders of mineral metabolicsm, sixth ed., Washington, D.C, American Scoiety for Bone and Mineral Research, 2006; 106-114

Inanici-Ersöz F, Gökçe-Kutsal Y, Oncel S, Eryavuz M, Peker O, Ok S. A multicenter case control study of risk factors for low tibial speed of sound among residents of urban areas in Turkey. Rheumatol Int. 2002; 22: 20–26.

Izuora K, Twombly JG, Whitford GM, Demertzis J, Pacifici R, Whyte MP. Skeletal fluorosis from brewed tea. J Clin Endocrinol Metab. 2011; 96: 2318–2324.

Jain AK, Kumar S. Bone and Joint day – India. Indian J Orthop. 2013; 47(5): 435–436.

Joshi VR, Mangat G, Balakrishnan C, Mittal G. Osteoporosis–approach in Indian scenario. J Assoc Physicians India. 1998; 46: 965–967.

Lin P, Ginty F, Appel L, et al. The DASH diet and sodium reduction improve markers of bone turnover and calcium metabolism in adults. J Nutr. 2001; 133: 3130–3136.

Lloyd T, Beck TJ, Lin HM, et al. Modifiable determinants of bone status in young women. Bone. 2002; 30: 416–421.

Lunt M, Masaryk P, Scheidt-Nave C, et al. The effects of lifestyle, dietary dairy intake and diabetes on bone density and vertebral deformity prevalence: the EVOS study. Osteoporos Int. 2001; 12: 688–698.

Makela M, Heliövaara M, Sievers K, Impivaara O, Knekt P, Aromaa A. Prevalence, determinants, and consequences of chronic neck pain in Finland. Am J Epidemiol. 1991; 134: 1356-1367.

Manolagas SC, O'Brien CA, Almeida M. The role of estrogen and androgen receptors in bone health and disease. Nature reviews Endocrinology. 2013; 9(12): 699-712.

Marwaha RK, Sripathy G. Vitamin D and Bone mineral density of healthy school children in northern India. Indian J Med Res 2008; 127: 239-244.

McGraw RL, Riggs JE. Osteoporosis, sedentary lifestyle, and increasing hip fractures: Pathogenic relationship or differential survival bias Calcified Tissue International. 1994; 55 (2): 87-89.

Melton 3rd LJ. The prevalence of osteoporosis: gender and racial comparison. Calcified tissue international, 2001; 69(4): 179-181.

Mitra S, Desai M, Ikram M. Association of estrogen receptor gene polymorphisims with bone mineral density in post menopausal Indian women. Mol Genet Metab. 2006; 87: 80–87.

NOS (National Osteoporosis Society) 2013. Vitamin D and bone health: a practical clinical guideline for patient management. Available at: http://www.nos.org.uk/document.doc?id=1352.

Patni R. Normal BMD values for Indian females aged 20-80 years. J MidLife Health. 2010; 1 :70–73.

Prince R, Devine A, Dick I, et al. The effects of calcium supplementation (milk powder or tablets) and exercise on bone mineral density in postmenopausal women. J Bone Miner Res. 1995; 10: 1068–1075.

Rao H, Rao N, Sharma LR. A clinical study of bone mineral density using heel ultra-densitometer in Southern Maharashtra. Indian J Orthop. 2003; 37: 9.

Rapuri PB, Gallagher JC, Kinyamu HK, Ryschon KL. Caffeine intake increases the rate of bone loss in elderly women and interacts with vitamin D receptor genotypes. Am J Clin Nutr. 2001; 74: 694–700.

Reid DM, New SA. Nutritional influences on bone mass. Proceed Nutr Soc. 1997; 56: 977–987.

Roodman GD, Windle JJ. Paget disease of bone. Journal of Clinical Investigation. 2005; 115(2): 200-208.

Sachan A, Gupta R, Das V, Agarwal A, Awasthi PK, Bhatia V. High prevalence of vitamin D deficiency among pregnant women and their newborns in northern India. Am J Clin Nutr 2005; 81: 1060-1064.

Sahu M, Bhatia V, Aggarwal A, Rawat V, Saxena P, Pandey A, Das V. Vitamin D deficiency in rural girls and pregnant women despite abundant sunshine in northern India. Clin Endocrinol (Oxf). 2009; 70: 680-684.

Shah SA, Patel PR. Prevalence of neck pain in computer operators. NHL Journal of Medical Sciences, 2015; 4 (1): 5-11.

Smeets-Goevaers CG, Lesusink GL, Papapoulos SE, Maartens LW, Keyzer JJ, Weerdenburg JP, et al. The prevalence of low bone mineral density in Dutch perimenopausal women: The Eindohoven perimenopausal osteoporosis study. Osteoporos Int. 1998; 8: 404–409.

Spiro A, Buttriss JL. Vitamin D: An overview of vitamin D status and intake in Europe. Nutrition Bulletin / Bnf. 2014; 39(4): 322-350.

Tárraga López PJ, López CF, de Mora FN, et al. Osteoporosis in patients with subclinical hypothyroidism treated with thyroid hormone. Clinical Cases in Mineral and Bone Metabolism. 2011; 8(3): 44-48.

Tenenhouse A, Joseph L, Kreiger N, Poliquin S, Murray TM, Blondeau L, et al. Estimation of the prevalence of low bone density in Canadian women and men using a population specific DXA reference standard: The Canadian multicentre osteoporosis study (CaMos) Osteoporos Int. 2000; 11: 897–904.

Teotia SPS, Teotia M, Jyoti Krishna. Vitamin D. In: Teotia SPS, Teotia M, editors. Nutritional and Metabolic Bone and Stone Disease: Asian Perspective, First Edition, New Delhi: CBS Publishers, 2008; 80-91.

Teotia SPS, Teotia M. Nutritional bone disease in Indian population. Indian J Med Res, 2008; 127: 219-228.

Teotia SPS, Teotia M. osteoporosis-A preventive breakthrough-National context. In: Pathak LA, editor. Postgraduate medicine. Mumbai:The Association of Physicians of India; 2004; 18: 302-312

Teotia SPS, Teotia M. Singh KP. Epidemiology of metabolic bone disease and clinically related disorders-India, 1963-2001. In: Thakur BB, Postgraduate medicine. Mumbai: The Association of Physicians of India; 2002; 501-514.

Thacher TD. Clarke BL. Vitamin D insufficiency. Mayo Clinic Proceedings. 2011; 86: 50–60.

Tiwari L, Puliyel JM. Vitamin D level in slum children of Delhi. Indian Pediatr 2004; 41: 1076-1077.

Tucker KL, Hannan MR, Chen H, Cupples LA, Wilson PWF, Kiel DP. Potassium, magnesium, and fruit and vegetable intakes are associated with greater bone mineral density in elderly men and women. Am J Clin Nutr. 1999; 69: 727–736.

Vu TT, Nguyen CK, Nguyen TL, Le BM, NguyenTrung Le D, Bui TN, et al. Determining the prevalence of osteoporosis and related factors using quantitative ultrasound in Vietnamese adult women. Am J Epidemiol. 2005; 161: 824–830.

Weinstein SL. 2000–2010: The Bone and Joint Decade. J Bone Joint Surg Am. 2000; 82: 1–3.

Xie Yanfei, Szeto Grace, Dai Jie. Prevalence and risk factors associated with musculoskeletal complaints among users of mobile handheld devices: A systematic review. Applied Ergonomics. 2017; 59: 132-142.