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RESEARCH ARTICLE

ASSESSMENT OF BONE HEALTH OF YOUNG FEMALE ADULTS AND IMPACT OF INTERVENTION

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ABSTRACT

Objectives: Identification of osteopenia and osteoporosis in young female adults and to assess the effect of intervention programme.

Materials and Methods: Target population was young female adults (N=500) taken from five private ladies hostels located at urban area of North Coimbatore, Tamilnadu, India. The Bone mineral density were measured and classified as either normal or osteopenia / osteoporosis. Out of 500 assessed, 193 were osteopenic and 51 were osteoporotic from which 50 subjects were selected at random for the further study. A schedule was formulated to collect details on socio demographic profile, diet and lifestyle pattern. Assessment of nutritional status through anthropometry, bio chemical estimation and clinical examination was done. Nutrition education was given to subjects (n=50) who fell below desirable level of bone mass. Due to practical difficulties after four months of regular follow up post assessment of BMD by QUS was carried out in only in twenty subjects and impact was found out.

Results and Discussion: The mean height of the subjects varies from 150.93±6.40 cm to 152.32±5.92 cm lower than the standard value suggested by NCHS (2008). The mean weight of the subjects ranged from 50.78±7.71 kg to 52.40±7.77 against the standard value of 54.4 kg. Based on weight 5.45%, 13.8% and 77.4% of the subjects were obese, overweight and normal respectively when compared with standard value. Though biochemical parameters were normal a deficit in the intake of nutrients namely energy, protein, calcium and iron were seen. They are physically inactive with inadequate sunlight exposure. The intervention for four months helped to improve the bone mass.

INTRODUCTION

Optimal health is becoming a daunting challenge to the young adults due to inappropriate high fat, fast food diet, aggressive stressful personalities worsened by work-life imbalances that drive them into chronic ailments all over the world. Modern science through improved sanitation, vaccination, antibiotics and medical attention has eliminated the threat of death from most infectious diseases which means that threat from lifestyle diseases like osteoporosis, diabetes, heart disease and cancer are now the primary causes of concern. With a population of 1.14 billion people, more than 200 million youth aged 15-24 years represent 21% of India's total population. The World Health Organization (WHO, 2004) has identified India as one of the nations that is going to have most of the lifestyle disorders in the near future. Nowadays, not only are lifestyle disorders becoming more common, but they are also affecting younger population. Hence, the population at risk shifts from 40+ to maybe 30+ or even younger. Among the lifestyle diseases, osteoporosis is a growing health problem recognized in both developed and developing countries associated with substantial morbidity and socio-economic burden worldwide. Bone Mineral Density (BMD) at all the skeletal sites in Indian women are much lower than values reported from developed countries, with a high prevalence of osteopenia and osteoporosis thought to be due to inadequate nutrition and faulty lifestyle practices. The causes of osteoporosis include controllable and uncontrollable risk factors. The uncontrollable risk factors are gender, family history, ethnicity and race, advancing age, postmenopausal status and body frame size. Controllable risk factors include low activity level, sedentary lifestyles over many years, smoking, alcohol abuse and inadequate diet including eating disorders, low calcium intake and low Vitamin D intake. Excessive consumption of soft drinks and caffeinated drinks cause calcium loss through the kidney and it affects bone health (National Osteoporosis Foundation, 2011). Taking care of controllable risk factors of healthy lifestyle (diet, exercise and sunlight exposure) can have a major positive impact on the bone metabolism and bone health of Indians. The peak bone mass of the population can be increased significantly by appropriate and timely intervention at a young age. Health care system in India must assume the responsibility of not only treating the people but also help in identifying this problem at an early age to institute preventive strategies to delay the onset or prevention of this disease thus related morbidity and mortality in older life can be reduced. A cost effective viable approach to bring necessary changes in behavior for adoption of healthy lifestyle practices is customized nutrition education. There are only limited Indian

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studies on status of bone health in an apparently healthy young adult population. Hence, the present work "Assessment of Bone Health of Young Female Adults and Impact of Intervention" was undertaken.

MATERIALS AND METHODS

Phase I: Primary Assessment N=500

Target population was young adults (N=500) taken from five private ladies hostels located at urban area of North Coimbatore. The objectives and purpose of the research was well communicated to the study participants and the written consent was obtained before the conduct of the study. The procedures used in this study were approved by the Research Ethics Committee for Nutrition Departments of PSG College of Arts and Science, Coimbatore. The bone density of all the participants was measured by Quantitative Ultrasound with the help of well trained technicians.

Phase II: Detailed Assessment of Vulnerable Group (Secondary Screening n=50)

Among the 500 selected for the study based on Bone Mineral Density values, 50 subjects those with either osteopenic or osteoporotic were taken for further investigations and intervention. A schedule was formulated to collect details comprising of socio demographic profile and diet and lifestyle pattern. Assessment of nutritional status through anthropometry (height, weight and waist hip ratio), bio chemical estimation (hemoglobin, calcium, alkaline phosphatase and protein) and clinical examination was done and recorded in the schedule. Other information related to bone health such as medical history of the parents, age of menarche and problems associated with menstrual cycles were also collected.

Phase III: Preparation of Educational Models and Imparting Nutrition Education

Nutrition education should be practical and suit the socio economic conditions, food habits and local food resources. A combination of strategies conducive to health and well-being were used to facilitate change in nutrition and lifestyle related behaviors. Nutrition education was given to subjects (n=50) who fell below desirable level of bone mass after BMD assessment. Through nutrition education the importance of diet, physical activity on bone health was inculcated by lecture cum discussion supported with power point presentation and through demonstration of exercises that strengthen muscle and bone by fitness expert. Besides this pamphlets and CD's were distributed to the subjects.

Phase IV: Post Assessment of Bone Mineral Density (n=20)

About fifty subjects out of a total of 244 with defective bone mass were selected at random for intervention. Due to practical difficulties after four months of regular follow up post assessment of BMD by QUS was carried out in only in twenty subjects and impact was found out.

Phase V: Analysis and Interpretation of Data

Information got through BMD scores, nutrition and dietary assessment was consolidated and statistically analyzed to arrive at meaningful conclusion using the Statistical Package for the Social Sciences (SPSS) statistical software. Mean and standard deviations (M ± SD) were computed for each variable under analysis. Paired't' test were used to find out statistical significance pre and post assessment.

RESULTS AND DISCUSSION

Measurement of Bone Mineral Density

The bone mineral density of the subjects was assessed by Lunar Achilles+ 11499 and the results based on T score are revealed in Table 1.

Table 1. Bone mineral density (T Score) of the subjects

T score	Condition	No. of subjects	Percentage
>-3.5	Severe Osteoporotic	0	0
-2.6 to -3.4	Osteoporosis	51	10.2
-0.1 to -2.5	Osteopenia	193	38.6
0	100% Healthy	9	1.8
-0.9 to 0.1 and above	Normal	247	49.4

The data reflects nearly half of the study population have not accumulated adequate bone mass. This could be due to such factors like physical inactivity, low calcium and Vitamin D intake, lifestyle and faulty diet habit heralding the early onset of bone disorders. Among the population assessed, 244 subjects were either osteopenic or osteoporotic from which 50 subjects were selected at random for the further detailed study.

Social history of the Intervention Subjects

The socio economic details were obtained from them with regard to age and family educational status. About 39 of them are in the age group of 18-20 years and rest of them between 21-22 years. Regarding education level of the parents in the current study the majority of the subject's parents had completed their post-graduation while 10% of their parents had education up to the higher secondary level. Based on HUDCO income classification (2007), it was found that most of the families (71.4%) belong to high income while only few (10.6%) are in low income group.

Anthropometric measurements

Height and weight

The mean height of the subjects varies from 150.93±6.40 cm to 152.32±5.92 cm, being lower than the standard value of 164 cm suggested by NCHS (2008). The mean weight of the subjects ranged from 50.78±7.71 kg to 52.40±7.77 also found to be lower than the NCHS (2008) standard value of 54.4 kg. It can be inferred that mean height and weight of all age groups was lower than the reference range.

Waist Hip Ratio

As osteoporosis is influenced by nutritional status (Prentice 1997), waist hip ratio being simple anthropometry, this was also used in the screening schedule for osteoporosis/osteopenia and the results were compared to the reference value (WHO, 2004). About 68% have an ideal ratio (0.8), whereas it was high (> 0.9) and low (< 0.79) in 6% and 16% respectively.

Bio – Chemical Assessment

Hemoglobin and protein measurements are the commonly estimated parameters in nutritional status assessment studies. Biochemical bone markers of bone turnover like serum calcium and alkaline phosphatase provide information on the diagnosis and monitoring of bone disease hence, they are dynamic measures of bone remodeling and are useful in predicting the course of change in bone. Hence hemoglobin (Cyanmethemoglobin method, 1985), protein (Biuret Method, 1996), serum calcium (O-Cresolphthalein Complexone, OCPC method 1994) and alkaline phosphatase (King and King's method, 1976) were estimated in all the 50 subjects.

Table 2. Estimation of Biochemical parameters in the subjects

Parameters	Mean	Standard range
Hemoglobin	12.3 g/dl ±0.76	12-15.6 g/dl
Calcium	9.1 mg/dl ±0.41	8.5-10.5 mg/dl
Alkaline phosphatase	97.8 IU/L ±18.11	36.0-120.0 IU/L
Protein	7.4 gm/ dl ±0.51	6.0-8.0 gm/ dl

Though the prevalence of anaemia in young women is high in India, in this study population hemoglobin level is in the desirable range. Reddy *et al.,* (2009) on assessment of bone densities in healthy youth found no significant differences in bone related biochemical parameters such as serum calcium, phosphorous, alkaline phosphatase among men and women with varying levels of bone mineral density. The present study supports this observation with regard to calcium and alkaline phosphatase.

Clinical Signs and Medical history

The information collected on this is presented and discussed below:

Table 3. Clinical Signs and Medical history

Type of faulty posture		
Criteria	No of Subjects	Percentage
Stooped posture	2	4
Curved upper back	12	24
Bowed legs	0	0
Absence of sign	36	72
Other information that impact bone health		
Weight loss	13	26
Lactose intolerance	1	2
Joint pain	22	44
Low back pain	21	42
Age of menarche		
11-13 years	23	46.0
14-16 years	27	54.0
Problems associated with menstrual cycle		
Prolong menstrual cycle	1	2
Delayed menstrual cycle	2	4
Over bleeding	1	2
Irregular menstrual cycle	2	4
Regular Menstrual cycle	44	88
Medical history of family members		
Fracture/ Bone disorders	11	22
Diabetes	11	22
Thyroid abnormalities	5	10
Obesity	5	10
PCOD/ Menstrual irregular	2	4
Absence	16	32

Stooped posture and curved upper back was noticed in two subjects and twelve has which could be the result of low bone mass accumulation. About 1/4th of the subject (26%) participants had weight changes and this might have influenced their bone mineral density. Out of 50 subjects, one subject is reported to have lactose intolerance. Gaber *et al.* (2002) in a study of Bone density revealed that chronic low back pain patients have an increased incidence of osteopenia and osteoporosis in those aged 40 years. About 86% of the subjects with low bone mass had joint pain & low back pain and the results are consistent with that in literature that inadequate bone mass may predispose to such discomforts. Age at menarche was independent in respect to the occurrence of osteopenia / osteoporosis among the study participants. Among the selected subjects 88% of the subjects had regular menstrual cycle while the rest had menstrual dysfunction. Though family fracture history is not a sensitive specific predictor of BMD but it does to some extent influence the bone mineral density of the family members and at least one fracture in the family members of 11 subjects was reported.

Dietary Pattern

Dietary habits

Information related to dietary habits, eating disorders, intake of dairy foods and nutrient intake were recorded and given in the following Tables.

Table 4. Dietary Habits

Criteria	No. of subjects	Percentage
Diet Type		
Non -vegetarian	33	66.0
Vegetarian	17	34.0
Eating Disorders		
Anorexia nervosa	4	8.0
binge eating	4	8.0
Bulimia nervosa	1	2.0
No eating disorder	41	82
Intake of dairy foods		
Milk	4	8
Coffee / Tea	38	76
Curd	10	20

Whether vegetarian diets confer benefit or harm to bone health is a contentious issue. Though the association between vegetarian and bone mineral density is controversial because of conflicting findings from research studies. In the present study, among 50 subjects, 33 (66%) with osteopenia/ osteoporosis are non-vegetarians. Eating disorders like anorexia nervosa, binge eating and bulimia nervosa are present among few of the subjects. Milk is consumed by only four of the subjects, whereas 38 of the subjects have coffee/tea while Curd was included daily in the diet by only 10 of the subjects. Coffee and tea though has milk are not beneficial to the bone as it has components like caffeine and tannins. The low consumption of milk and curd observed in the study may have contributed to low bone density.

Nutrient Intake

Through 24 hour food recall the food intake was quantified from which nutrient intake was calculated using Nutritive Value of Indian Foods by Gopalan *et al*. (2000) and Dr. Mohan's Atlas of Indian foods (2013) and presented in Table 5. Among the many factors that influence the bone protein has

Table 5. Mean Nutrient Intake of the Subjects

S. No.	Nutrients	*RDA	Mean intake	Percentage surplus / deficient
1	Energy(kcal)	2320	1078±300.8	-1242
2	Protein(g)	60	36.9±27.0	-23.1
3	Fat (g)	30	31.1±14.8	1.1
4	Calcium(mg)	600	478±102.1	-122
5	Iron(mg)	17	11.1±3.0	-5.9

*source ICMR 2010

been identified as detrimental and beneficial to the bone, depending upon a variety of factors, including level of protein, the protein source, calcium intake and acid base balance of the diet. The diet of the respondents had protein which is much below the recommended allowance. Regarding calcium the level in the di*et al*ong with the source, type and amount of protein are crucial in bone mass accumulation. The average calcium intake of the subjects was much below the recommended daily allowances. Though the association between dietary iron with bone mineral density is less studied, it has been established that iron is an important mineral for all cells including osteoblasts, which are involved in bone formation. So dietary iron may be an important in bone mineralization than originally thought and its combined effect with calcium on bone mineral density warrants exploration. In this study dietary calcium and iron was low when compared with RDA of the ICMR (2000).

Lifestyle pattern

Lifestyle approaches such as proper diet, adequate Vitamin D and regular activity will help to build and maintain bone mass throughout life and contribute to overall health and vitality. Information on regularity in exercise and sunlight exposure was collected and discussed as follows:

Physical activity

Exercise must be regular and ongoing to have a proper benefit. Among 50 subjects only 6 of them are doing regular exercise in spite of which they have weak bones which could be to other factors like hypovitaminosis D, inadequate bone building nutrients in the diet and intake of foods that have negative association with bone. Thirteen subjects are not regular in doing exercise while 31 did not indulge in any form of exercise. In general to hasten bone development process exercise should be made a daily habit.

Sunlight exposure

Vitamin D helps in the growth, development and maintenance of strong and healthy bones. Low Vitamin D status is becoming common even in a tropical country like ours which can be a contributory factor to the development of osteoporosis and osteomalacia / rickets in younger age group. Lack of sun exposure is widely accepted as the primary cause of epidemic low vitamin D status worldwide. Among the study population majority of them are not getting exposed to adequate sunlight. The exposure to sunlight is during the time when they move from the hostel to the university and vice versa. In most of the respondents the average exposure per week is only 67.5 minutes.

Pre and Post Assessment of the Subjects (n=20)

As many risk factors are modifiable such as calcium intake and physical activity, through intervention desirable changes in behavior was brought and the effect of the same is given in Table 6.

Table 6. Pre and Post Assessment of the Subjects

Criteria		Mean ±SD		Mean Difference	Between Groups	't' Value
		Initial (I)	Final (F)			
Height		152.83±5.9	152±6.7	0.83	I vs F	0.14
Weight		53.89±6.7	53.19±6.3	0.70	I vs F	0.16
BMD	Osteopenia	-1.96±0.3	-1.20±0.8	0.76	I vs F	3.275**
	Osteoporosis	-2.77±0.1	-1.74±0.5	1.03	I vs F	4.606**

*p<=0.05, **p<=0.01

Regarding height and weight the mean difference obtained was statistically insignificant implying that it these didn't change much pre and post intervention. Stear *et al.,* (2003) studied whether increases in calcium intake and physical activity effectively increase the bone mineral status of adolescent girls aged 16-18 years. DEXA of the whole body, spine, forearm and hip was performed before and after intervention. They concluded that calcium supplementation and exercise enhanced bone mineral status. The result of the above study corroborates with the findings of this study as there is statistically significant difference before and after the intervention. Diet modification and physical activity can be used as a effective strategy for maximizing bone mass.

Conclusion

About 50% of the study population had either osteopenia and osteoporosis and education proved to be an efficient strategy to bring about significant improvement in the bone status. Education helped to modify the lifestyle in terms of nutrition and outdoor physical activity as they are the key determinants of bone health. It can be concluded that adaptation of healthy lifestyle practices right from young age will help to ward of diseases and keep them physically fit and morally strong.

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