

Primary Prevention of Osteoporosis: Time to Redefine the Wheel?

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Abstract

Osteoporosis and fragility fracture is largely preventable. Impressive research and policy efforts now contribute to the promotion of optimal bone health during the growing years. There is also an increasing uptake of older people into bone health programs but the gap is unbridled, for there is, yet, no current evidence of concerted efforts towards the application of clearly defined, easily adaptable and widespread intervention for promoting bone health among the premenopausal age-groups. Since contemporary public health underscores population-applicable, lifestyle approaches to health promotion and disease prevention, this review puts into both physiological and public health perspectives, current guidelines for prevention of osteoporosis and suggests a paradigm change towards the appropriate consideration of primary prevention of osteoporosis in the population.

Keywords: Primary prevention; Osteoporosis; Premenopausal; Exercise; Bone health

Introduction

Osteoporosis, along with other slowly progressing chronic diseases, was in 2009 described by the United Nations Secretary General, Mr Ban Ki-moon as 'a global public health emergency in slow motion'[1]. According to Rose (1994), a widespread problem of the magnitude presented by osteoporosis must be addressed by a corresponding widespread intervention [2]. Apparently, current case finding strategies and disease risk profiling among post-menopausal adults may not suffice in the effort to curb the osteoporosis epidemic which silently evolves across the lifespan. Since, contemporary public health underscores population-applicable, lifestyle approaches to disease prevention [2]; a paradigm change towards concise, age-specific, easily adaptable and widespread interventions for promoting bone health among the non-postmenopausal population should be an imperative goal for policy makers, clinicians as well as researchers.

As with most diseased states, osteoporosis prevention may be founded on the consideration of its pathophysiology and the risk factors that aid the increasing incidence and prevalence of fragility fracture in the population. The preventative axiom suggests that a small risk exposure to a large number of people is likely to generate

many more disease cases than a high risk exposure to a small number of people [2]. Hence, a preventative strategy targeting only high-risk individuals may benefit these individuals, but the total burden of the disease within the population will be less affected [2]. Unfortunately, the trends in previous guidelines and advocacies for prevention, treatment and management of osteoporosis have largely targeted high-risk individuals [3]. As a result, whilst tremendous breakthrough has been achieved via therapeutic interventions to increase bone mass density as well as reduce the incidence of fragility fracture among osteoporotic populations, the global prevalence of osteoporosis has been less abated [4,5]. It, thus, appears that interpretation and implementation of significant bone health research findings have suffered incomplete translation into widespread preventative strategies for combating the incidence and prevalence of osteoporosis.

Current perspectives on bone health promotion in the context of the pathophysiology of osteoporosis and public health

Some guidelines for the prevention and management of osteoporosis have been rightly orientated towards nutrition and exercise-related lifestyle modifications across the lifespan [6-8]. However, the models of prevention from these guidelines have centred mostly on risk-based case finding strategies and pharmacological approaches to minimise loss of bone mineral and prevent fragility fracture among postmenopausal adults [8-10]. Hence, the plethora of research that has been carried out on the prevention and treatment of osteoporosis were predominantly among postmenopausal women [11-14].

The optimal time for positive intervention outcomes for bone health has been identified by Kannus et al. [15] and Karlsson et al. [16] as the period of growth during the pre-pubertal years. However there is yet no strong evidence for exclusive immunity against fracture

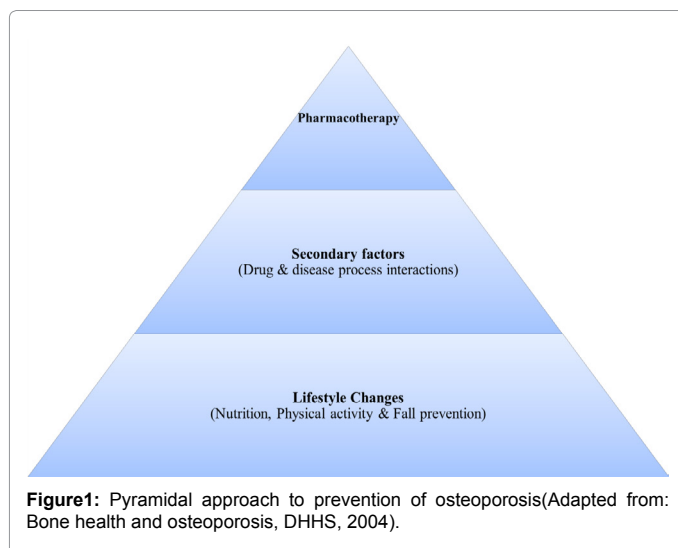


Figure1: Pyramidal approach to prevention of osteoporosis(Adapted from: Bone health and osteoporosis, DHHS, 2004).

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incidence as a result of exercise and adequate nutrition during growth, despite cessation of healthy lifestyle habits later in life [17]. Hence, seminal bone health researchers have advocated the continuous need for physical activity for optimal bone health across the lifespan [18-20]. This need for bone-loading physical throughout the life-cycle is further reflected in the pyramidal approach to the prevention of osteoporosis (Figure 1), in which lifestyle measures for maximising bone health (such as physical activity, nutrition, moderate alcohol intake, tobacco avoidance, and modifying the risk of falls forms the broad base of the prevention pyramid [21].

The report, on bone health and osteoporosis by the US surgeon general suggested lifestyle modifications as a first step in maximising bone health at every point in the life course of all individuals in the population [21]. This conventional model appears to be the most prominent guideline for the primary prevention of osteoporosis. Its proposition for maximising bone health at every point in the life course nevertheless, lack specificity to how osteoporosis prevention may be approached at each stage across the lifespan. An ideal model for enhancing bone health may be expected (on the basis of contemporary understanding of skeletal tissue morphology) to be all encompassing, yet population specific. Whilst the pyramidal approach to osteoporosis prevention [21] made some prescriptions for promoting bone health among children and post-menopausal adults, it lacked specific recommendations for the premenopausal age group, and as a result, defining bone health augmenting strategies for this population group may be an important step to bridge the gap in the knowledge base.

Apparently, various conventional guidelines and statutory bodies support early prevention of osteoporosis via peak bone mass maximisation strategies (during growth) in children and adolescence, as well as prevention of falls and fractures in older/postmenopausal population via exercise and lifestyle modifications [8,22]. For instance, the American College of Sports Medicine (ACSM) position stand on physical activity and bone health suggested mixed loading exercise programmes (impact exercise with high-magnitude resistance exercises) performed at least 3 days per week for 10-20 min (2 or more times per day) for augmenting bone mineral accrual in children and adolescents [22]. The authors also gave generic recommendations for components of exercise regimens that may be employed for minimising bone loss in adults. However, as a result of most of the guidelines being primarily aimed at pharmacological prevention of osteoporosis among post-menopausal adults, and the conventional failure to specify if the exercise-related recommendations for “adults” should be applied to premenopausal populations, the window of opportunity to promote bone health among premenopausal adult is often missed.

Furthermore, there has been evidence that premenopausal and postmenopausal bones respond differently to the same exercise intervention [13,14,23]. The proffering of exercise and lifestyle recommendations by guidelines, research/opinion papers and advocacy messages without definite prescriptions on how the frequency, and/or duration of these types of exercises could be varied to bring about optimal bone health across different “adult” age groups (i.e. pre- and post-menopausal) may well be an exercise in futility for one or the other [8,10]. On the assumption that the children and post-menopausal bone health recommendations are accurate and being realised, the optimal bone health gap between healthy child/adolescent years and the postmenopausal years becomes precariously widened. The result is evident in the defiant prevalence of the osteoporosis epidemic across populations [4,5].

The current lack of specificity for osteoporosis preventative

strategies among premenopausal adults may have been due to the dearth of exercise-related interventions that are aimed at primary prevention of osteoporosis especially among young adults [24]. Until recently, exercise-mediated efforts on bone health promotion and osteoporosis prevention strategies have not been focused on premenopausal women due to perceived quiescent physiology of skeletal material at this stage of life. However, the absence of considerable exposure to osteoporosis risk factors post achievement of peak bone mass makes the premenopausal women population an appropriate target for primary prevention of osteoporosis. At this stage, public health policy and health promotion strategies may be employed to prevent the emergence or development of risk factors among this generally “unexposed” population.

The paradigm shift: primary vs. secondary prevention of osteoporosis

Founded on the existence of the natural history of diseases on a continuum, with health at one end and advanced disease at the other; the Leavell and Clark [25] prevention model, delineates levels of application of preventative measures for promoting health and arresting the disease process at different points along the time course of the disease. Based on the natural history of osteoporosis, and the results of seminal investigations on exercise and mature bones [26,27], which evidenced the efficacy of lifestyle exercise for enhancing bone health of premenopausal women, a practical life course approach to prevention of osteoporosis is, therefore, proposed and illustrated in Figure 2.

This four-level model proposes a primordial, primary, secondary and tertiary prevention levels for osteoporosis. In the primordial osteoporosis prevention stage, the goal of prevention is to maximise peak bone mass and the targets are the population in the growing years (neonates to adolescence). For instance, integration of physical education classes into the primary and secondary schools’ curriculum are educational policies for discouraging sedentary life styles early in life, hence reinforcing the nature-enhanced functional adaptation of immature bone to mechanical loading. Presently, robust secondary prevention of osteoporosis involving the identification of ‘at risk’ individuals and routine BMD testing for over 65 year olds appears to have been established [3]. On the other hand, tertiary prevention, which usually goes paripassu with management of osteoporosis as a chronic condition, offers little help for reduction of the disease burden that may be attributed to osteoporosis. Tertiary prevention does, however, aim to reduce or limit impairment and disabilities, minimise the suffering emanating from compromised bone health status and supports the patient’s adjustment to inherent conditions.

The caveat is that these forms of prevention (secondary and

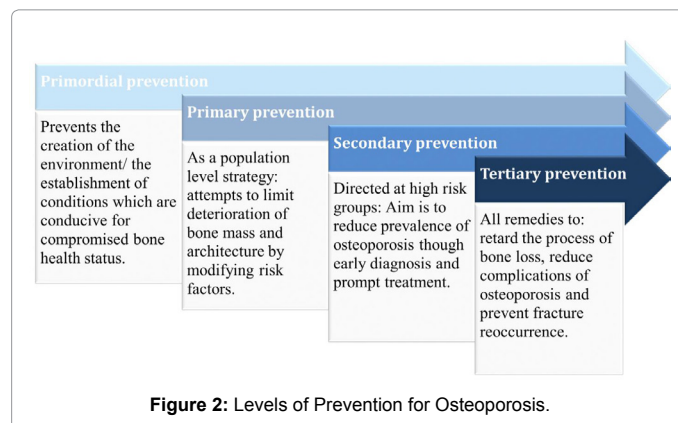


Figure 2: Levels of Prevention for Osteoporosis.

tertiary) are usually more expensive and less effective than the primary and primordial prevention stages. To corroborate this notion, Kohrt et al. [28] highlighted in their review that, the large 9-15% increases in BMC and BMD sequel to pharmacology therapy have at best resulted in 7-21% increases in fracture resistance. In contrast, the relatively small 5-7% increases in BMC and BMD in response to mechanical loading (even in the mature and senescent skeleton) may be potentially translated to very large increases (64% to 94%) in bone strength and resistance to fracture [27]. Policy makers, clinicians and researchers may hence concentrate additional efforts on the institution of robust primary and primordial osteoporosis prevention strategies.

Primary prevention of osteoporosis may be considered as any preventive actions to enhance bone health prior to the rapid onset of bone loss and/or deterioration of bone mass architecture. It is known that a chronic disease will never progress to its clinical stages in an individual if addressed early. Given that, the main aim of primary prevention is to modify or alter the course of risk exposure, the biological plausibility of current conventional approach to prevention of osteoporosis may not be fully justified. For bone health promotion purposes, premenopausal women should hence, be rightly perceived as the large proportion of the population with a small risk exposure but with the potential to generate many osteoporosis cases in the near future. The premise for the present model which proposes concise osteoporosis prevention among currently healthy premenopausal women is the reduction in the propensity for bone health compromise to the eventual point of fragility fracture in future. It is thought that targeting of primary prevention with the aid of lifestyle exercise will favourably impact the disease process such that the hypothetical 3-5% gains [26,29] in bone mass during the premenopausal years would consolidate the gains in bone health promotion efforts during the children/adolescent stage and hence delay the time before the fracture threshold range is reached later in the postmenopausal years.

The proposed approach may be applied, on individual and public health bases, to individuals defined by significant risk or presence of compromised bone health status as well as persons who will benefit from bone health promotion and osteoporosis prevention initiatives. As in the pyramidal approach to prevention of osteoporosis, the greater each individual's commitment to engagement in tailored health promotion systems during the pre-pathogenic stages of the disease continuum (Figure 2), the longer it takes for them to reach the end stage of the continuum (if at all).

Conclusion

Disease prevention is cost effective as it eliminates the need for the high cost implications (both human and financial) of diagnostic testing and therapy [30]. Current case finding strategies and disease risk profiling among post-menopausal adults should be rightly considered as secondary prevention of fragility fractures. The window of opportunity for optimal bone health during the premenopausal years needs to be maximised. Research, guidelines and policy efforts may now be rightly orientated towards primary prevention of osteoporosis among pre-menopausal adults as well as primordial prevention in neonates through adolescence. Incorporation of prototypes of feasible and specified lifestyle exercise prescriptions into population-based prevention strategies among the premenopausal age group may potentially address the economic health challenges of quality and costs, as well as reduce health burden associated with the incidence and prevalence of osteoporosis.

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