Medical Study Department

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Impact of Nutritional Status, Serum Calcium and Physical Activity on Bone Mass in Early Adolescence

Thesis Submitted For Fulfillment
For Ph D. Degree in Childhood Studies

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2011

ACKNOWLEDGEMENT

First I want to thank Allah who helped me so much till I finished my work.

I m deeply thankful to ***Prof. Dr. Salah Eldin Mostafa,*** Prof. of Public Health, Institute of Postgraduate Childhood Studies, Ain Shams University

I am very thankful to ***Prof. Dr. Ahmed El-Kahky***, Prof. of Physical Therapy, Institute of Postgraduate Childhood Studies, Ain Shams University. His assistance and guidance were very useful for me.

I like also to express my gratitude to ***Prof. Dr. Mona El-Tobgui***, Prof. of Child Health, Child Health Department, National Research center, who helped me to finish my research.

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LIST OF ABBREVIATIONS

Abbreviation	Word
AIs:	Adequate Intakes
BMI:	Body mass index
BA:	Bone Area
BMC:	Bone Mineral Content
BMD:	Bone Mineral Density
CAPMAS:	Central agency for Public Mobilization and Statistics
CDC:	Central Diseases Control
DRI:	Dietary Reference Intake
DXA:	X-ray absorptiometry
EARs:	Estimated Average Requirements
FAO:	Food and Agriculture Organization
H/A:	Height for age
Ht:	Height
PTH:	Parthormone
RDA:	Recommended Daily Dietary Allowances
RNI:	Reference Nutrient Intake
SD:	Standard deviation
SE:	Standard Errors
ULs :	Upper Intake Levels
W/A :	Weight for age

W/H:	Weight for height
WHO:	World Health Organization
Wt:	Weight
Y:	Years

Impact of Nutritional Status, Serum Calcium and Physical Activity on Bone Mass in Early Adolescence

ABSTRACT

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Background: Osteoporosis is a major health problem that its roots begins from childhood and adolescence were peak bone accumulation takes place.

Methodology: A prospective study aimed to identify the association between bone mass including bone mineral density (BMD) with dietary intakes of calcium and phosphorus and physical activities among early adolescent boys and girls. There was a follow-up in the period between April 2008 and October 2008. Data were collected at Hoda Sharawi preparatory school for girls and Giza preparatory school for boys. The data collection included questionnaire from subjects regarding social, nutritional status, physical status, anthropometric measurements including weight, height, arm circumference and bone mineral density. The subjects were collected randomly among boys and girls between 11-16 years of age and the study ended up with 100 boys and 100 girls who continued with the study.

Results: The comparison between average nutrient intakes and (RDA) in boys and girls showed differences either higher or lower in boys calories (2231 vs. 2500 in RDA), carbohydrate (311.17 vs. 344 in RDA), fat (84.29 vs. 92 I RDA) and calcium (705.08 vs. 1200 in RDA) while proteins (57.12 vs. were higher than 45.00 in RDA), in girls fat (80.86 vs. 84 in RDA) and calcium (624.47 vs. 1200 in RDA) while proteins (55.15 vs. were higher than 46.00 in RDA) comparison between boys and girls in average nutrient intakes showed differences in most of the nutrients. There was a higher level of physical activities in boys than girls. The correlation between (BMD), calcium intake, anthropometric measurements and physical activity showed a week correlation between (BMD) and daily calcium and a positive correlation with physical exercise (p-value in boys = 0.002 and in girls = 0.003), while no correlation with daily calcium intake in girls.

Conclusion: The study revealed a significant difference between anthropometric readings in pre and post study readings in both boys and girls but not (BMD).

Key words: Bone mineral density (BMD), Recommended daily allowances (RDA), Body mass index (BMI), Nutrient intakes (NI).

Introduction

Introduction

Adolescence is a period of rapid skeletal growth period in which nearly half of the adult skeleton is produced.

It has been suggested that 50% of the maximal peak bone mass is accumulated during puberty in normal people who have adequate intakes of calcium, vitamin D and other macro and micronutrients, however, some data suggest that bone accumulation early in life has little impact on adult bone density because the juvenile bone is largely replaced through growth.

If this concept generalizes, then intervention to maximize peak bone mass could be directed at adolescents rather than young children (Weaver, 2002).

Osteoporotic fractures are major public health problem in both males and females. Bone density is one of the major predictors of these osteoporotic fractures, and result of the amount of bone gained in the early life (Peak bone mass) and subsequent bone loss. There is evidence to suggest that physical activity and to a lesser extent diet (particularly calcium) during adolescence are determinants of Peak bone mass. It seem likely that the vast majority of adult bone mass is attained before the age 14 years (Sabatier, et al., 1996).

The roots of Osteoporosis lie in childhood, as much bone is laid down during puberty as is last in all later life (Brown, 2003).

Gender differences in bone mass in children are currently controversial. Most studies report higher femoral bone mass in boys, and higher spiral bone mass in girls, whereas other reported no differences (Nelson, et al., 1994).

It has been hypothesized that this may be explored by size differences, as a real bone mass only partially estimates true bone mass. However, studies of volumetric bone mass have reported gender differences at the hip while eliminating an apparent age on size effect, Suggesting that other factors, especially the effect of physical activity in different populations, may contribute to gender differences. (Lu, et al., 2001).

Aim of the work

Aim of the Study

The purpose of the study was to assess and prove the association between bone mass including bone mineral density (BMD), with dietary intakes of calcium and phosphorus and physical activities among early adolescents.

Hypothesis

Adolescents with adequate intakes of calcium and practicing physical activities regularly will have higher bone mineral density.

Review of Literature

REVIEW OF LITERATURE

Bone mass is the result of a life long balance between the process of bone formation and resorption in the adult. Skeleton bone remodeling is the fundamental physiologic mechanism that allows repair of injuries such as fractures, renewal of aging bone tissue and rearrangement of skeletal architecture to maximize its flexibility to stress and resistance to load. Most metabolic bone diseases including osteoporosis are the consequence of an imbalanced bone remodeling. Awareness of osteoporosis and its complications is growing, as the use of treatments that favorably alter the natural history of the disorder. There is thus increasing reasons to develop strategies for screening in order to target treatment more effectively and reduce the number of fracture, particularly in postmenopausal women. (Osteoporosis, 2000)

Osteoporosis is a major health problem. It is a disease of progressive bone loss associated with an increased risk of fractures. The disease often develops unnoticed over many years, with no symptoms or signs , until fractures occur.

The strength of bone depends on their mass and density. Bone density depends in part on the amount of calcium, phosphorus and other minerals. When bones contain less mineral, their strength is decreased and they lose their internal supporting structure (Osteoporosis, 2000). The peak bone mass is reached in mid of third decade (25 years). After that bone remodeling continues. However bone loss is slightly more than bone gain, about 0.3% to 0.5% a year. Not getting enough vitamin D and calcium in the diet can accelerate the process (Mayo foundation, 2001).

Bone growth during childhood and adolescence is as important as bone loss in the developed osteoporosis. Bone grow in size and strength during childhood. The degree of bone mass attained helps determining skeletal health throughout life. The more bone mass is gained at adolescence, the more protection is secured later in life against bone density loss (Osteoporosis, 2000). Poor nutrition, including low calcium diet, low body weight and a sedentary life style have been linked to osteoporosis as well as cigarette smoking and excessive alcohol use.

It has been also found that fractures result from osteoporosis are about twice as common in women as in men. This is due to decreased estrogen level which accelerates bone loss to about 1-3%per year. Also malabsorption and long term medication as corticosteroids, thyroid hormones, diuretics that cause excretion of calcium, heparin, methotrexate and some anti seizer medications can cause bone loss.

Therefore screening tests for early detection of osteoporosis should be done and measures that can prevent and reduce the risk of osteoporosis should be adopted. Good nutrition with adequate calcium and vitamin D, limitatation of smoking, caffeine and alcohol, hormonal replacement therapy for women and exercise that help building strong bone and slowing bone loss are important preventive measures (Kanis et al., 1997).

Back ground

Epidemiology of osteoporosis:

Prevalence of osteoporosis in different regions of the world mostly relate to hip fracture, it is estimated that about 1.7 million hip fractures occurred worldwide in 1990 (cooper et al.,1992). These were not distributed uniformly, incidence rates are higher in women than men. The sex differences are partly explained by the heritability of skeletal size, men have greater bone mass and lower fracture rates than women (Melton, 1991).

Differences in bone mass might also relate to pattern of diet and exercise. A positive result of calcium supplementation on bone mass was recently demonstrated in elderly women with low calcium intake (Chevalley, 1992).

Similarly, a protective effect of exercise has been proposed to explain the lower prevalence of osteoporosis among women of Asian and African heritage (Melton, 1991). Clinical trials do suggest that exercise programmes can preserve bone mass (Gleeson, 1990).

Studies in developing countries are few, but diet with low calcium intake or increased protein and alcohol intakes may have adverse effects on bone density. Studies from India clearly show that osteoporosis occurs in population groups consuming low calcium traditional vegetarian diets and living in areas where drinking water contains high concentrations of natural fluorides. Unlike the osteoporosis of the geriatric population in affluent societies, the type of osteoporosis in the developing countries affects cortical bone throughout the body, and is found in younger age groups.

Considerable epidemiologic data have been accumulated seeking to evaluate the relation between calcium intake and bone density. Peak bone mass, that is attained during adolescence, young adulthood can be maximized by raising calcium intake to the adequate intake levels recommended by the 1997 food and nutrition board.

Higher calcium intakes have been related to higher bone mass in children, young adults, and post-menopausal women in 64 out of 86 observational epidemiologic studies (Heaney, 2000). However in most studies, the benefit of added calcium on bone mass disappears when supplementation is halted, although one trial showed a persistent benefit persisting after 3-4 years. These data suggest that adequate calcium intake needs to be maintained throughout childhood, adolescence and young adulthood to have a lasting impact on peak bone mass.

In post menopausal women, reviews of over 20 studies concluded that calcium supplementation can decrease bone loss by ~ 1% per year (Nordin, 1997). In a follow up analysis of 13 trials, calcium induced significant mean gains (or slowed loss) of 0.6% at the forearm, 3% at the spine and 2.6% at the femoral neck (Mackerras and Lumley, 1997). A more recent follow up analysis found that in 15 trials, calcium changes were 1.66% at the lumber spine and 1.64% at the hip (Shea, et al., 2002). Therefore calcium supplementation has been shown to be effective in retarding bone in postmenopausal women. The beneficial effect of calcium intake on bone mass in postmenopausal women may be modified by factors including age, number of years since menopause, baseline calcium intake before supplementation, and possibly physical activity levels. In addition, the effect of calcium may be greater at the sites with more cortical bone (HOSC, et al., 2004), in elderly and late post menopausal women, and in women with low baseline calcium intakes. In large enough doses calcium can reduce the higher PTH levels and lower the rate of bone remodeling (Mckane, et al., 1996).

Phosphorus intakes doesn't seem to influence skeletal homeostasis within normal ranges of intake (RDA 700 mg/day), although through excessive intakes particularly when combined with low calcium intake may be deleterious (Calvo, et al., 1990). Alternatively, adequate phosphorus intake is essential for bone building during growth and low serum phosphate will limit bone formation and mineralization (Heaney, 2004). Foods that are high in phosphorus are milk, milk products poultry, fish, meat, eggs, grains and legumes. High phosphorus intakes with low calcium may lead to secondary hyper parathyroidism and bone loss. A diet adequate in calcium, moderate protein and sufficient phosphorus was associated with higher bone density *(whiting, et al., 2002).*

Phosphous deficiency may be a marker of general nutritional inadequacy and in that regard could lead to an increased risk of fracture. At any age, the ratio of phosphorus to calcium is probably more important than the intake of phosphorus alone *(Shapiro and Heaney, 2003).*

Prevalence of osteoporosis among adults, and adolescents in Egypt is still unknown. A study done by Makhlouf 1997, showed a proportion of 21.7% in women and 18.6% in men among a group of senile hospitalized individuals. A national survey was done by the national nutrition institute for assessment of the nutritional status of 4876 elderly in 2001 (Hassan, et al., 2001), chows that prevalence of osteoporosis was 5.8% among the total sample of men and women 56 years and more. It was more among males than females.

Bone density remodeling and determinant factors

There are major factors that can lead to osteoporosis. A full cycle of bone remodeling takes, about 2-3 months in young age. After skeletal growth is completed, bone continuously undergoes remodeling to maintain calcium concentration in extracellular fluids, and to repair microscopic fractures that occur over time. The process is initiated by the release of interleukin -1 and other cytokines by bone – lining cells. These lead to activation of preosteoblasts which undergo differentiation into mature osteoblasts at bone surface. Excavation of bone surface starts to be followed by secretion of collagenous matrix by osteoblasts. In a few days, salts of calcium and phosphates precipitate into crystals of hydroxy appatite *(Anderson, 2000)*.

Hormones affecting bone cells:

- Parathormone acts directly on osteoblasts, which increase the production of interleukin – 6 and other cytokines that in turn stimulate osteoclasts to resorb bone.

- Estrogen: helps to block the production of PTH-stimulated interleukin -6 and other cytokines.

- Calcitonin: directly inhibits osteoclast activity (resorption). Impaired production of this hormone. could occur in the elderly which could contribute to age – related bone loss, but no data support this possibility (Anderson, 2000).

<u>Assessment of bone mass</u>

A number of techniques may be used to assess the risk of fracture. In general, they fall into two major categories: clinical assessment of risk factors and physical measurements of skeletal mass. The rationale for the use of any of these techniques in dependent on the well established relationship between bone mineral density and the ability of bone to withstand compressive, torsional and bending forces (Erksson, et al., 1989).

Techniques for measuring bone mass or density

1- Conventional skeletal radiography

Relatively insensitive and bone loss is apparent only when mass has decreased by about 30-50%.

2- Radiographic photodensitometry

It depends on measuring the optical density of x-ray film of bones. The radiation dose is the same as for radiogrammetry.

3- Radiogrammetry

Radiogrammetry has been used for many years and is simple and inexpensive to perform. It relies on linear measurements on x-ray film of cortical bone taken under standardized condition.

The absorbed radiation is small, but it is less sensitive than absorptiometric measurements (Garn, 1992).

4- Single energy photon absorptiometry (SPA)

SPA has been available for several decades and is widely used. It most commonly uses a gamma-ray source coupled with a scintillation detector, which together scan across the area of interest. The radiation dose of SPA is very low and applied to a small volume of tissue.

5- Single energy x-ray absorptiometry (SXA)

Is a newly developed technique suitable for scanning appendicular sites. It avoids the need for isotopes and is likely to replace SPA. (Farrel and Webber, 1989).

6- dual-energy absorptiometry

The proximal femur and the vertebral bodies, with their associated processes are very irregular bones and are difficult to measure. Furthermore, they are surrounded by a widely varying amount of fat, muscle mass and other soft tissues.

These and other factors limit the use of SPA and SXA to the appendicular skeleton. The development of dual photon absorptionetry (DPA) and more recently dual energy x-ray absorptionetry (DEXA) have resolved at least some of these problems. As with SPA, the radiation dose for DPA is low *(Farrel and Webber, 1989)*.

7- Dual energy x-ray absorptiometry (DEXA)

Within the past few years sources of gamma radiation have been replaced by x-ray generators.

Like DPA, this technique determines bone mineral density in two dimensions.

DEXA has now largely replaced DPA for screening because of its greater precision, ease of use and freedom from several technical artifacts (Uebelhart, et al., 1990).

8- Quantitative computed tomography (QCT)

In QCT a thin transverse slice through the body is imaged. Under appropriate conditions the image can be quantified to give a measure of volumetric bone mineral density. The comparatively high doses of radiation limit the number of repeated measurements that can be done *(Uebelhart, et al., 1990)*.

Bone health and calcium intakes in infants children and adolescent

Older children and adolescents currently do not achieve the recommended intake of calcium. Maintaining adequate calcium intake during childhood and adolescence is necessary for the development of peak bone mass, which may be important in reducing the risk of fractures and osteoporosis later in life. Optimal calcium intakes are especially relevant during adolescence, when most bone mineral accretion occurs. A well-rounded diet including low – fat dairy products fruits and vegetables with appropriate physical exercise are important for achieving good bone health and establishing these practices in childhood is important so that they will be followed throughout the life span *(Greerand and Krebs, 2006)*.

A group of observational and longitudinal studies examined the effect of early – life calcium intake on bone health. They focused their analysis to identify consistent findings at specific bone sites to determine whether effects differed by the age of children studied, and to establish the relationship between bone changes and baseline calcium intake. They found that increase in BMD due to calcium intake among children appear to occur primarily in cortical bone sites. Older children (pubertal) appear to have greater annual increases in lumbar BMD than younger prepubertal children.

The annual percent increase in midradius BMD appears to be greater at higher intakes among the older children, but this relationship appears to be less apparent among the younger children *(Wosje and specker, 2000)*.

To investigate if bone mass, morphology, and biochemical properties are affected by deficient dietary calcium concentrations, a study was conducted on the long bones (Tibia and Femur) of growing female rats after 13 weeks of consuming 1,2,3,4,5,6,7 grams of calcium per Kgm diet of the rats while dietary phosphorous and vitamin D remained constant. All bone parameter, measured were significantly impaired by calcium deficiency in rats fed ther diet containing 1gm calcium / Kgm, but all parameters stabilized between 2 and 3 gm/ kgm diet, with no differences between 3 and 7 gm/kgm. The results suggest that a threshold response in bone calcium retention or bone mass at approximately 2.5 gm calcium/ kgm diet is associated with similar threshold responses in bone breaking strength and related biomechanics as well as trabecular structural properties *(Hunt, et al., 2008)*.

Physical activity, diet and skeletal health

Osteoporosis is a systemic disease characterized by low bone mass and micro architectural impairment of bone tissue, with a consequent increase in bone fragility and susceptibility to fracture. The magnitude of this disorder will get worse by 60%, unless suitable intervention can be undertaken (Cooper, et al., 1992). Osteoporotic hip fractures can result in up to 20% excess mortality within one year. Additionally, up to 50% of patients will be disabled, half of them requiring long term nursing home care (Rutherford, 1997).

The functional demand imposed on bone is a major determinant of its structural characteristics. Biomechanical studies indicate that stress applied to a skeletal segment affects the geometry of bone (Carter, et al., 1996). The stimulatory effect occurs when the skeleton is subjected to strains exceeding habitual skeletal loads, and the intensity of load is more important than the duration of the stimulus. Conversely, a reduction of skeletal loads leads to a reduction of osteoblast activities and eventually to a negative bone balance (Frost, 1987).

Bone mass grows rapidly until the third decade, keeps more or less constant until the fifth decade in women and the sixth decade in men and then declines. The effects of exercise have been shown in both cross-sectional and longitudinal studies. Cross-sectional studies show that individuals below the age of 50 participating in exercise programmes have an average of 8% greater bone mineral density (BMD) than age and sex matched individuals, while after the age of 50 the difference is only 6%. Longitudinal studies show a 2% increase before age 50 and a 1% increase after 50 *(Forwood and Burr, 1993).*

Studies showed that children regularly carrying out moderate weight bearing physical exercise have greater bone mass than age matched peers, possibly caused by decreased bone resorption. A study conducted on a group of 26 pre-pubertal boys (age 10 ± 1.4 years), were involved in gymnastic training, spending about 3 hours/ day in active games or sport and 3 hours in secondary activity, such as watching T.V or reading. A second group of 10 children (age 10.4 ± 0.6 years) spent less than 1 hour / day in active games or sport and more than 4 hours in secondary activities. Total body dual energy x-ray absorptiometry scans were performed and bone area (BA) and bone mineral content (BMC) calculated for the whole skeleton and for individual skeletal segments. The number of hours spent on weight – bearing activities was significantly correlated to the BMC at the level of the arms and spine. Each hour per day of weight bearing activity increased total bone density by 2% (Branca, 1999).

A study of the effect of mechanical load on bone mass was conducted on weight lifters. At the start of the training, they have BMD similar to that of the normal controls, in 3 weeks of training weight lifters achieved a higher radial BMD. Weight lifters have a higher BMD throughout life, though it follows the same pattern of decline with age (Karisson, et al., 1993). In early post-menopausal women, 9 months of weight training had a moderate effect on lumbar BMD (+1.6%) compared to a decrease in controls (-3.6%), (Pruitt, et al., 1992). In children the time spent in weight bearing activities is correlated to BMD at all sites, radius, femoral neck and lumbar spine *(Slemenda, et al., 1991)*.

Studies showed that environmental factors, such as diet and physical activity, account for 20% of the variance of bone density. Several dietary factors have an influence on bone mass and turnover *(Reid and New, 1997)*, calcium, phosphorus, fluoride, zinc, copper, sodium and potassium. Adequate quantities of such nutrients are probably necessary for exercise to be active on bone mass, though so far this interaction has been proven for calcium only in humans. Calcium intake varies widely among different world populations. Bone mineral density in adulthood has been related to a lifetime calcium intake *(Matkovic, 1991)*.

Supplementation trials carried out in children and adolescents have shown a positive effect on bone mass. A three years supplementation of the diet with 1000 mg calcium citrate in boys 6-14 years showed that calcium enhanced the rate of increase in bone density *(Johnston, et al., 1992)*. And an 18 months trial in adolescent girls with 500 mg/day calcium citrate also led to a significant increase in total bone density (Lee, et al., 1995).

In children, as long as calcium requirements are covered, exercise is more important as a determinant of bone mass. Physical activity appeared to be more important than calcium intake in determining bone density, in studies where subject has an adequate calcium intake (Branca, 1999).

Bone mineral status in later life is a function of the maximum bone mineral mass attained in young adult life and of subsequent age – related bone loss: Increasing peak bone mass in young persons could reduce the incidence of later osteoporosis fractures. Modification of diet and physical activity during childhood and adolescence may be an effective way to maximize peak bone mass *(Sabatier, et al., 1996)*. In a study conducted by *Stear, et al., (2003)* on adolescent girls aged 16-18 years regarding the effect of increased of calcium intake on bone mineral status, they found that the effect of calcium intervention shows that the magnitude of the effect is likely to be produced on population based intervention regardless of habitual calcium intake which varies and that makes it difficult to judge the optimal calcium intake for this age group. Previous studies showed that the effect of calcium supplementation reduces the rate of bone remodeling, leading to modest, increase in bone mass by reducing the remodeling space *(Heaney, 2001)*. Other studies showed that the effect of supplementation disappears once the supplement is withdrawn *(Lee, et al., 1997)*.

This suggests that the increase in calcium intake may have no lasting benefit unless the supplementation is continued indefinitely. The findings of all these studies supported the existing evidence that lifestyle interventions enhance bone mineral status in children and adolescents. Whether this is a lasting benefit, leading to optimum peak bone mass and associated with a reduction of the risk of osteoporosis, has yet to be determined.

Weaver, (2000) studied the relationship between dietary calcium, physical activity and bone mass. He concluded that during the development of peak bone mass, calcium intakes of <1 gm /day are associated with lower bone mineral density and at intakes approaching calcium requirements, physical activity is a more important predictor of bone mineral density than is calcium intake. Calcium requirements as modified by physical activity need to be determined for each population subgroup according to sex, age, race and cultural environment.

Prentice, (2004) reviewed the evidence on diet and nutrition relating to osteoporosis and provided recommendations for preventing osteoporsis, in particular, osteoporotic fracture. He concluded that there is unsufficient knowledge linking bone mineral status, growth rates or bone turnover in children and adolescents to long – term benefits in old age for these indices to be used as markers of osteoporotic disease risk for adults, the evidence of a link between intakes of any dietary component and fracture risk is not sufficiently secure to make firm recommendations, except in case of calcium and vitamin D.

Takata, (2004) discussed the effect of exercise and nutrition on bone numeral density (BMD), and the quality and quantity of exercise and nutrition for the primary prevention of osteoporosis. The results suggested that exercise and nutritional supplements are effective for increasing BMD among children or and possibly inhibit the loss of BMD after menopauses however the evidence regarding the effective kind and duration of exercise is limited. More évidence is needed about increasing the nutritional intake from food and combination with nutritional supplements.

Risk Factors for developing osteoporosis:

Age and sex: osteoporosis is a disease that generally manifests itself late in life, may originate during the period of skeletal growth and peak bone mass accumulation. At the age of 40 bone mineral density (BMD) begins to diminish gradually in both sexes, at menopause, bone loss increases greatly in women (at a rate of 2% to 3% per year) and continues for 5-10 years postmenopausal. Then the rate declines gradually to 0.5% to 1% per year thereafter until the age 70, when the loss rates are about the same for both genders.

Estrogen depletion: is a major determinant of osteoporosis risk in women as it occurring at menopause.

Lactation: Women who breast feed for 6 months ar longer experience a striking but transient bone loss. Sufficient calcium and vitamin D intakes for mothers during this time is essential.

Body weight: the greater the body mass, the greater is the bone mineral density (BMD), and the opposite is also true in heavier individuals, there is a load (weight) that is born by different skeletal sites. Lifting and carrying of children may improve arm bone mass and density which are normally less affected by body weight.

Limited exercise: immobility in varying degrees is a well recognized cause of bone loss. Stresses from muscle contractions and the body in an upright position against the pull of gravity stimulate osteoblast function *(Anderson, 2000)*. Weight – bearing physical activity is essential for normal skeletal development during childhood and adolescence and for achieving and maintaining peak bone mass in young adults. Also, strength training and other forms of exercise in older adults preserve the ability to maintin balance and reduce the risk of falling and possible consequent fractures. Among the physical activity goals particularly to women is prevention and treatment of osteoporosis (Anderson, 2000).

Researches pointed out that, by using radiologic measures of bone health, physical activity is the most important modifiable factor that determines increased bone growth and development in adolescents (Lanoa, et al., 2005) this was confirmed recently by a 10- year longitudinal study in adolescents (Lloyd, et al., 2004). In 80 women who were followed from 12 to 22 years of age with an average daily calcium intake of 1058+ 440 mg/day, only exercise history (Participation in sports), rather than calcium intake, was significantly correlated with bone mineral density and bone strength. It is well known that weight bearing exercise plays a role in achieving maximal peak bone mass, but data to quantify the effect are limited. It is unclear, however, whether any given level of calcium intake influences the degree of benefit derived by exercise on bone mass or whether exercise alone independent of calcium intake, improves bone mass. Some may speculate that less – active people need more calcium in their diets than active ones, but the study found no interaction between calcium intake and physical activity (Lloyd, et al., 2004).

Fractures of the hip, spine and forearm have long been regarded as the classical sites of osteoporotic fractures, however, almost all type of fractures are increased in individuals with comporomized bone quantity and quality (Jonell and Kanis,2005). Clinically, fragility fractures may be defined as fractures that occur as a result of minimal trauma, such as a fall from a standing height or less, or not identifiable trauma at all. The life-time risk at 50 years of age for any osteoporotic fracture ranges between 40-50% in women and 13-22% in men, which is considered very high (Johnell and kanis, 2005).

There are many risk factors for osteoporotic fractures, such as age, gender, race, geographical region, diet, life style hormonal status, bone density, bone quality, body mass index and medical conditions. Some of them cannot be modified, others, however, can be prevented or influenced aiming to decrease fracture incidence (Donatas and Yiennokopoulos, 2007).

Age factor is one of the important factors of fracture incidence. Fracture risk is much higher in the elderly than in young (Slemenda, etal, 1988) the frequency of hip fractures in particular increases exponentially with age, especially after the age of 70, in both men and women in most regions of the world (Cummings and Melton, 2002).

Hormonal factors and gender differences play an important role in fracture risk. Women attain a lower peak bone mass compared to men.

The increased bone loss in women after menopause and their increased exposure to falls compared to men increase the incidence of fractures especially hip fractures. Other hormonal factors that increase fracture risk are premature menopause, primary or secondary amenorrhea, hyper thyroidism, hyperadrenocorticism, and primary and secondary hypogonadism in men (Donatas and yiannakopoulos, 2007).

Life style is also an important risk factor for fracture incidence. It is important for all persons to b e accustomed to a healthy balanced diet and physically active life style beginning from childhood and continuing throughout life, for normal skeletal growth and aging (Rittweger, 2006). Adequate calcium intake has been demonstrated to be significant for increasing and maintaining bone mass. The importance of vitamin D for the intestinal absorption of calcium is also well documented.

Hence, inactivity or immobilization, low dietary calcium intake, vitamin D deficiency, as well as cigarette smoking, caffeine intake, excessive alcohol consumption, consist life style risk factors for osteoporotic fractures (Gass and Dawson-Hughes, 2006).

Prevention of osteoporosis-related fractures and falls

Primary prevention during growth and adolescence should aim at attainment of a high peak bone mass, adequate calcium intake, exercise and early diagnosis and treatment of potential skeletal deformities (Karlesson, 2004). Secondary prevention during middle age aims at identifying the population with low bone mass and more than one risk factor for an osteoporotic fracture and entering upon pharmacological and life style multifactorial interventions.

Pharmacological interventions include Calcium, Vitamin D, hormone replacement therapy, selective estrogen receptor modulators, calcitonin, bisphophonates and parathyroid hormone. Some of the preventive measures for osteoporosis have also been demonstrated to be effective for prevention of falls, such as adequate calcium and vitamin D intake and exercise (Boonen, et.al., 2006). Various kinds of exercise induce an increase in bone mineral density and may indirectly protect individuals from fractures by improving mobility, muscle strength and balance, thereby reducing the risk of falls (Lock , etal ., 2006). Tertiary prevention in the elderly aims at dealing with high-risk individuals, those with established osteoporosis or post-fracture treatment ,a part from pharmacological treatment, it aims to ensure intestinal absorption of calcium is improved and vitamin D levels are adequate (Wilkins and Birge 2005)

Risk factor for falls should be examined and dealt with, as fall incidence is age-related about 30% of person of 65 years of age fall each year, reaching 50% of those 80 years or older (Skelton, etal., 2004).

Personal risk factors for falls to be assessed include lack of physical activity, muscle weakness, gait and balance problems, neuromuscular diseases, disability of lower extremities, inadequate foot wear, functional limitations regarding activities of daily living, proprioceptive impairment, dizziness, fainting or loss of consciousness, cardiovascular, conditions medications such as sedative and antidepressants (Tinetti, 2003).

Osteoporosis, screening and treatment initation

Osteoporosis is characterized by low bone mass and is a progressive, systemic disease that leads to an increase in bone fragility and susciptibility to fracture Detection of osteoporosis is possible at treatable stages of the disease, and early detection and treatment have been shown to decrease associated morbidity and mortality *(Watts, 2002)*. Dual energy x-ray absorptiometry (DXA) is currently considered the ideal standard for measuring bone mineral density and predicting fracture risk (Kulak and bilezikian, 1999). Fracture risk is also affected by other factors, such as poor bone quality, but bone density is the best predictor of fracture risk. The U.S food and Drug administration has approved several measures for the prevention and treatment of osteoporosis including bisphosphonates, calcitonin and other hormone therapy some degree of awareness of the disease and potential interest in treatment are especially accepted when a physician orders a test. The factors associated with treatment following screening in an at risk population not specifically referred by a physician have not been well documented (Marci, et al., 2000).

Many disorders may affect bone mass during childhood and adolescence. The number of disorders that have been identified as affecting bone mass in this age group is increasing as a consequence of the wide use of bone mass measurements. The increased survival of children and adolescents with chronic disease or malignancies and some treatment regimens has resulted in an increase in the incidence of reduced bone mass in this age group. The first approach to osteoporosis management in children and adolescents should be aimed at treating the underlying cause. The prevention is a key factor and it should begin in childhood.

Pediatricians should have a major role in the prevention of osteoporosis and to suggest strategies to achieve an optimal peak bone mass (Sodini, et al., 2005).

It is evident that the amount of bone that is gained during adolescence is the main contributor to peak bone mass and in turn, it is a major determinant of osteoporosis and fracture risk in the elderly. Goran, et al., (2000) examined whether computed tomography measurement for bone volume and density in the axial and the appendicular skeletons could be tracked through puberty in 40 healthy children (20 girls and 20 bays). Longitudinal measurements of cancellous bone density of the vertebral bodies and cortical bone areas of the femurs at the begining of puberty accounted for 62-92% of the variations seen at sexual maturity. When baseline values for these bone traits were divided into quartiles, a linear relation across stage of sexual development was observed for each quartile in both boys and girls. The regression lines differed among quartiles for each trait, paralleled each other and did not overlap. They concluded that they can identify those children who are genetically susceptible to develop low values of peak bone mass and to whom osteoporosis prevention trials should be directed.

Eating disorders are common in young women. The synergetic effect of malnutrition and estrogen deficiency produces significant bone loss characterized by decrease in osteoblastic bone formation and an increase in osteoclastic bone resorption. Severity of bone loss in anorexia nervosa varies depending on duration of illness, the minimal weight ever and vigorous exercise. Long term consequences occur, such as fractures risk increase in patients who have suffered anorexia nervosa, compared with general population.

The first line of treatment to recover bone mass is nutritional rehabilitation together with weight gain. Hormonal replacement therapy may be effective if combined with an anabolic method (Ma del socorro, et al., 2005).

Estimating fracture risk using BMD studies :

Bone quality is considered to be normal in osteoporosis, but the quantity of bone is reduced.

The net balance between the formation of bone (a function of osteoblasts) and its resorption (a function of osteoclasts) determines whether the amount of bone increases or decreases over time. Bone mass, as determined by the net effect of these 2 processes, increases from birth until the third decades men and women. A more rapid decline occurs in women during their early menopause (Riggs and Melton, 1992).

BMD is the best independent risk factor for fractures (Paradimitropoulos, etal., 1997).

BMD can be partly quantified by histomorphometric analysis of bone biopsy specimens, but this means of analysis is expensive and not useful in clinical settings. The widespread use of simple noninvasive bone densitometry has resulted in significant improvement in the early detection of osteoporosis.

Dual-energy x-ray absorptiometry (DEXA) is a precise way of measuring BMD. The radiation risk of DEXA is extremely low (10% of the radiation of chest radiograph) Assessment of BMD using radiographs of the hand and ultrasound attenuation are methods that are less expensive the DEXA and might be used to screen patients, but their clinical role, and whether these methods will replace DEXA, remains uncertain.

Heel ultrasound can be used as screening test for osteoporosis, but up to 10% of patients will have false normal results, in spite of having significant osteoporosis (Wade, 2001).

Epidemiologic studies of the relation between physical activity and risk for osteoporotic fracture have been suggestive but inconclusive. Case-control studies have shown that person, with fractures are more likely to report having been inactive recently and earlier in their lives (Grisso, etal, 1997). In a prospective study (paganini-Hill, etal, 1991), it was found that women and men who were active for at least 1 hour daily had a 38% and 49% reduced risk for hip fracture, respectively, compared with their less active peers.

Other prospective studies with lower statistical power have suggested that physical activity protects against hip fracture but have not found these relations to be statistically significant in multivariate analysis (Wickhem, etal., 1989). In an earlier examination of the risk factors for hip fracture among women in the study of osteoporotic fractures (Cummings, etal., 1995), It was found that women who reported walking for exercise had a statistically significant

30% reduction in risk for hip fracture compared with women who did not walk for exercise.

Physical activity may prevent hip fractures in several ways. Exercise may reduce the likelihood of falling or may enable a protective response in the event of fall through enhanced balance reaction time, coordination, mobility and muscle strength (Nelson, etal., 1994). Exercise may also enhance bone mineral density or the structural integrity of bone, reducing the likelihood of fracture in the event of fall (Chilibech, etal., 1995). The link between physical activity and hip fracture, however in multifactorial and is not completely explained by its effects on bone mass and muscle strength (Gregg, etal., 1998). Low-intensity activities may be the most effective recommendation for sedentary women. Future research should evaluate whether different type, of patterns of physical activity affect other types of osteoporotic fracture and whether they do so primarily through effects on the skeleton muscular fitness, or balance or through other mechanisms .

Fragility factures occur because bones with reduced strength are subjected to critical forces, which most often arise from a fall (Pasco, etal., 1999).

Forces generated from falls will depend on the characteristics of the fall, which are influenced by age and the weight of the faller. Bone mineral density (BMD) is a good indicator for bone strength. However a major proportion of women with fractures do not have osteoporosis according to bone densitometric criteria (Siris, etal., 2004), because BMD fails to identify other factors that influence strength, such as bone size, bone geometry and microarchitectural changes (Seeman, 1997).

Many studies have focused on single BMD sites to predict fractures (Henry, etal., 2002). However, it is common in clinical practice for BMD to be measured at both the spine and the hip, but there is little current evidence-based data to assist in making treatment decisions on the basis of multiple-site BMD assessment (Lu, etal., 2001).

The 1-year mortality rate among elderly people after a hip fracture is 20%, and a significant proportion of survivors are admitted to nursing homes, about half of them are permenantly physically limited functioning (Aharonoff, etal., 1997).

After the age of 65 years, half of women and one quarter of men will sustain at least 1 osteoporotic fracture (Oden, etal., 1998). Factors commonly associated with hip fracture among the elderly include female gender, white race, advanced age, level of physical functioning, medication use and dietary factors (Ettinger, 2003).

Cognitive and physical functioning risks related to hip fracture have been confirmed by some researchers, while others suggested also that educational attainment and type of residence are independent predictors of hip fracture risk that contribute to a substantial proportion of hip fractures among elderly people (Wilson, etal., 2006).

It has been estimated that half of all women of age 50 years and older will sustain at least one osteoporotic fracture during their remaining lifetime as a consequence of bone fragility and increased susceptibility to fracture.

Intervention to prevent bone loss in early postmenopausal women is an effective approach to control the increasing incidence of osteoporosis. Such a strategy would avoid the accelerated bone loss and microarchetictural deterioration observed in the first decade after menopause .

In fact, by the time osteoporosis is diagnosed, subjects have generally lost about 20% of their peak bone mass, and even with long-term effective therapy, it may by fully possible to restore bone mass to peak levels, reverse architectural deterioration, and regain peak bone strength once such bone loss has occurred (Shumaker, etal., 2003).

It has been recently recognized that elevated bone turnover adversely influences bone mass and fracture risk (Melton, etal., 1997). Bone turnover accelerates at the time of menopause (Delmas, 1995), and remains elevated thereafter(Garnero, etal., 1996).

Reduction in biochemical markers of bone turnover has been correlated with increases in bone density and reduced fracture risk(Hochberg, etal., 2002).

In the past, many experts believed that the most effective way for women to prevent osteoporosis was to initiate hormone therapy immediately after menopause and continue its use throughout their lives (Gibaldi, 1997). Despite the fact that hormone therapy is still recommended for the treatment of vasomotor symptoms, recent clinical trial data suggest that the risks associated with prolonged hormone therapy outweigh the benefits (Lacey, etal., 2002). Moreover, many women cannot or will not use hormone therapy because of contraindications or such side effects as breast tenderness, fluid retention, and uterine bleeding (Ryan, etal., 1992).

Treatment of early postmenopausal women with a drug like alendronate (a potent and selective inhibitor of osteoclast-mediated bone resorption) effectively normalized bone resorption and increased and maintained bone density at the lumbar spine, hip, femoral neck and hip trochanter. Treatment was associated with a favorable safety and tolerability profile. Therapy with alendronate is effective in preserving bone mass in postmenopausal women and is a promising strategy for the prevention of postmenopausal osteoporosis (McClug, etal., 2004)

Role of micronutrients in bone structure and function

Calcium, phosphate and Vitamin D are essential for normal bone structure and function, but other micronutrients also have essential roles in bone. Evidence indicated that those with life history of adequate calcium intake will be at a lower risk of osteoporosis when they are older *(Anderson, 2000)*.

Phosphates are available in almost all foods. Calcium and phosphate ions in proportionate amounts are needed for bone mineralization. Too much phosphate compared to calcium stimulates PTH and hence bone loss follows. Milk and products contain calcium and phosphorus in optimum ratio for proper bone formation *(Clavo and Park, 1996)*.

Vitamin D is obtained from the diet in the form of ergocalciferol and cholecalciferol as well as from cutaneous synthesis after sun-exposure. It is then hydroxylated in the liver to 25 (OH) D, calcidiol and then to active metabolite (1.25 (OH)2 cholicalciferol) in the kidney. This active metabolite stimulates calcium absorption across the intestine, facilitates development of pre-osteoclasts at remodeling sites and stimulate the synthesis and the release of osteocalcin by osteoblasts *(Elizabeth and Bess, 2000)*.

Magnesium is essential for proper body response to PTH. So, magnesium deficiency leads to hypocalcaemia despite of rising PTH level. This hypocalcaemia is unresponsive to calcium supplementation *(Heaney, 2000)*.

Vitamin K is essential for osteocalcin carboxylation (maturation), which appears to prevent over mineralization. Deficiency of vitamin K occurs in individuals on long – term haemodialysis and elders, because of low consumption of dark green vegetables *(Anderson, 2000)*. There is evidence that vitamin K plays an important role in bone health and mineral ion, important to counteract the osteoporotic process of aging.

Zinc is essential for enzymes in osteoblasts that are responsible for collagen synthesis as alkaline phosphatase *(Anderson, 2000)*.

The skeleton serves as a buffer to help regulate acid – base balance. A high acid diet may contribute to the progressive decline in bone mass and osteoporosis. An oral dose of potassium bicarbonate in postmenopausal women, sufficient to neutralize endogenous acid improves calcium balance and bone *(Brazil, 1995)*.

Dietary Factors affecting bone mass and bone mineral density (BMD)

The precise timing of peak bone mass at specific skeletal sites is uncertain although reports have indicated that bone mass may peak any time during the second, third or fourth decades and timing differ for compact and cancellous bone tissue *(Recker, et al., 1992)*. Bone mass of lumbar vertebrae has been shown to peak as early as second decade *(Bonjuour, et al., 1991)*. Most of the skeletal peak bone mass is already attained at the age of 16-18 years *(Matkovic, et al., 1994)*, although some additional growth may take place during the third and fourth decade, depending on the skeletal site.

Although bone mass achieved by early adulthood primarily reflects bone mass achieved during growth, the additional gain in bone mass that may potentially occur is likely to be dependent on life cycle factors predicted during young adulthood. These factors may include physical activity *(Andon, et al., 1991)* and nutrient intake, in particular calcium intake, however, relatively little work has been done in this age group.

Of the work that has been conducted in young women, Recker et al (1996) reported that calcium intake and physical activity were significantly associated with increase in both compact and trabecular bone tissue. Calcium is assumed to influence maximum bone mass. It has been suggested that there is a level of calcium below which accumulation of skeletal mass is a function of intake and above which accumulation is constant, and not dependent on further increase in intake *(Matkovic and Ilich, 1993)*. There is no agreement as yet on the level of this threshold intake, some estimated threshold intakes, from a meta- analysis of more than 500 balance studies to be 10901, 1390, 1480, and 957 mg/day for infants, children, adolescents and young adults, respectively *(Matkovic and Heaney, 1992)*. How these high estimates are disputed *(Kanis, 1994)* and moreover not strongly supported from data of other studies *(Ruiz, et al., 1995)* that reported a relation between habitual calcium intake and bone density during adolescence. However, intervention studies have shown an increased bone mineral density (BMD) in children who received a daily calcium supplement in comparison with children receiving a placebo *(Bonjour, et al., 1997)* but this effect disappears after stopping supplementation *(Lee WTK, et al., 1996)*. There have been no supplement studies continuing the peak bone mass density has been reached, so it is not clear whether a higher peak bone mass can be attained by long term high calcium intake. Results of cross – sectional and progressive studies in young adult women are inconsistent and show only weak positive associations at the most *(Kanders, et al., 1998)*.

In girls aged 11-15 years, accumulation of skeletal mass is an ongoing process, while 20 to 23 years old women have attained peak bone mass of the radius *(Anderson, et al., 1993)*. In this young adult girls, the weak positive association was no longer significant after adjustment for menarche, triceps skin fold and arm circumference, and every intake which are associated with body size and bone size *(Prentice, et al., 1994)*.

In a number of observation studies calcium intake was weakly associated with BMD at different skeletal sites in children *(Rubia, et al., 1993)* as well as young adult women *(Metz, et al., 1993)*. In other studies calcium intake was not significantly determinant of BMD, *(Valimaki, et al., 1994)* which could be due to small variations in calcium intake in relatively homogenous populations.

The relationship between dietary calcium and bone mass in premenopausal women has been evaluated with a conclusion that there was overall evidence for a positive association.

Dietary calcium, physical activity and the growing skeleton:

Recent advances in imaging techniques to evaluate bone geometry have contributed to understanding the interaction of calcium intakes and physical activity on the growing skeleton. Intervention studies showed that bone mass could be improved with both calcium or milk powder and exercise (Weaver, 2000). In postmenopausal women, subjects with calcium intakes over 1 gm/ day randomized to exercise intervention has improved BMD at the spine (Specker, 1996) and tibia and hip *(Prince, et al., 1995)* compared to calcium alone however, the interaction between dietary calcium and physical activity in the growing skeleton remained uncertain because of lack of intervention studies.

Two important intervention studies have been reported since 2002 that revealed the interaction of dietary calcium and physical activity and growing bone. Scientists studied 239 children aged 3-5 ys for 1 years who were randomized to 1gm/day calcium or placebo and to two exercise regimens, gross motor (weight bearing) or fine motor (sitting). Leg BMC gain, determined by dual energy X-ray absorptiometry (DEXA), was significantly higher only in the combined calcium and weight – bearing exercise group (Specker and Binkely, 2003).

A second randomized trial using a factoral design, in 66 older girls aged 8.8 + 0.1 years found a positive interaction of milk mineral supplements and moderate impact exercise for 20 minutes 3 times per week for 8.5 months on some bone sites but not others (Inliano-Burns, et al., 2003). High impact exercise alone increased bone mass at the loaded site (Tibia Fibula) and calcium alone increased bone mass at non- loaded sites (humerus and ulna – radius). A significant ($P<0.05$) exercise – calcium interaction was detected at the femur, but not the tibia – fibula.

Main effects of calcium intake and physical exercise on bone gain have been reported in a number of randomized, controlled trial in children (Heaney, et al., 2000). The effects may differ at bone, the stage of maturity of the growing skeleton, or the interdependency of calcium intake and physical activity. Cortical – rich bone regions, have responded more to calcium supplementation in most trial than trabecular-rich regions (Wosje and Specker, 2000). On the other hand, activity trials in children have shown significant increases in trabecular bone (French, et al., 2000). Mechanical loading stimulates trabecular number and size (Rubbin, et al., 2002). Activity trials usually are more effective in prepubertal children possibly because of synergistic activity between exercise and growth hormone (Bass, 2000). Findings on the benefits of calcium supplementation in prepubertal VS. Pubertal children have been inconsistent. In the study of calcium supplementation that has spanned puberty, the benefits of calcium on bone were greater during the pubertal growth spurt than during bone consolidation (Matkovic, et al., 2005).

The Executive Summary of Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, Institute of Medicine ISBN, (1997). Since1941, Recommended Dietary Allowances (RDAs) has been recognized as the most authoritative source of information on nutrient levels for healthy people. Since publication of the 10th edition in 1989, there has been rising awareness of the impact of nutrition on chronic disease. In light of new research findings and a growing public focus on nutrition and health, the expert panel responsible for formulation RDAs reviewed and expanded its approach--the result: Dietary Reference Intakes. This new series of references greatly extends the scope and application of previous nutrient guidelines. For each nutrient the book presents what is known about how the nutrient functions in the human body, what the best method is to determine its requirements, which factors (caffeine or exercise, for example) may affect how it works, and how the nutrient may be related to chronic disease. The first volume of Dietary Reference Intakes includes calcium, phosphorus, magnesium, vitamin D, and fluoride. The second book in the series presents information about thiamin, riboflavin, niacin, vitamin B6, folate, vitamin B12, pantothenic acid, biotin, and choline. Based on analysis of nutrient metabolism in humans and data on intakes in the U.S. population, the committee recommends intakes for each age group--from the first days of life through childhood, sexual maturity, midlife, and the later years.

Recommendations for pregnancy and lactation also are made, and the book identifies when intake of a nutrient may be too much. Representing a new paradigm for the nutrition community, Dietary Reference Intakes encompasses: Estimated Average Requirements (EARs). These are used to set Recommended Dietary Allowances. Recommended Dietary Allowances (RDAs). Intakes that meet the RDA are likely to meet the nutrient requirement of nearly all individuals in a life-stage and gender group. Adequate Intakes (AIs). These are used instead of RDAs when an EAR cannot be calculated. Both the RDA and the AI may be used as goals for individual intake. Tolerable Upper Intake Levels (ULs). Intakes below the UL are unlikely to pose risks of adverse health effects in healthy people. This new framework encompasses both essential nutrients and other food components thought to pay a role in health, such as dietary fiber. It incorporates functional endpoints and examines the relationship between dose and response in determining adequacy and the hazards of excess intake for each nutrient.

The relationship between physical activity, increased risk of fracture and osteoporsis

The most important factor in the primary prevention of osteoporosis is the attainment of an optimal peak bone during adolescence. In addition to endogenous factors such as genetic, environmental factors such as dietary habits and physical activity, influence the accretion of bone mass during this critical period of skeletal growth. The most important factors are: First, calcium dietary intake in adolescents is generally less than the current recommended RDA of 1200 mg/day. Second, physical activity particularly weight bearing exercise has a positive impact on bone. Third, several studies, suggests that the various forms of hormonal contraception exert different effects on bone mass in adolescents (Cromer and Harzel, 2001).

Low bone mass is a determinant of fractures in healthy children. Some studies provided limited evidence on the association between ethnicity, birth weight, family size, socioeconomic status, dietary calcium intake, physical activity and fracture incidence, but no studies have investigated whether these determinants of fracture risk act through affecting bone mass or through other mechanisms. Clark, et al., (2008) carried out a population – based birth cohort to confirm which variables are determinants of fracture risk and to study which of these risk factors act independently of bone mass. They concluded that vigorous physical activity is an independent risk factor for childhood fracture risk, however the interrelationship between physical activity, bone mass, and childhood fracture risk suggests that the higher bone mass associated with increased physical activity doesn't compensate for the risk caused by increased exposure to injuries.

The relationship and determinants of whether occult bone disease is associated with a history of frequent fractures in children have been studied by Olney, et al., (2008) as a case control study where children with two or more incidence of fractures were recruited as the cases of the study and children with no history of fractures served as controls. Food intake, activity surveys, physical examination, laboratory tests and dual – energy radiographic absorptiometry were used. They concluded that there was a significant association between a history of frequent fractures and hypercalcuria in children, and suggested that the appropriate screening evaluation for children who present with a history of frequent fractures consists of a dietary history especially for calcium and vitamin D intakes, a physical examination to assess for pubertal delay, and urinary calcium concentration in relation to creatinine to assess hypercalcuria.

Stress fractures are particularly concerning in active female adolescents and young adults because they may be related to insufficiency of bones to withstand repetitive loading. A women's peak bone mass is achieved by her early 20s (Theintz, et al., 1992) and is one of the strongest predictors of her long – term risk of osteoporosis (Kanis, 2003).

A cohort study of older adolescent track- and- field athletes demonstrated that age at menarche was an independent risk factor for stress fracture, with earlier ages providing significant protection (Bennell, 1996). Menarche occur near the end of pubertal growth spurt, which is accompanied by a rapid increase in bone mass and BMD, one of the main determinants of bone ability to withstand loading (Eastell, 2003). Other studies didn't support this finding, although more of which suggested an inverse relationship between age of menarche and risk of stress fracture (Bennell, et al., 1999). Several other studies have also consistently suggested that stress fractures are less common among athletes with regular menses, however, the studies have not been sufficiently large to provide adequate statistical power to reach a firm conclusion. The presumed mechanism by which regular menses would offer protection against stress fracture is the improved BMD associated with a normal endogenous estrogen state (Loud, et al., 2007).

Fractures in childhood have long been considered an unavoidable consequence of growth. In recent years studies have showed the epidemiology of these very common fractures, and have also showed considerable variation by fracture type and from country to country. There have also been a number of studies aimed to identify risk factors especially for the most common distal arm fractures. These studies have consistently associated bone mineral density with these fractures. Other risk factors include obesity, physical inactivity, sports, beverages and calcium intake and there is accumulating evidence that a substantial proportion of fractures in children are preventable (Jones, 2004).

Studies have provided limited evidence on the association between ethnicity birth weight, family size, socioeconomic status, dietary calcium intake, physical activity and fracture incidence. No studies have investigated whether these determinants of fractures risk act through affecting bone mass or through other mechanisms. Clark, et al., (2008) studied this issue on children from birth to 11 years of age in a cohort study. Data were collected on early life condition, diet, puberty and physical activity and they were linked to reported fractures between 9 and 11 years of age. They concluded that vigorous physical activity is an independent risk factor for childhood fracture risk, and that those who reported daily or more episodes of vigorous physical activity had double the fracture risk compared with those with less than 4 episodes per week. However the interrelationship between physical activity, bone mass, and childhood fracture risk suggests that the higher bone mass associated with increased physical activity does not compensate for the risk caused by increased exposure to injuries.

Stress fractures can be defined as skeletal defects that result from the repeated application of stress lower than that required to fracture a bone in a single loading, often called fatigue or insufficiency fractures which are relatively uncommon in general but are a source of significant morbidity in active population, with annual incidence rate ranging as high as 20% in prospective studies of young female athletes (Brukner, et al, 1999). In some cases, a stress fracture may be an indicator of inadequate bone mass (Marx, et al., 2001). These fractures would be particularly important findings if noted during adolescence, a critical period for bone mass acquisition. More than one half of adult bone calcium is acquired during the teenage years and women's peak bone mineral density (BMD), a major determinant of her long term risk of osteoporosis, is thought to be achieved in early adulthood (Eastell, 2003).

Weight bearing exercise is a major stimulus for skeletal remodeling, increased bone mineralization, and increased BMD (Lloyd, et al., 2000). Therefore, maximization of peak BMD through participation in athletic activities during adolescence could assist in the prevention of osteoporosis later in these young women's lives (Etherington, et al., 1996). In addition, some female athletes who participate in high levels of activity may lead to pattern of unhealthy eating which may lead to irregular menstrual cycles and a state of low serum estrogen levels that can counteract the beneficial effects of exercise on BMD (Rencken, et al., 1996).

The prevelance of stress fractures among children and adolescents is unknown, and the result from studies of older adolescent girls have not been consistent with those from studies of adult women (Nattiv, 2000). Bennell et al., (1995) conducted a retrospective study of 53 Australian female track and field athletes 17 to 26 years of age and found that menstrual irregularities and restrictive eating behaviors were risk factors for stress fracture but low BMD was unrelated to fractures, however, in a prospective follow-up study of the same cohort study they found that lower bone density and a history of menstrual disturbances were significantly related to stress fractures.

A similar track and field athletes study carried on U.S students found that a history of stress fracture and low BMD were significant predictors of stress fractures but menstrual history was not (Nattiv, 2000). Hormonal status, serum calcium and vitamin D levels and nutritional history were not considered as significant predicators of stress fractures. The inconsistencies among earlier studies and more recent investigations may be accounted for by differences in sample size and that some of the studies being underpowered to detect significant differences in the proposed predictors of stress fractures.

In their study on preadolescent and adolescent girls Field, et al., (2004) found the age of the participant was the most consistent correlate to stress fractures. The participants had self – reported their weight and height, menarcheal history, physical activity, dietary intake and disordered eating habits. The fact that age was the most consistent correlate to stress fractures might be due to the duration of the exposure time, the older the adolescent girl is, the longer she might have been participating in risk- associated activities and the greater the chance that she has sustained a stress fracture. Alternatively, it could be that older girls had begun to participate in high school sports or other higher levels of competition, in which the intensity of the training sessions is greater than the intensity of training sessions for girls at younger ages.

Menarche occurs near the end – of the pubertal growth spurt, which is accompanied by rapid increase in bone mass and BMD (Eastell, 2003), BMD is one of the main determinants of bone's ability to withstand loading and recent evidences reemphasized the observation that stress fractures result from the imbalance between the microfracture caused by repeated loading cycles and the bone's own response to remodel the damaged region (Romani, et al., 2002). Because remodeling is a constant dynamic process, it may be inadequate acceleration of this process that results in stress fractures, therefore, the more relevant activity parameter is likely to be the rate of increase in exercise volume not the total volume itself.

Methodology

Methodology

Study design

A prospective study was conducted with follow-up after six months from April 2008 to October 2008.

Boys and girls between 12-16 years of age from preparatory schools in Cairo to assess the effect of Physical exercise on the outcome of the results.

Study setting

The study was conducted on at Hoda Sharawi preparatory school for girls and Giza preparatory school for boys, Cairo, Egypt.

The pilot study

At first, a detailed questionnaire (Annex 1) was designed after consultation with the supervisors. Pilot study was done on 20 subjects (boys and girls). The outcome of the pilot study was discussed, and the questionnaire was rearranged to be used for collection of the data from sample.

The main study

The collection of data included:

1- Filling of detailed questionnaire from the subjects (boys and girls) regarding the social and physical status of the subjects, families and a detailed nutritional status of the subjects (boys and girls).

2- Anthropometric measurements including weight, height, body mass index (BMI) and arm circumference of all subjects (boys and girls).

3- Densitometry measurements for bone mineral density (BMD) for all subjects using Pixi instrument.

Sample size

This step was assessed when schools were identified, based on population frame of the schools that were randomly assigned from the participating schools, of boys and girls of these randomly selected schools between 11- 16 years of age. Selected by time from April to October 2008 for who fulfilled the inclusion and exclusion criteria. From the outcome of the random selection, the study began with number of students that some of them were droped off the study and others refrained from continuing in the study. From the remaining students , 100 boys and 100 girls were randomly included in the study for assessment of dietary intakes of calcium, phosphorus, proteins, carbohydrates and fat, also for measurement, of bone mineral density (BMD).

Inclusion Criteria

Normal adolescents within the age range of 11-16 years, will be included and who had the consent signed by one of his or her parents to enter the study.

Exclusion Criteria

1. Any medical diagnostic disease
2. Acquired, congenital and metabolic diseases including thyroid diseases, kidney diseases, liver diseases and adrenal malfunction that will result in hormonal disturbances, homeostatic disorders and disturbances in calcium and phosphorus deposition in bones, as obtained from the students' medical history.

Questionnaire design

In order to satisfy the objectives of the study a questionnaire was designed to cover the major variables related to the study of demographic variables, physical exercise, anthropometric measurements, and dietary 24 hours recall.

After pre-testing and justifying, the questionnaire was translated into Arabic and applied to the students of the selected schools.

The Pre-structured interview questionnaire of information on the following items:

Demographic variables

Age (in years) and sex.

Physical activities

Physical activities which include activities within the school break, walking to school or practicing physical exercise (min. /day).

Duration of exercise in minutes per day was calculated by asking each student about his or her activity during or outside the school day.

Anthropometric measurements

These were done for the student, including weight, height and arm circumference. Anthropometric measurements were obtained once in the beginning of the study with duplicate measurements per subject made independently by two observers and two values were averaged. The processes were repeated after six months by same procedure.

- Weight;

A platform (bathroom) type scale was used. Students were weighted bare footed with light clothes.

- Height:

Vertical measurement board for adults was used. The detailed method is described in (Annex 3).

$$\text{Body mass index (BM1)} = \frac{\text{Wt (kg)}}{\left(\text{Ht in (m)}^2\right)}$$

Was used to detect underweight is < 25.0 and obesity ≥ 30.0

The table used showing critical weights for different heights is shown in (Annex 4).

Dietary assessment

- Dietary pattern (Food frequency questionnaire):(Annex no.2)

This method was used to obtain qualitative descriptive information about usual food and beverage consumption pattern for the students per 4 days period. The questionnaire includes:

· **Energy food items:**

Cereals and its products – oil fats – sugar and sweets.

· **Tissue building foods:**

Meat, chicken, fish, eggs, legumes, milk and its products.

· **Protective foods:**

Vegetables rich in carotene, fruits rich in calcium.

· **Beverages:**

Tea, coffee, cola and fruit juices.

Twenty four hour recall method:

In this method every surveyed student was asked to recall the exact foods and beverages in take during the previous 24 hours period.

Quantities of food and beverages consumed were estimated in household measures and grams.

Detailed description of all food and beverages consumed, including cooking methods and amounts of each ingredient in the recipe was recorded (Annex 5).

The conversion of subject's consumption measures to grams was achieved through the use of pretreated list of weights of commonly used measures in Egypt developed by national nutrition institute.

Adequacy of the diet consumed was assessed comparing the energy and nutrient intake of the person with his recommended daily allowances (RDA).

The conversion of grams of foods and beverages to energy and nutrients was carried out by computer program based on energy and nutrient data base developed form.

The total amount of nutrient intakes and energy consumed were calculated for the 4 days of recording and then averaged per day and compared to the recommended daily allowance of each individual calculated by special tables (WHO 2005) (Annex 6).

Measurement of Bone Mineral Density (BMD)

BMD was measured for all survey candidates by special quantitative densitometer, acting peripherally on distal forearm bones, it is called PIXI (Peripheral instantaneous X-ray imager) manufactured in U.S.A by Lunar Corporation at Madison, Wisconsin.

Bone mineral density measured by DEXA:

The Principle concept of bone mineral density measured by DEXA is that the device includes an X-ray source that emits two-radiation beam, one for penetration of soft tissue and the other for penetration of bone.

Dual-energy x-ray absorptiometry (DEXA) is a precise way of measuring BMD. The radiation risk of DEXA is extremely low (10% of the radiation of chest radiograph)

The beam travel through the subjects' bone and soft tissue, continue upward and enter a detector where the intensity of the incoming beam is registered. The intensity of the incoming beam after attenuation reflects the bone mineral density that is a measurement of bone mineral found in the region of interest. BMD is measured in grams per centimeter squared. BMD is derived using BMC divided by area, where bone mineral content (BMC) is measured in grams and area is measured in grams per centimeter squared. BMD is derived using BMC divided by area, where bone mineral content (BMC) is measured in grams and area is measured in centimeters squared. Measurements of bone mineral densit by (DEXA) were done at the lower end of fore arm of the non dominated hand (distal third of left radius and ulna) using LUNAR DPX-MD+ densitometer presented by T and Z score where T is the difference between individual's bone mineral density and the mean young adult value of the reference population; Z is the difference between individual's bone mineral density and the mean age – matched value of the reference population.

According to world Health Organization (WHO):

Normal : T-Score greater than (-1.0); Osteopenic: T –Score greater than or (-2.5). and less than or equal to (-1.0); Osteoporosis: T-Score less than or equal to (-2.5).

The quality control procedure was followed in accordance with the manufactures recommendations. Daily calibration routine was done using the standard phantom supplied by manufacturer.

<u>Data handling and statistical analysis:</u>

Data were collected, checked, revised and entered the computer.

Data were analyzed by SPSS statistical package version 12. Excel computer program was used to tabulate the results, and represent it graphically; qualitative variables were expressed as count and percentages.

The significant difference in the distribution of the qualitative variables were tested by the Chi square test of distribution at $p<0.05$.

Quantitative variables from normal distribution were expressed as mean and S.D. The significant difference between before and after were tested by using Paired t-test at $p<0.05$.

The significant difference between groups were tested by using independent t-test at $p<0.05$.

Pearson correlation coefficient was calculated to measure the power and direction of the relationship between the quantitative variables at $p<0.05$.

Results

Results

Effect of nutrition status, calcium content and physical activities on the bone mineral density in the adolescent's stage

Table (1) shows the comparison between the pre follow up measure and the post follow up measure of the anthropometric measures and bone mineral density in boys. The table results show that there is a significant difference between the pre follow up and post follow up measure of weight, height and arm circumference of boys. The mean of weight and of height `<0.01), (157.79 vs. 155.69 in height, p=0.001<0.05) and (23.13 vs. 21.79, p=0.004<0.01) in arm circumference. Also the table results show that there is no significant difference between the pre follow up and post follow up measure of body mass Index and in bone Mineral Density since the time interval was not long enough. Figures (1) and (2) show these results.

Table (1): Comparison between the pre follow up measure and the post follow up measure of the anthropometric measures and Bone Mineral Density in boys (n=100)

Anthropometry	pre follow up	post follow up	t-value	p-value
	Mean ± S.D	Mean ± S.D		
Weight	50.90± 2.64	52.05± 2.64	4.10	0.003**
Height	155.69± 1.03	157.79±1.32	5.34	0.001**
Arm circumference	21.79± 0.92	23.13± 0.84	6.93	0.004**
Body Mass Index	20.81± 0.57	20.70± 0.63	0.86	0.393
Bone Mineral Density	0.32± 0.024	0.33± 0.026	0.86	0.393

S.D = Standard Deviation
* = There is a significant difference by using paired t- test at $p<0.05$
** = There is a significant difference by using paired t- test at $p<0.01$

Fig. (1): Comparison between the pre follow up measure and the post follow up measure of the anthropometric measures in boys

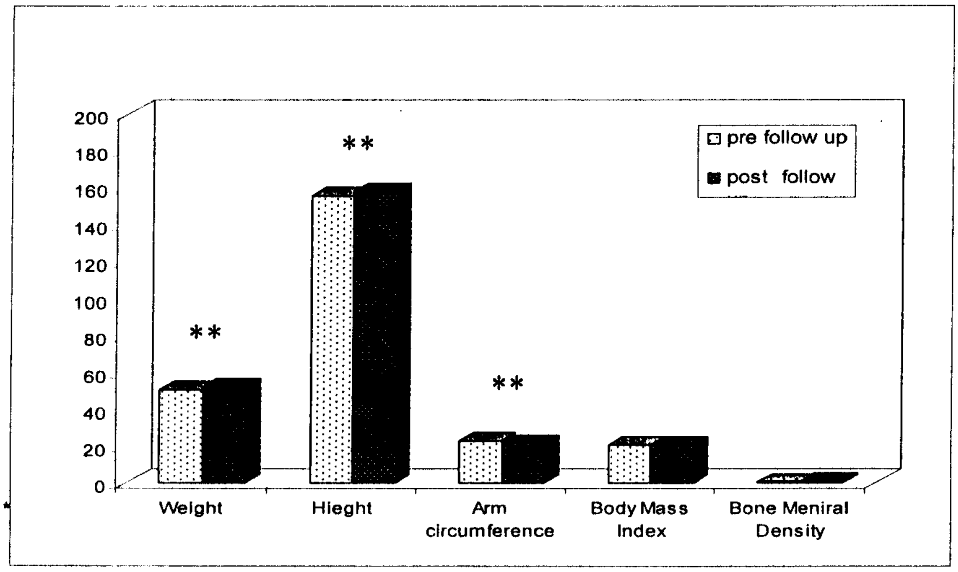


Fig.(2) Comparison between the pre follow up measure and the post follow up measure of the Bone Mineral Density in boys

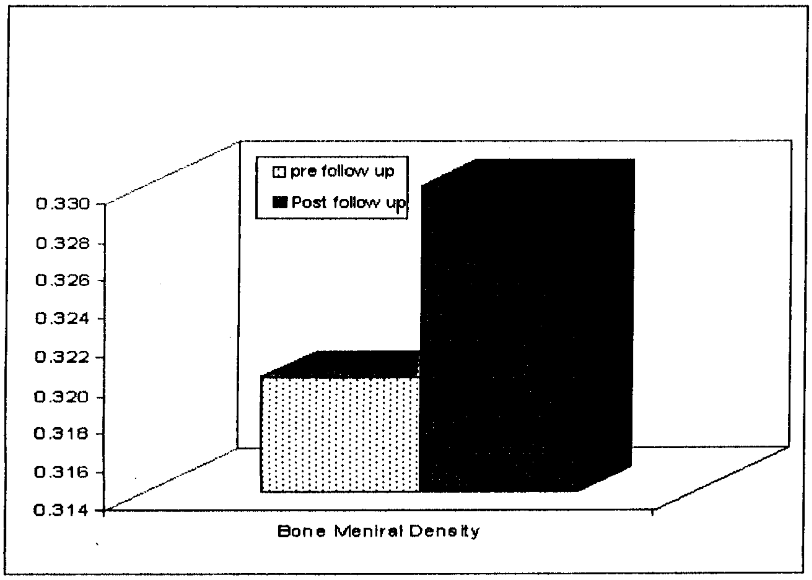


Table (2) shows the comparison between the pre follow up measure and the post follow up measure of the anthropometric measures and bone mineral density in girls. The table results show that there is a significant difference between the pre follow up and post follow up measure of weight, height and arm circumference of girls. The mean of weight and of height increases in the post follow up measure than the pre follow up (51.49 vs. 49.83, $p=0.031<0.05$) in weight, (149.20 vs. 146.90, $p=0.003<0.01$) in height and (24.04 vs. 22.54, $p=0.002<0.01$) in arm circumference. Also the table results show that there is no significant difference between the pre follow up and post follow up measure of body mass Index and in bone Mineral Density since the time interval was not long enough. Figures (3) and (4) show these results.

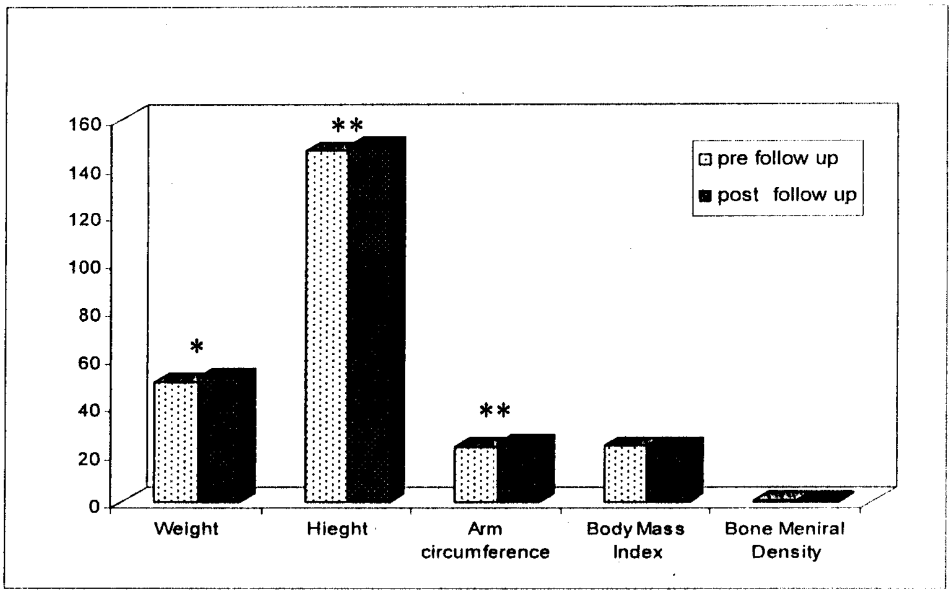
Table (2): Comparison between the pre follow up measure and the post follow up measure of the anthropometric measures and Bone Mineral Density in girls (n=100)

Anthropometry	pre follow up	post follow up	t-value	p-value
	Mean ± S.D	Mean ± S.D		
Weight	49.83± 2.47	51.49± 2.06	2.19	0.031*
Height	146.90± 1.21	149.20± 1.02	3.02	0.003**
Arm circumference	22.54± 0.58	24.04± 0.67	7.06	0.002**
Body Mass Index	22.92± 0.63	22.94± 0.68	0.06	0.952
Bone Mineral Density	0.32± 0.017	0.33±0.018	1.76	0.081

S.D = Standard Deviation

* = There is a significant difference by using paired t- test at $p<0.05$
** = There is a significant difference by using paired t- test at $p<0.01$

Fig. (3): Comparison between the pre follow up measure and the post follow up measure of the anthropometric measures in girls



* = There is a significant difference by using paired t- test at p<0.05
** = There is a significant difference by using paired t- test at p<0.01

Fig.(4) Comparison between the pre follow up measure and the post follow up measure of the Bone Mineral Density in girls

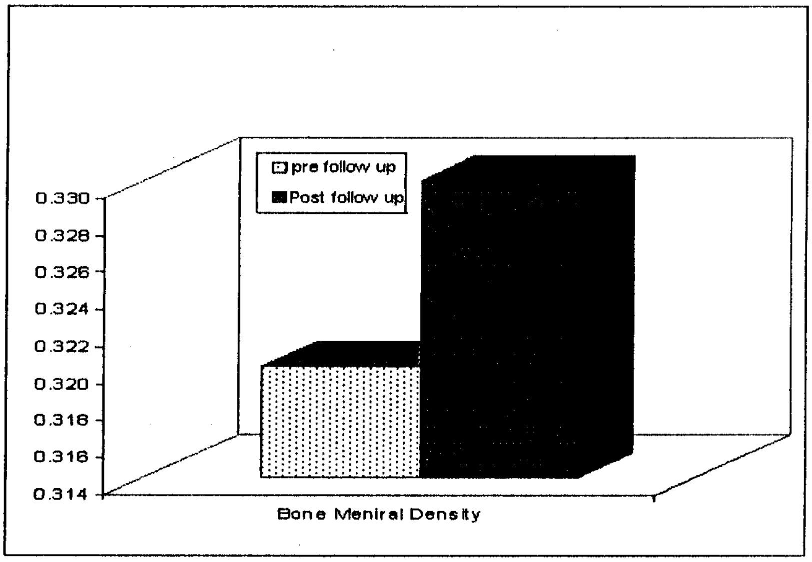


Table (3) shows the comparison between the average nutrient intakes and RDA in boys. The table results show that there is a significant difference between the average nutrient intakes and RDA in all nutrients except Sodium. The average nutrient intake from Calories (2231 vs. 2500 in RDA), Retinol (877.01 vs. 1000 in RDA), Carbohydrate (311.17 vs. 344 in RDA), Fat (84.29 vs. 92 in RDA), and Calcium (705.08 vs. 1200 in RDA) are less than the RDA. But the average nutrient intake from Protein, Potassium, Phosphorus, Vitamin C, Niacin, Iron, Riboflavin and Thiamine is more than the RDA.Figures (5) show the comparison between the average nutrient intakes and the RDA in boys

Table (3): Comparison between the average nutrient intakes and RDA in boys (n=100)

Nutrient	Mean (nutrient intakes)	S.D	RDA	t-value	P-value
Calories	2231.76	50.73	2500.00	8.39	0.003**
Retinol (U gm)	877.01	62.85	1000.00	2.56	0.012*
Carbohydrate (gm)	311.17	6.67	344.00	6.51	0.001**
Fat (gm)	84.29	1.98	92.00	6.80	0.004**
Protein (gm)	57.12	2.39	45.00	7.29	0.001**
Potassium (mg)	1723.59	80.25	1525.00	2.71	0.008**
Phosphorus (mg)	1462.92	104.98	1200.00	2.83	0.006**
Sodium (mg)	1360.37	72.45	1500.00	2.42	0.180
Calcium (mg)	705.08	46.75	1200.00	14.39	0.002**
Vitamin C (mg)	210.74	24.89	50.00	10.69	0.004**
Niacine (mg)	28.27	2.12	17.00	8.90	0.006**
Iron (mg)	14.58	0.47	12.00	6.58	0.001**
Piboflavin (mg)	3.13	0.23	1.50	11.90	0.005**
Thiamine (mg)	1.94	0.10	1.50	6.69	0.009**

RDA= Recommended daily Allowance

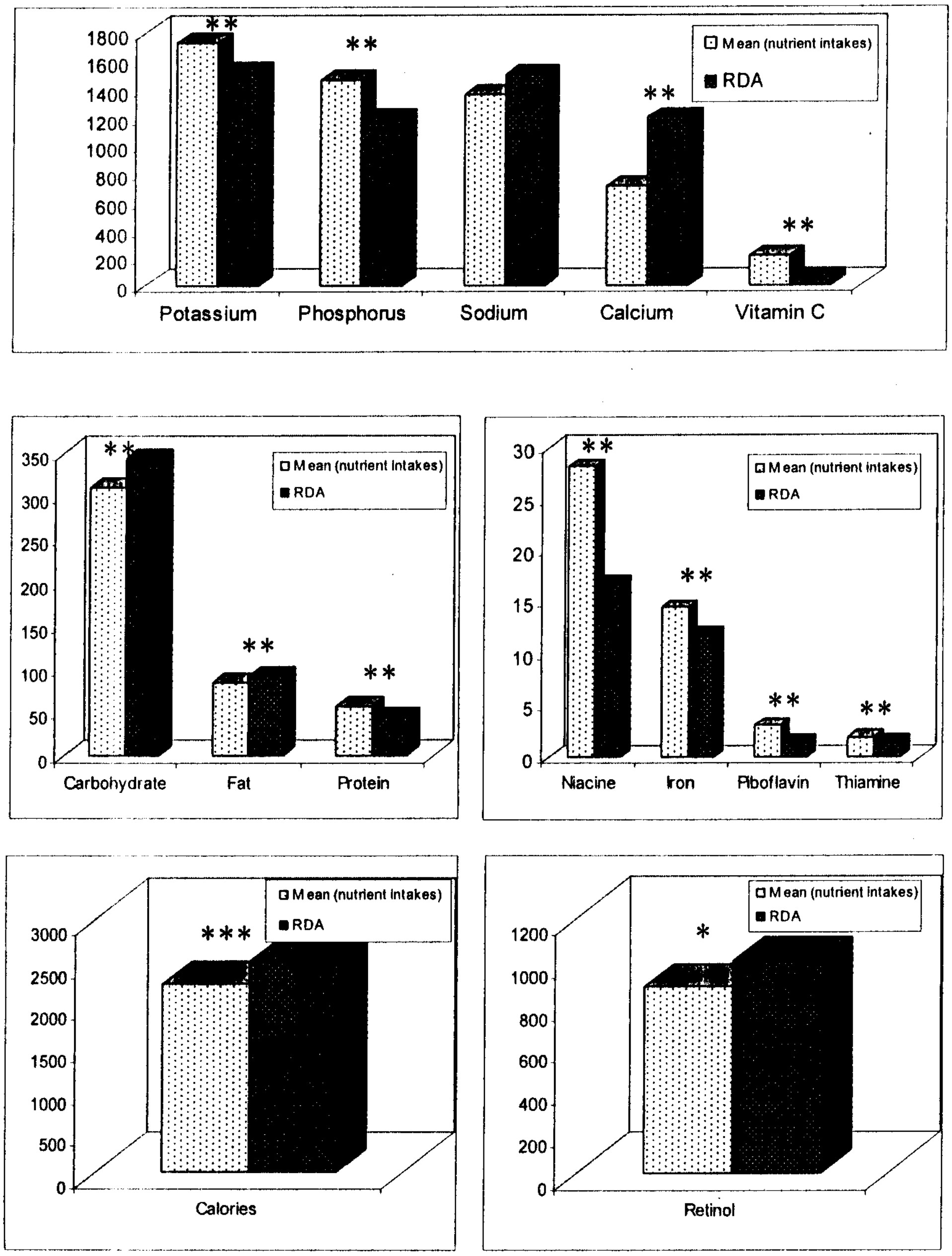
S.D = Standard Deviation

*= There is a significant difference between nutrient intakes and RDA by using independent t- test at $p<0.05$

**= There is a significant difference between nutrient intakes and RDA by using independent t- test at $p<0.01$

***= There is a significant difference between nutrient intakes and RDA by using independent t- test at $p<0.001$

Fig (5): Comparison between the average nutrient intakes and RDA in boys



*= There is a significant difference between nutrient intakes and RDA by using independent t- test at p<0.05

**= There is a significant difference between nutrient intakes and RDA by using independent t- test at p<0.01

***= There is a significant difference between nutrient intakes and RDA by using independent t- test at p<0.001

Table (4) shows the comparison between the average nutrient intakes and RDA in girls. The table results show that there is a significant difference between the average nutrient intakes and RDA in all nutrients except Calories, Retinol, Carbohydrate, and Sodium. The average nutrient intake from Fat (80.86 vs. 84 in RDA), Phosphorus (1124.38 vs. 1200 in RDA) and Calcium (624.47 vs. 1200 in RDA) is less than the RDA. Average nutrient intake from Protein, Potassium, Vitamin C, Niacin, Iron, Riboflavin and Thiamine is more than the RDA.Figures (6) show the comparison between the average nutrient intakes and the RDA in girls.

Table (4): Comparison between the average nutrient intakes and RDA in girls (n=100)

Nutrient	Mean (nutrient intakes)	S.D	RDA	t-value	P-value
Calories	2245.87	40.89	2300.00	1.97	0.052
Retinol (U gm)	798.28	63.43	800.00	0.04	0.971
Carbohydrate (gm)	324.39	5.54	317.00	1.89	0.062
Fat (gm)	80.86	2.19	84.00	2.52	0.013*
Protein (gm)	55.15	2.34	46.00	5.82	0.005**
Potassium (mg)	1667.78	67.40	1525.00	2.68	0.009**
Phosphorus (mg)	1391.21	61.58	1500.00	2.25	0.027*
Sodium (mg)	1124.38	82.30	1200.00	1.21	0.230
Calcium (mg)	624.47	48.73	1200.00	16.67	0.004**
Vitamin C (mg)	158.77	17.15	50.00	9.30	0.001**
Niacine (mg)	20.05	0.79	15.00	6.95	0.009**
Iron (mg)	17.41	0.49	15.00	5.25	0.006**
Piboflavin (mg)	2.89	0.18	1.30	13.40	0.002**
Thiamine (mg)	1.603	0.06	1.00	13.92	0.001**

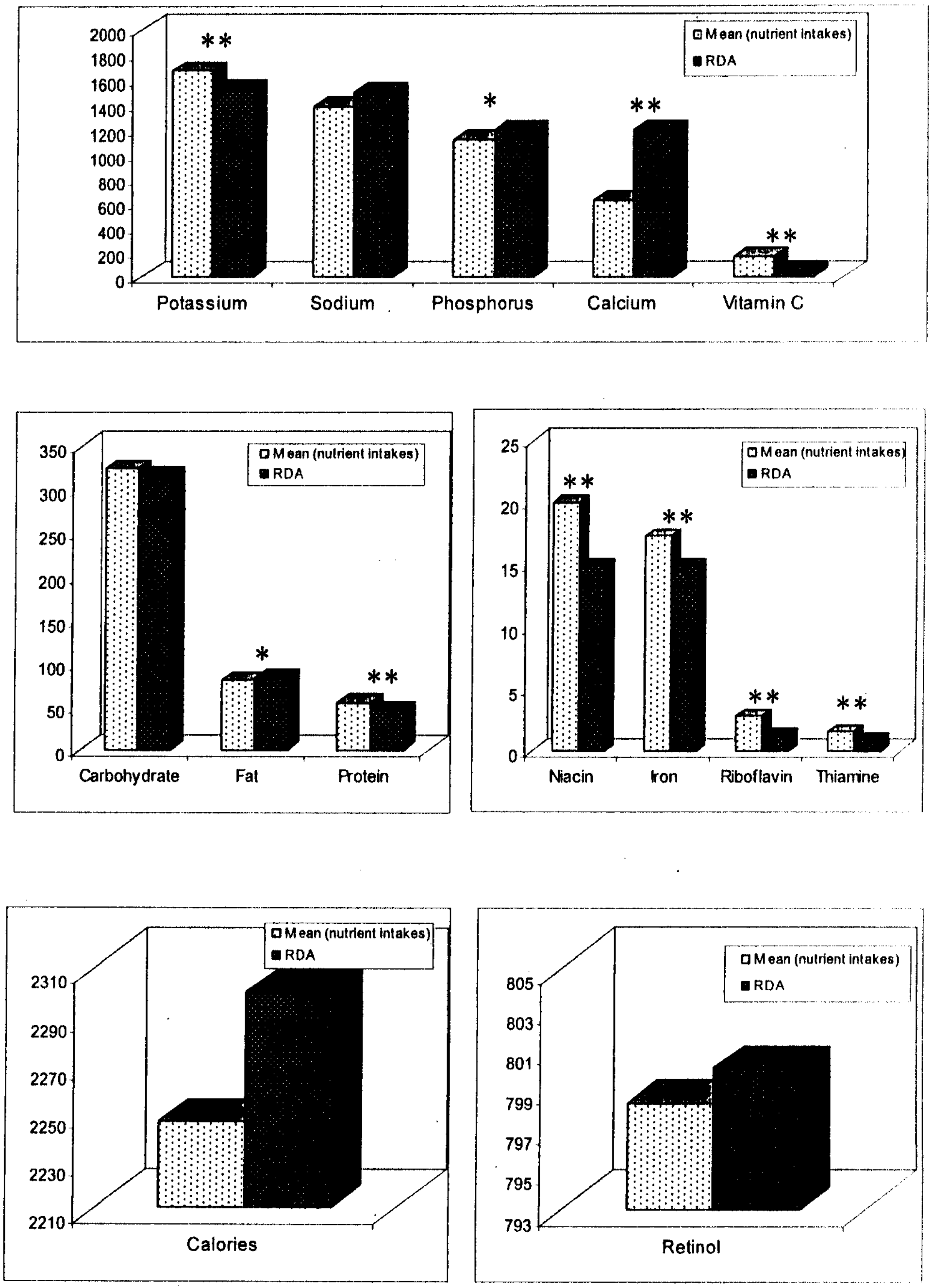
RDA= Recommended daily Allowance

S.D = Standard Deviation

*= There is a significant difference between nutrient intakes and RDA by using independent t- test at $p<0.05$

**= There is a significant difference between nutrient intakes and RDA by using independent t- test at $p<0.05$

Fig (6): Comparison between the average nutrient intakes and RDA in Girls



*= There is a significant difference between nutrient intakes and RDA by using independent t- test at p<0.05

**= There is a significant difference between nutrient intakes and RDA by using independent t- test at p<0.01

Table (5) shows the comparison between boys and girls in average nutrient intakes. The table results show that there is a significant difference between boys and girls in the average of Fat (84.29 in boys vs. 80.86 in girls), Carbohydrate (311.17 in boys vs. 324.39 in girls), Phosphorus (1462.92 in boys vs. 1124 in girls), Iron (14.59 in boys vs. 17.41 in girls), Thiamine (1.94 in boys vs. 1.6 in girls), Niacin (28.27 in boys vs. 20.05 in girls) and Vitamin C (210.74 in boys vs. 158.77 in girls). And there is no significant difference between boys and girls in the average of the other nutrient intake.

Average nutrient intake from Fat, Phosphorus, Thiamine, Niacin and Vitamin C is higher in boys than girls. But the average nutrient intake from Carbohydrate and Iron is higher in girls than boys. Figures (7) show the Comparison between boys and girls in average nutrient intakes.

Table (5): Comparison between boys and girls in average nutrient intakes

Nutrient	Boys	Girls	t-value	p-value
	Mean ± S.D	Mean ± S.D		
Calories	2231.76± 44.1	2245.87± 39.59	0.34	0.738
Retinol (U gm)	877.09± 60.65	798.28± 59.84	1.17	0.243
Carbohydrate (gm)	311.17± 6.78	324.39± 5.65	2.07	0.040*
Fat (gm)	84.29± 2.02	80.86± 2.13	2.04	0.043*
Protein (gm)	57.12± 2.61	55.15± 2.52	0.86	0.391
Potassium (mg)	1723.59± 88.24	1667.78± 68.13	0.62	0.539
Phosphorus (mg)	1462.92± 112.68	1124.39± 82.49	3.02	0.003**
Sodium (mg)	1360.37± 70.52	1391.21± 61.18	0.41	0.683
Calcium (mg)	705.08± 49.14	624.47± 49.25	1.65	0.100
Vitamin C (mg)	210.74± 20.79	158.77± 17.44	2.73	0.007**
Niacine (mg)	28.27± 2.03	20.05± 1.49	5.63	0.003**
Iron (mg)	14.59± 0.47	17.41± 0.54	4.67	0.001**
Piboflavin (mg)	3.13± 0.17	2.89± 0.15	1.30	0.197
Thiamine (mg)	1.94± 0.13	1.6± 0.10	4.25	0.009**

S.D = Standard Deviation

* = There is a significant difference between boys and girls in nutrient intakes by using independent t- test at $p<0.05$

** = There is a significant difference between boys and girls in nutrient intakes by using independent t- test at $p<0.01$

Fig. (7): Comparison between the boys and girls in average nutrient intakes

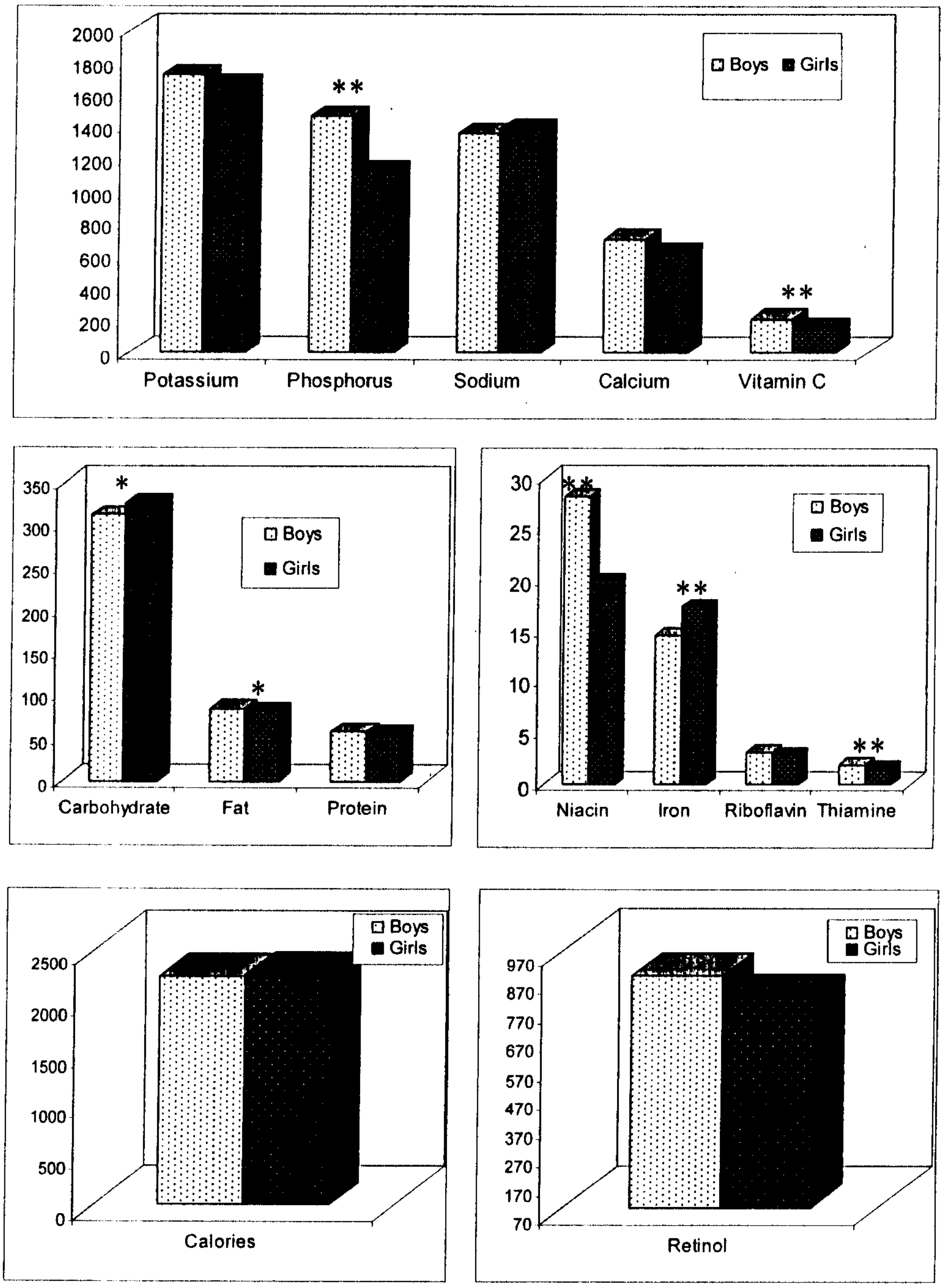


Table (6): shows that there is a significant difference between boys and girls in number of meals by using independent t-test, the average number of meals of boys (mean ± S.D= 3.05 ± 0.04) is higher than the corresponding of girls (mean ± S.D= 2.85 ± 0.07). There is a significant difference between boys and girls in physical activities which includes activities within the school break, walking to school or practicing physical exercise (min. /day). The table results show that girls are lower in physical activities than boys (mean ± S.D= 115.25 ± 6.03). Figures (8) and (9) show these results.There is a significant difference between boys and girls in body mass index BMI (weight/ height^2 in meter). The table results show that girls are higher in body mass index than boys (mean ± S.D= 22.93 ± 4.10). There is no significant difference between boys and girls in bone mineral density (BMD).

Table (6): Comparison between boys and girls in number of meals and average (min/day) of exercises

Variables	Boys	Girls	t-value	p-value
	Mean ± S.D	Mean ± S.D		
Number of meals per day	3.05 ± 0.04	2.85 ± 0.07	4.16	0.002**
Physical activity (min./day)	171.80 ± 8.63	115.25 ± 6.03	7.19	0.005**
BMI	20.70 ± 4.03	22.93 ± 4.10	3.90	0.000**
BMD	0.33 ± 0.04	0.34 ± 0.06	1.04	0.302

* = There is a significant difference between boys and girls by using independent t- test at p<0.05
** = There is a significant difference between boys and girls by using independent t- test at p<0.01

Fig.(8): comparison between boys and girls in number of meals per day

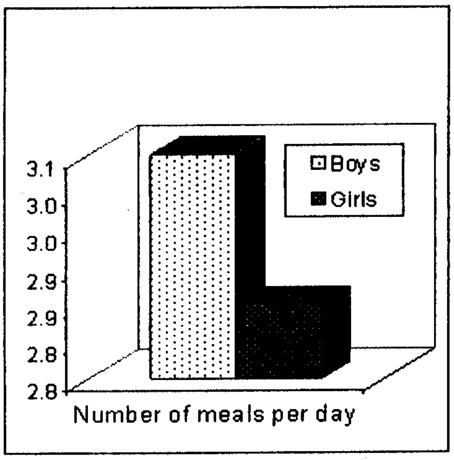


Fig.(9): comparison between boys and girls in Physical activity

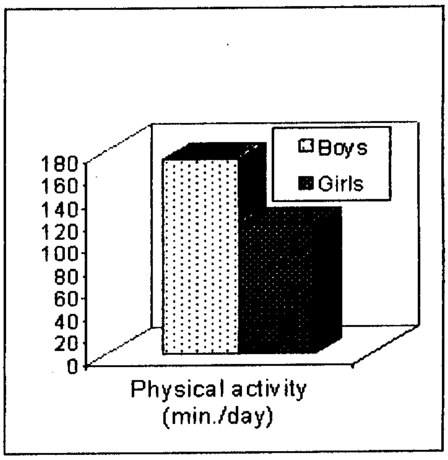


Table (7) shows that there is no significant difference between boys and girls in each of the studied life style by using Chi square test of distribution except arriving to school by walking. Girls are more likely to go to schools walking. 73 percent of girls in the studied group like to go to school by walking while 26.9 percent only of boys like to go to school by walking. The table results also show that there is no significant difference between boys and girls in house sun exposure.

Table (7): Comparison between boys and girls regarding to life style habbits

Life style	Boys		Girls		Total		χ^2	p-value
	Frequency	%	Frequency	%	Frequency	%		
Number of meals outside the home	32	46.4%	37	53.6%	69	100%	0.36	0.540
Regularity of diets	60	54.5%	50	45.5%	110	100%	0.90	0.340
Meals with the family	84	52.5%	76	47.5%	160	100%	0.40	0.520
Obesity in the family	19	40.4%	28	59.6%	47	100%	1.72	0.180
Underweight in the family	44	44.0%	56	56.0%	100	100%	1.44	0.230
Practicing walking	73	54.1%	62	45.9%	135	100%	0.89	0.340
Arriving to school by walking	7	26.9%	19	73.1%	26	100%	5.53	0.010*
Practicing activities	80	49.7%	81	50.3%	161	100%	0.01	0.937
House sun exposure	74	52.5%	67	47.5%	141	100%	3.09	0.070

*= significant difference by using Chi square test at p-value<0.05

Table (8) shows the Comparison between boys and girls in number of meals outside the home per day (32 vs. 37). There is no much preference of having meals outside home between boys and girls. Figure (10) shows this result

Table (8): Comparison between boys and girls in number of students eating outside the home per day

number of outside meals/day	Boys		Girls		Total	
	No.	%	No.	%	No.	%
Yes	32	46.4%	37	53.6%	69	100%
No	68	54.0%	58	46.0%	126	100%

$\chi 2=2.76$, $p>0.05$

Fig. (10): Comparison between boys and girls in number of meals outside the home

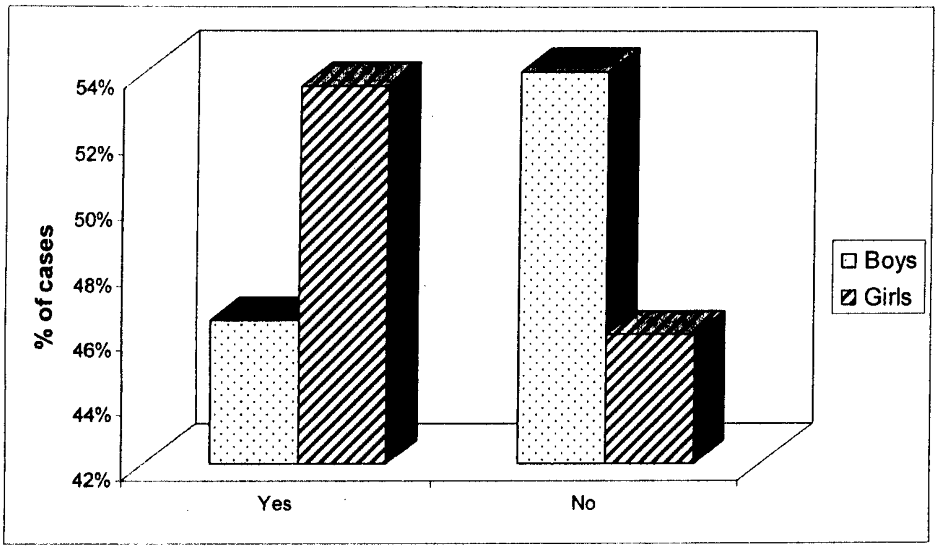


Table (9) shows the Comparison between boys and girls in regularity of diets. There is no much preference of regularity of diets between boys and girls (60 vs. 50). Figure (11) shows this result.

Table (9): Comparison between boys and girls in regularity of diets

regularity of diets	Boys		Girls		Total	
	No.	%	No.	%	No.	%
Yes	60	55%	50	46%	110	100%
No	27	46%	32	54%	59	100%

$\chi 2=2.31$, $p>0.05$

Fig.(11): Comparison between boys and girls in regularity of diets

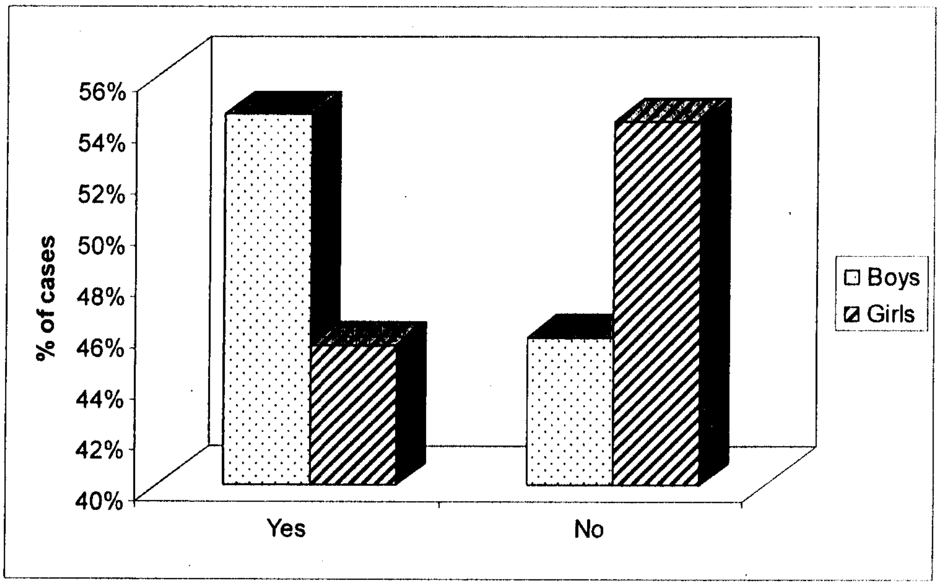


Table (10) shows the Comparison between boys and girls in meals with the family. There is no much preference of meals with the family between boys and girls (84 vs. 76). Figure (12) shows this result.

Table (10): Comparison between boys and girls in meals with the family

Meals with the family	Boys		Girls		Total	
	No.	%	No.	%	No.	%
Yes	84	52.5%	76	47.5%	160	100%
No	11	32.4%	23	67.6%	34	100%

$\chi 2=1.86$, $p>0.05$

Fig.(12): Comparison between boys and girls in meals with the family

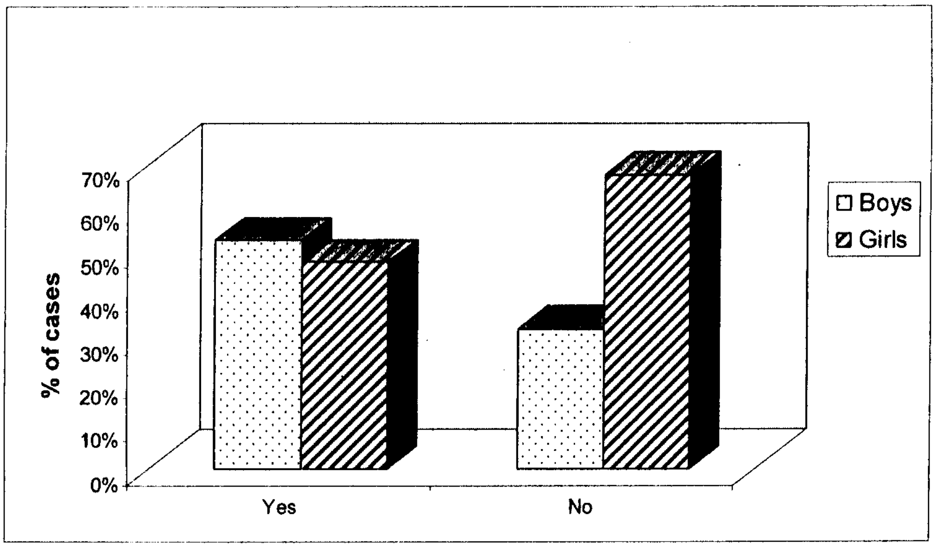


Table (11) shows the Comparison between boys and girls in existence of obesity in the family. There is no much prevalence of obesity in the family between boys and girls (19 vs. 28). Figure (13) shows this result.

Table (11): Comparison between boys and girls in existence of obesity in the family

Obesity in the family	Boys		Girls		Total	
	No.	%	No.	%	No.	%
Yes	19	40.4%	28	59.6%	47	100%
No	78	59.6%	71	40.4%	149	100%

$\chi 2=2.43$, $p>0.05$

Fig.(13): Comparison between boys and girls in existance of obesity in the family

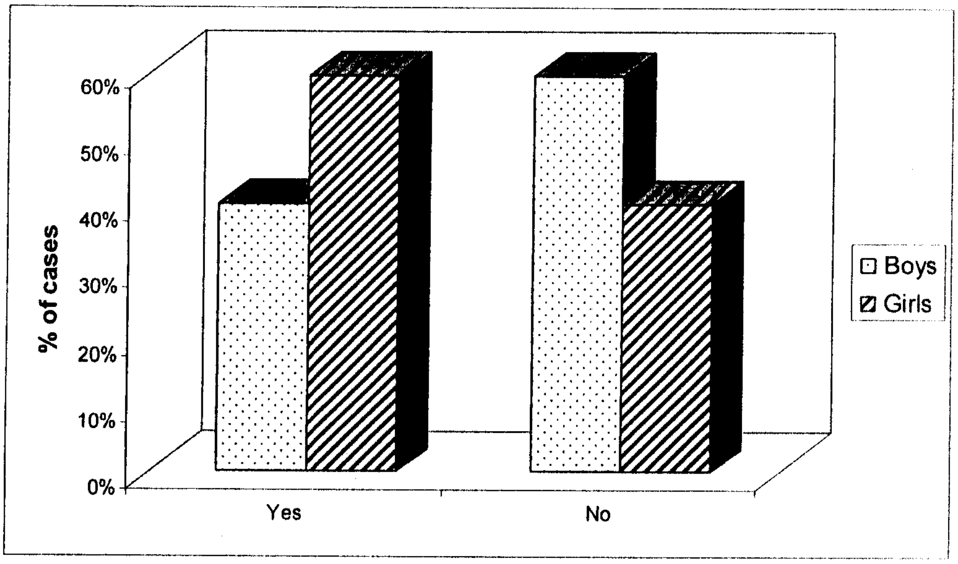


Table (12) shows the Comparison between boys and girls in existence of underweight in the family. There is no much prevalence of underweight in the family between boys and girls (44 vs. 56). Figure (14) shows this result.

Table (12): Comparison between boys and girls in existence of underweight in the family

Underweight in the family	Boys		Girls		Total	
	No.	%	No.	%	No.	%
Yes	44	44.0%	56	56.0%	100	100%
No	53	55.2%	43	44.8%	96	100%

$\chi 2=1.36$, $p>0.05$

Fig.(14): Comparison between boys and girls in existance of underweight in the family

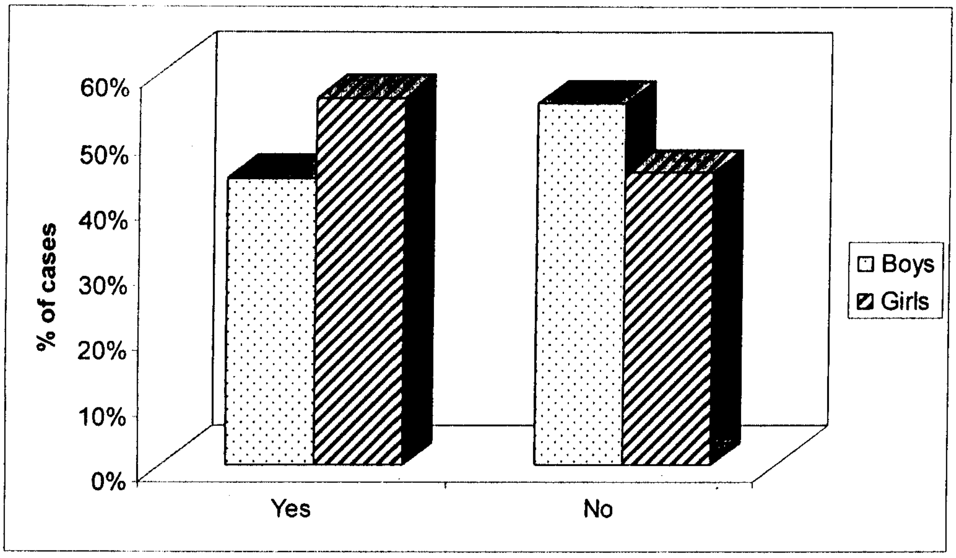


Table (13) shows the comparison between boys and girls in practicing walking. There is slight preference of practicing walking in boys than girls (73 vs. 62). Figure (15) shows this result.

Table (13): Comparison between boys and girls in practicing walking

Practicing walking	Boys		Girls		Total	
	No.	%	No.	%	No.	%
Yes	73	54.1%	62	45.9%	135	100%
No	24	41.4%	34	58.6%	58	100%

$\chi 2=1.97$, $p>0.05$

Fig.(15): Comparison between boys and girls in practicing walking

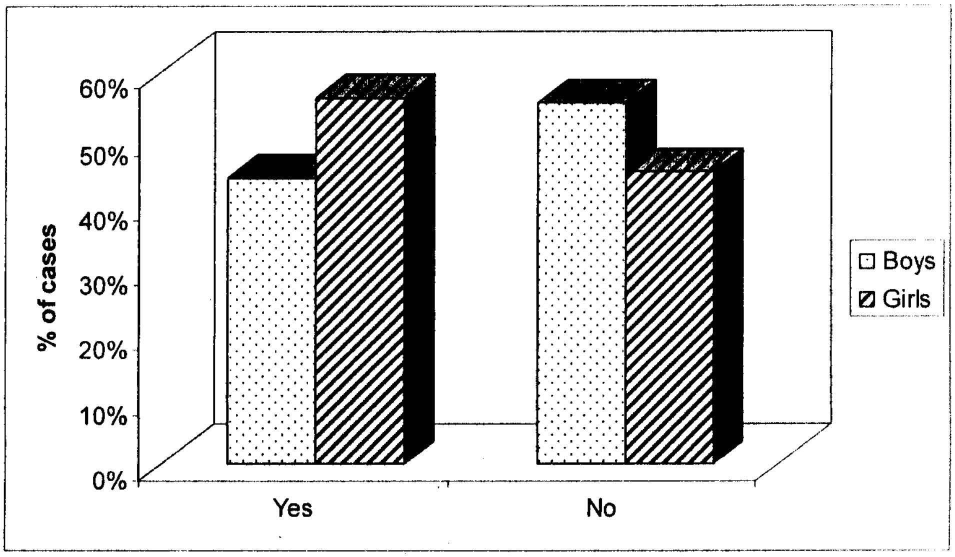


Table (14) shows the Comparison between boys and girls in the method of arriving to school. There is much preference of walking to schools in girls than boys (73.1% for girls versus 26.9% only for boys).

Table (14): Comparison between boys and girls in the method of arriving to school

Method of arriving to school	Boys		Girls		Total	
	No.	%	No.	%	No.	%
Walking	7	26.9%	19	73.1%	26	100%
Transportation	88	53.3%	77	46.7%	165	100%

$\chi 2=5.56$, $p<0.05$

Fig.(16): Comparison between boys and girls in the method of arriving to school

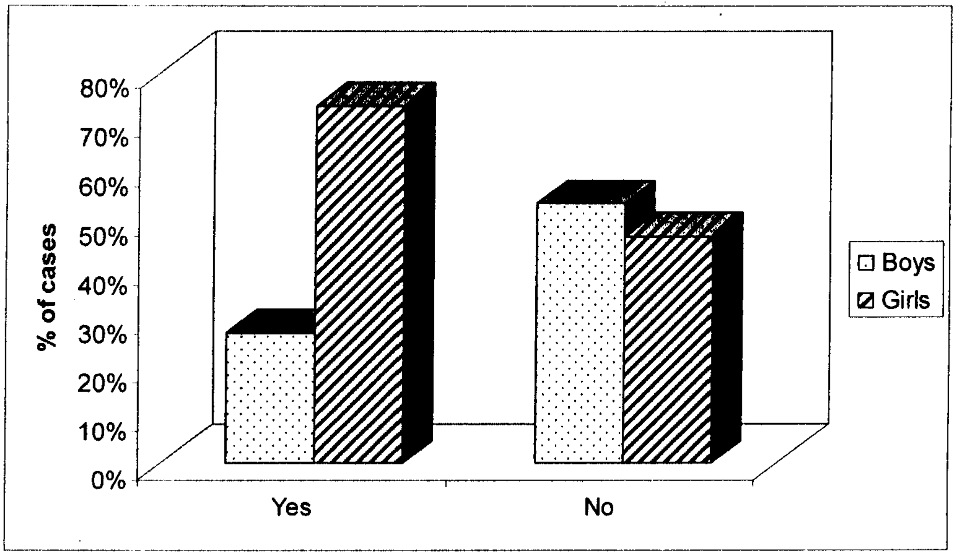


Table (15) shows the comparison between boys and girls in house sun exposure. There is no much different between boys and girls (74 vs. 67). Figure (17) shows this result.

Table (15): Comparison between boys and girls in house sun exposure

House sun exposure	Boys		Girls		Total	
	No.	%	No.	%	No.	%
Yes	74	52.5%	67	47.5%	141	100%
No	13	32.5%	27	67.5%	40	100%

$\chi 2=2.79$, $p>0.05$

Fig.(17): Comparison between boys and girls in house sun exposure

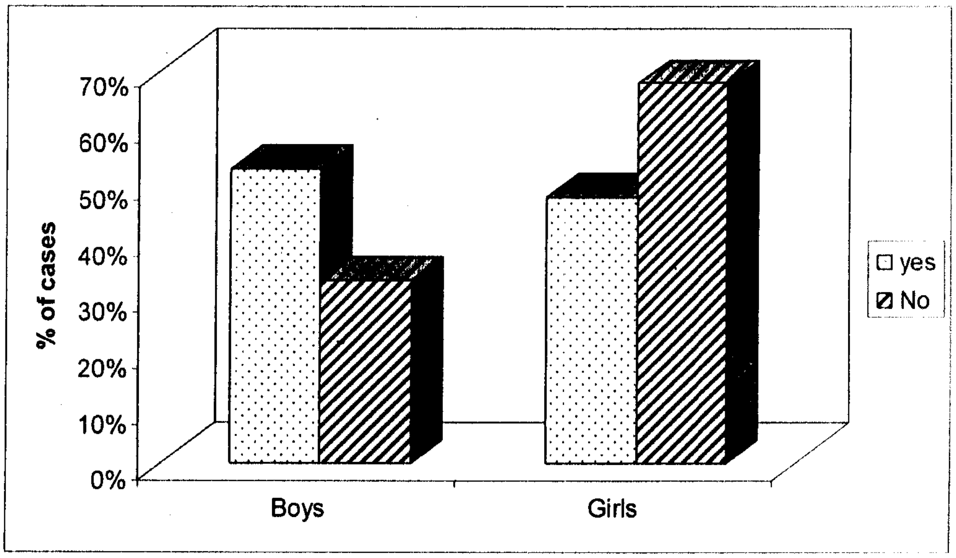


Table (16) shows the correlations between Bone Mineral Density, daily Calcium intake, Physical activity (min./day), age and some of anthropometric measurements in boys and girls. The table results show that there is no correlation between Bone Mineral Density and the daily calcium intake in mg, a strong positive correlation between bone mineral density and physical activity (min./day) in boys (r = 0.972, p<0.001). Also there is no correlation between Bone Mineral Density and the daily calcium intake in mg, a strong positive correlation between bone mineral density and physical activity (min./day) in girls (r = 0.898, p<0.001). This means that as physical activity (min./day) increases bone mineral density increases. There is a positive correlation between age and bone mineral density in girls (r = 0.516, p<0.05). There is a weak correlation between the bone mineral density and each of the anthropometric measures in boys and girls. Figures (18) and (19) show these results.

Table (16): Correlations between Bone Mineral Density with daily Calcium intake, Physical activity (min./day), age and some of anthropometric measurements

		BMD (Boys)	BMD (Girls)
Calcium (mg)	r	0.418	0.055
	p-value	0.412	0.586
Physical activity (min./day)	r	0.972	0.898
	p-value	0.002**	0.003**
AGE	r	-0.024	0.516
	p-value	0.810	0.020*
Weight	r	0.448	0.438
	p-value	0.049*	0.049*
Height	r	0.407	0.339
	p-value	0.048*	0.047*
Arm Circumference	r	0.330	0.319
	p-value	0.048*	0.049*

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Fig.(18): The correlation between Physical activity (min./day) and bone mineral density of boys in the study group

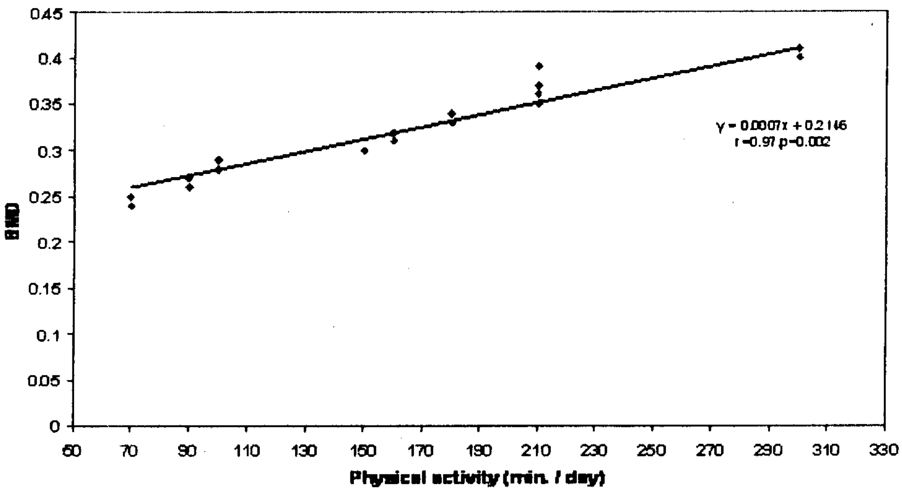
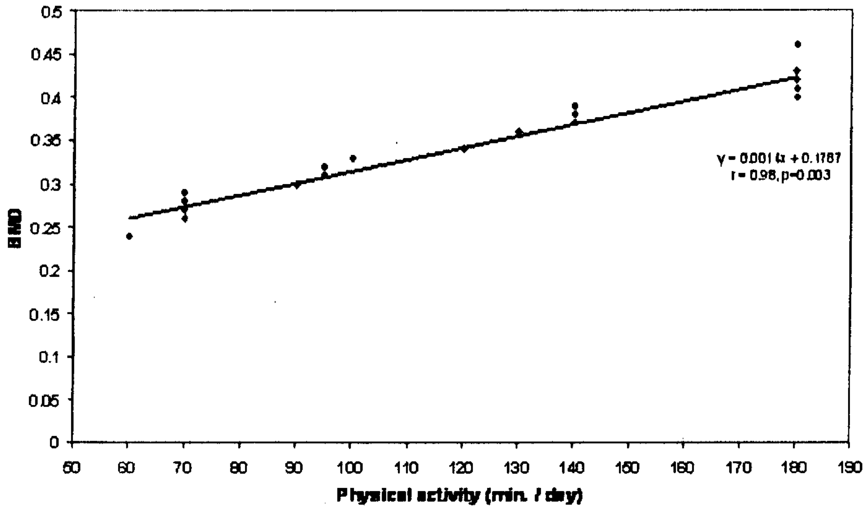


Fig.(19): The correlation between Physical activity (min./day) and bone mineral density of girls in the study group



Discussion

Discussion

Growth and development in anthropometric measures and Bone Mineral Density in adolescent's boys and girls:

The results showed that there was a significant difference between the pre follow up and post follow up measure of weight, height and arm circumference of boys. The mean of weight and of height increases in the post follow up measure than the pre follow up (52.05 vs. 50.90 in weight, 157.79 vs. 155.69 in height and 23.13 vs. 21.79 in arm circumference). Also the results showed that there was no significant difference between the pre follow up and post follow up measure of body mass Index and in bone Mineral Density as the time interval was not long enough.

The results showed also that there was a significant difference between the pre follow up and post follow up measure of weight, height and arm circumference of girls. The mean of weight and of height increases in the post follow up measure than the pre follow up (51.49 vs. 49.83 in weight, 149.20 vs. 146.90 in height and 24.04 vs. 22.54 in arm circumference). Also the table results showed that there was no significant difference between the pre follow up and post follow up measure of body mass Index and in bone Mineral Density since the time interval was not long enough.

The findings revealed that, the peak of BMD for boys and girls may be due to their higher weights, heights and body mass index (BMI). These results are in agreement with Adult Egyptian

Data by Nadia L. Soliman et al, (2002); Thailand reference data by Pongchaiyakul et al, (2002); and Lebanon by Maalouf et al, (2000). The current results go in line with many bone densitometry studies that the BMD decreased by age after achieving the peak. This is obvious in both genders which may be attributed to a dramatic decline in sex hormones status. Actually, the effect of estrogen on the skeleton has been the subject of intensive investigation. More over, it is generally accepted and documented that there are many intervening environmental factors that impinge on normal peak bone mass and exert modifying effects on its accumulation (Riggs and Melton, 1986; El-Desouki, 1995; Shore et al, 1995; Bainbridge et al, 2004; Shonau, 2004; Kemmler et al, 2006). Nutrition is an important modifiable factor in the development and maintenance of bone mass. Therefore adequate provision of nutrients composing bone matrix constituents and regulating its metabolism as vitamins should be provided from birth in order to achieve maximal compatibility of hard tissue (Gordon, 2000; Eisman, 2001).

Several studies revealed that the measures of body size associated with BMD to a greater extent in weight bearing sites i.e. the larger body size, the greater BMD and the smaller skeletal size, the lesser BMD and those were under severe weight reduction programmed diet and dietary refraint leads to considerable amount of bone loss (Fogelholm et al, 2001; Liao et al, 2003; Liao et al, 2004; Torstveit and Sundgot- Borgen, 2005). It is reported by Dinnie et al, 2000 that the body weight, body mass index are positively associated with BMD which may be attributed to several factors: increase weight is associated with increase level of serum calcitonin, androgens, estrogen and mechanical stress, all of which may be protective against the age related bone loss (Aust. J. Basic ,2009). The most powerful stimuli for bone formation are supposed to be stretching of muscles. The age related loss of bone mass density may be partly due to loss of muscular wasting. However, the increase of bone mass density in obese may be due to increase muscular power to support the increase in body weight (Morii and Takaishi, 2006; Hsu et al, 2006).

Body weight: the greater the body mass, the greater is the bone mineral density (BMD), and the opposite is also true in heavier individuals. Limited exercise: immobility in varying degrees is a well recognized cause of bone loss. Stresses from muscle contractions and the body in an upright position against the pull of gravity stimulate osteoblast function (Anderson, 2000).

Age factor is one of the important factors of fracture incidence. Fracture risk is much higher in the elderly than in young (Slemenda, et al, 1991) the frequency of hip fractures in particular increases exponentially with age, especially after the age of 70, in both men and women in most regions of the world (Cummings and Melton, 2002).

But these results are not clear in our study since the bone mass for the adolescents in this age is not complete, also the difference between the bone mass for boys and girls in this age is not clear.

Comparison between the average nutrient intakes and RDA in adolescent's boys and girls

For nutrient intakes and RDA in boys, our results show that there was a significant difference between the average nutrient intakes and RDA in all nutrients except Sodium. The average nutrient intake from Calories (2231 vs. 2500 in RDA), Retinol (877.01 vs. 1000 in RDA), Carbohydrate (311.17 vs. 344 in RDA), Fat (84.29 vs. 92 in RDA), and Calcium (705.08 vs. 1200 in RDA) are less than the RDA. But the average nutrient intake from Protein, Potassium, Phosphorus, Vitamin C, Niacin, Iron, Riboflavin and Thiamine is more than the RDA.

These results was in agreement with the study which adopt that the older children and adolescents currently do not achieve the recommended intake of calcium. Maintaining adequate calcium intake during childhood and adolescence is necessary for the development of peak bone mass, which may be important in reducing the risk of fractures and osteoporosis later in life. Optimal calcium intakes is especially relevant during adolescence, when most bone mineral accretion occurs. A well-rounded diet including low – fat dairy products fruits and vegetables with appropriate physical exercise are important for achieving good bone health and establishing these practices in childhood is important so that they will be followed throughout the life span (Greerand and Krebs, 2006).

As for the average nutrient intakes and RDA in girls. The table results show that there is a significant difference between the average nutrient intakes and RDA in all nutrients except Calories, Retinol, Carbohydrate, and Sodium. The average nutrient intake from Fat (80.86 vs. 84 in RDA), Phosphorus (1124.38 vs. 1200 in RDA) and Calcium (624.47 vs. 1200 in RDA) is less than the RDA. Average nutrient intake from Protein, Potassium, Vitamin C, Niacin, Iron, Riboflavin and Thiamine is more than the RDA.

The findings revealed that the average nutrient intakes for both boys and girls much less than the recommended RDA in the most of nutrients, these may be due to bad feeding habits or consuming delivery foods or it may be related to socioeconomic status. These results were in agreement with Bone Mineral Density and Bone Markers among Egyptian adolescents done by S. A. Ibrahim et al, 2003; adolescents suffer from negative impacts such as a low body mass index and multinutrient deficiencies that have profound effects on the development of maximal skeletal maturity.

Comparison between boys and girls in the average nutrient intakes

The study results showed that there was a significant difference between boys and girls in the average of Fat (84.29 in boys vs. 80.86 in girls), Carbohydrate (311.17 in boys vs. 324.39

in girls), Phosphorus (1462.92 in boys vs. 1124 in girls), Iron (14.59 in boys vs. 17.41 in girls), Thiamine (1.94 in boys vs. 1.6 in girls), Niacin (28.27 in boys vs. 20.05 in girls) and Vitamin C (210.74 in boys vs. 158.77 in girls). And there is no significant difference between boys and girls in the average of the other nutrient intake.

Average nutrient intake from Fat, Phosphorus, Thiamine, Niacin and Vitamin C was higher in boys than girls. But the average nutrient intake from Carbohydrate and Iron was higher in girls than boys.

The dietary analysis of some American studies showed that overall the children had intakes of energy, total carbohydrate, fibre and iron below the reference nutrient intake (RNI) values recommended by the Department of Health (1991). Their intakes of other nutrients were generally adequate. There was no beneficial effect of additional calcium in gymnasts who already consume their recommended nutrient intake for calcium (K.A. Warda et al., 2007). While total sugars and percentage energy from fat were higher than recommended. As such, these findings are in line, to an extent, with those on older children (Nelson et al., 1990; Clive Hunt, 1995). Girls had significantly lower intakes than boys of energy and all nutrients except vitamin C. For boys and girls nutrient intakes were not related to age, over this age range. Children receiving a free school meal, when compared with those who had a lunch provided by the home, or to those having a paid school meal, had significantly lower daily intakes of most nutrients, (Clive Hunt, 1995).

Phosphorus intakes doesn't seem to influence skeletal homeostasis within normal ranges of intake (RDA 700 mg/day), although through excessive intakes particularly when combined with low calcium intake may be deleterious (Calvo, et al., 1990). Alternatively, adequate phosphorus intake is essential for bone building during growth and low serum phosphate will limit bone formation and mineralization (Heaney, 2004). Foods that are high in phosphorus are milk, milk products poultry, fish, meat, eggs, grains and legumes, and sodas, with only milk also having high amounts of calcium. High phosphorus intakes with low calcium may lead to secondary hyper parathyroidism and bone loss. A diet adequate in calcium, moderate protein and sufficient phosphorus was associated with higher bone density (Whiting, et al., 2002), and also in agreement of the study which conducted by Stear, et al., (2003) on adolescent girls aged 16-18 years regarding the effect of increased of calcium intake on bone mineral status, they found that the effect of calcium intervention shows the magnitude of the effect likely to be produced on population based intervention regardless of habitual calcium intake which varies and that makes it difficult to judge the optimal calcium intake for this age group. Previous studies showed that the effect of calcium supplementation reduces the rate of bone remodeling, leading to modest, increase in bone mass by reducing the remodeling space (Heaney, 2001).

Other studies showed that the effect of supplementation disappears once the supplement is withdrawn (Lee, et al., 1997).

Comparison between boys and girls in frequency of exercises and number of meals:

In order to benefit from nutrition, the boy or the girl must be doing a minimum of one hour per day of physical exercise. Exercise in excess in women particularly may lead to disruption of menstrual cycle and cause their estrogen levels to be insufficient for bone growth. On the contrary, exercise too little produces muscle weakness and not strong enough to protect the bones. Everybody knows the importance of exercise for health, especially bone, exercise in adolescents, often leads to obtain the maximum bone mass appropriate to body building for the adolescents (National institute of health (2003).

The present study showed a significant difference between boys and girls in number of meals with the average number of meals in males (3.05) while in female (2.85), there was also a significant difference between boys and girls in physical activities within school break, walking to school or practicing physical exercise (min/day). The girls are lower in physical activities than boys (115.25 vs 171.80). The reason could be that girls prefer to sit more on the computer, television for longer time than boys.

Comparison between boys and girls in meals with family:

Having meals with the family is not very common among the adolescents as they eat must of their meals outside the home mostly having breakfast at school, and unfortunately they eat foods high is calories, also they don't have always dinner at home, mostly preferring fast food. The bad feeding habits make children eat unhealthy food leading to obesity or underweight. The researchers explained that to congregate around dining table has many psychological benefits and also help in monitoring what their children eat avoiding bad feeding habits such as soft drinks, high-calorie diets such as fried foods and also help to adjust the amounts they eat to discipline the children and control the quality and quantity of food consumed (American Dietetic Association (2001)). The present study showed that there was no much preference between boys and girls in number of meals outside home but showed a considerable number of boys and girls that prefer to have meals outside of the home.

Comparison between boys and girls in household sun exposure:

Studies suggested that physical activity and sun exposure to sunlight are important in the bone mineralization of prepubertal male and female children. The magnitude of both gender and environmental differences in bone mass in this age group is substantial, suggesting that modification at this stage of life may influence peak bone mass and possibly fracture risk in later life (National institute of health (2002)). In the recent study there was no much difference between boys and girls in household sun exposure.

Correlations between Bone Mineral Density, Physical activity, age and some of anthropometric measurements in boys and girls:

The study results showed that there was a strong positive correlation between bone mineral density and physical activity (min./day) in boys ($r = 0.972$, $p<0.001$). Also there was a strong positive correlation between bone mineral density and physical activity (min./day) in girls ($r = 0.898$, $p<0.001$). This means that as physical activity (min./day) increases bone mineral density increases. There was a positive correlation between age and bone mineral density in girls ($r = 0.516$, $p<0.05$). There was a weak correlation between the bone mineral density and each of the anthropometric measures in boys and girls. These results are in agreement with Luiz Antônio et al. (2005); stating that boys who suffered forearm fracture showed lower bone mineral density compared with the control group. In the case group, milk intake and physical activity were lower than in the control group. Also this result was in support of Muhsin et al. (2003) stating the importance of calcium intake and bone mineralization in the prepubertal stage, suggested by our findings, which yielded a positive correlation only in the prepubertal stage. One of the reasons for the same effect not being observed in puberty is thought to be due to the hormonal changes and active role of sex steroids. This shows how critical the prepubertal period is for future bone health. During this critical period of prepuberty, the significance of nutrition and physical activity is evident.

Our results were in line also with the study of the main effects of calcium intake and physical exercise on bone gain have been reported in a number of randomized, controlled trial in children (Heáney, et al., 2000). The effects may differ at bone, the stage of maturity of the growing skeleton, or the interdependency of calcium intake and physical activity. Cortical – rich bone regions, have responded more to calcium supplementation in most trial than trabecular- rich regions (Wosje and Specker, 2000). On the other hand, activity trials in children have shown significant increases in trabecular bone (French, et al., 2000). Mechanical loading stimulates trabecular number and size (Rubbin, et al., 2002). Activity trials usually are more effective in prepubertal children possibly because of synergistic activity between exercise and growth hormone (Bass, 2000). Findings on the benefits of calcium supplementation in prepubertal VS. Pubertal children have been inconsistent. In the study of calcium supplementation that has spanned puberty, the benefits of calcium on bone were greater during the pubertal growth spurt than during bone consolidation (Matkovic, et al., 1994).

The study results was in agreement of Nadia L. Soliman et al. (2009), that there was a significant correlation between bone density and the anthropometric measurements in all sites and in all age groups. Also by Adam D.G et al. (2008), that Physical activity in adolescence is beneficial for increasing bone mineral density; however, it's unclear whether these benefits persist into adulthood.

Alan D Rogol, et al. (2000) says that nutritional status and heavy exercise training are only two of the major influences on the linear growth of children.

RW Jakes (2001) is in agreement of the recent study that high impact activities may help preserve bone density and reduce the risk of fracture.

Similarly, a protective effect of exercise has been proposed to explain the lower prevalence of osteoporosis among women of Asian and African heritage (Melton, 1991). Clinical trials do suggest that exercise programmes can preserve bone mass (Gleeson, 1990).

Researches pointed out that, by using radiologic measures of bone health, physical activity is the most important modifiable factor that determines increased bone growth and development in adolescents (Lanoa, et al., 2005) this was confirmed recently by a 10- year longitudinal study in adolescents (Lloyd, et al., 2004).

Primary prevention during growth and adolescence should aim at attainment of a high peak bone mass, adequate calcium intake, exercise and early diagnosis and treatment of potential skeletal deformities (Karlesson, 2004).

Epidemiologic studies of the relation between physical activity and risk for osteoporotic fracture have been suggestive but inconclusive. Case-control studies have shown that person, with fractures are more likely to report having been inactive recently and earlier in their lives (Grisso, etal, 1997). In a prospective study (paganini-Hill, etal, 1991), it was found that women and men who were active for at least 1 hour daily had a 38% and 49% reduced risk for femur, hip fracture, respectively, compared with their less active peers.

Other prospective studies with lower statistical power have suggested that physical activity protects against hip fracture but have not found these relations to be statistically significant in multivariate analysis (Wickhem, etal., 1989). In an earlier examination of the risk factors for hip fracture among women in the study of osteoporotic fractures (Cummings, etal., 1995), It was found that women who reported willing for exercise had a statistically significant 30% reduction in risk for hip fracture compared with women who did not walk for exercise.

Physical activity may prevent hip fractures in several ways. Exercise may reduce the likelihood of falling or may enable a protective response in the event of fall through enhanced balance reaction time, coordination, mobility and muscle strength (Nelson, etal., 1994). Exercise may also enhance bone mineral density or the structural integrity of bone, reducing the likelihood of fracture in the event of fall (chilibech, etal., 1995). The link between physical activity and hip fracture, however in multifactorial and is not completely explained by its effects on bone mass and muscle strength (Gregg, etal., 1998). Low-intensity activities may be the most effective recommendation for sedentary women. Future research should evaluate whether different type, of patterns of physical activity affecting other types of osteoporotic fracture and whether they do so primarily through effects on the skeleton muscular fitness, or balance or through other mechanisms .

Bone mass grows rapidly until the third decade, keeps more or less constant until the fifth decade in women and the sixth decade in men and then declines. The effects of exercise have been shown in both cross-sectional and longitudinal studies. Cross-sectional studies show that individuals below the age of 50 participating in exercise programmes have an average of 8% greater bone mineral density (BMD) than age and sex matched individuals, while after the age of 50 the difference is only 6%. Longitudinal studies show a 2% increase before age 50 and a 1% increase after 50 (Forwood and Burr, 1993).

Studies showed that children regularly carrying out moderate weight bearing physical exercise have greater bone mass than age matched peers, possibly caused by decreased bone resorption. A study conducted on a group of 26 pre-pubertal boys (age 10 ± 1.4 years), were involved in gymnastic training, spending about 3 hours/ day in active games or sport and 3 hours in secondary activity, such as watching T.V or reading. A second group of 10 children (age 10.4 ± 0.6 years) spent less than 1 hour / day in active games or sport and more than 4 hours in secondary activities. Total body dual energy x-ray absorptiometry scans were performed and bone area (BA) and bone mineral content (BMC) calculated for the whole skeleton and for individual skeletal segments. The number of hours spent on weight – bearing activities was significantly correlated to the BMC at the level of the arms and spine. Each hour per day of weight bearing activity increased total bone density by 2% (Branca, 1999).

Studies showed that environmental factors, such as diet and physical activity, account for 20% of the variance of bone density. Several dietary factors have an influence on bone mass and turnover (Reid and New, 1997), calcium, phosphorus, fluoride, zinc, copper, sodium and potassium. Adequate quantities of such nutrients are probably necessary for exercise to be active on bone mass, though so far this interaction has been proven for calcium only in humans. Calcium intake varies widely among different world populations. Bone mineral density in adulthood has been related to a lifetime calcium intake (Matkovic, 1991).

Weaver, (2000) studied the relationship between dietary calcium, physical activity and bone mass. He concluded that during the development of peak bone mass, calcium intakes of <1 gm /day are associated with lower bone mineral density and at intakes approaching calcium requirements, physical activity is a more important predictor of bone mineral density than is calcium intake. Calcium requirements as modified by physical activity need to be determined for each population subgroup according to sex, age, race and cultural environment.

Summary and Conclusion

Summary and Conclusion

The aim of this study was to identify the association between bone mass including bone mineral density (BMD), with dietary intakes of calcium and phosphorus and physical activities among early adolescents. There are also some specific objectives like identification of risk factors for bone mineralization disorders that many predispose to osteoporosis and fracture risk among susceptible population and to test the effect of physical excise for the prevention of osteoporosis.

A prospective study was conducted with follow-up after six months from April 2008 to October 2008. The study was conducted on at Hoda Sharawi preparatory school for girls and Giza preparatory school for boys.

Data collection included filling of detailed questionnaire from subjects regarding social, nutritional status and physical status. Anthropometric measurements including weight, height, body mass index and arm circumference for all subjects and also densitometry measurements for bone mineral density.

Based on population frame of the schools that were randomly assigned from participating schools, boys and girls from the age of 11-16 were selected by time from April to October 2008 who fulfilled inclusion and exclusion criteria. From the outcome of the random selection, the study ended up with 100 boys and 100 girls who continued with the study for assessment of dietary intakes of calcium, phosphorus, proteins, carbohydrates and fat, also measurement of bone mineral density.

The questionnaires were designed to satisfy the objectives of the study covering major variables related to the study including physical exercise, and dietary 24 hours recall. The demographic variables included age and sex.

Physical activities were calculated by assessment of activities in the school break, walking to school and other physical activities (min./day).

Anthropometric measurements included weight, height, and arm circumference, done independently by two observers in the beginning of the study and after six months.

Dietary assessment was done by food frequency questionnaire including records of energy foods, tissue building foods, protective foods and beverages. In this method every surveyed student was asked to recall foods and beverages intake during the previous 24 hours period. The conversion of subjects consumption measures to grams was achieved through the use of pretreated list of weights of commonly used measures in Egypt and the compiled food consumption tables of the nutrition institute were used to determine energy and nutrient intakes of each individual and to compare this to those of the recommended daily allowances (RDA). The total amount of nutrient intakes and energy consumed were calculated for 4 days of recording and then averaged per day.

The bone mineral density (BMD) was measured for all subjects by a special desitometer acting peripherally on distal forearm bones by using P/I (Peripheral instantaneous x-ray imager). The technique is called DEXA (Dual-energy x-ray absorptiometry).

According to (WHO):

Normal: T-score greater than (-1.0).

Osteopaenic: T-score greater than (-2.5) and less than (-1.0) and osteoporosis: T-score less than (-2.5).

Our study reported a significant increase of the anthropometric measurements (weight, height and arm circumference) between first and second readings in both boys and girls while bone mineral density (BMD) and body mass index (BMI) showed no significant difference since the time interval between first and second readings was not long enough.

The comparison between the average nutrient intakes and RDA in boys showed a significant difference between nutrient intakes and RDA in all nutrients except sodium. Calories, retinol, carbohydrates, fat and calcium were less then RDA while proteins, potassium, phosphorus, vitamin C, niacin, iron, riboflavin and thiamine were more than RDA. The same comparison in girls showed a significant difference between average nutrient intakes and RDA in all nutrients except calories, retinol, carbohydrates, and sodium. The average nutrient intakes from fat, phosphorus and calcium were less than RDA, while average nutrient intakes from protein, Potassium, Vitamin C, niacin, iron, riboflavin and thiamine were more than RDA.

The comparison between boys and girls in average nutrient intakes showed that there was a significant difference between boys and girls in the average intakes of fat, carbohydrates, Phosphorus, iron, thiamine, niacin and vitamin C, while no significant difference in the average of other nutrient .

The comparison between boys and girls in number of meals showed that the average number of meals was higher in boys than in girls.

There was a significant difference between boys and girls in body mass index (BMI), girls were higher than boys.

There was a significant difference between boys and girls in physical activities which include activities within school break, walking to school or practicing physical exercise.

The comparison between boys and girls in number of meals outside homes showed no much preference of having meals outside home between boys and girls same comparison in regularity of diets showed no preference between boys and girls. The same results were also showed in having meals with the family.

The comparison between boys and girls in the study group showed no much prevalence of either obesity or underweight among their families.

The comparison between boys and girls in practicing walking showed slight preference of practicing walking in boys than girls. Meanwhile the method of arriving to school showed much preference of walking to schools in girls than boys.

The correlations between bone mineral density (BMD), daily calcium intake, physical activity (min/day), age and some anthropometric measurements in boys and girls showed that there was a weak correlation between (BMD) and the daily calcium intake, a strong positive correlation between bone mineral density and physical exercise in boys. In girls there was no correlation between bone mineral density and daily calcium intake but a strong positive correlation between physical activity and bone mineral density. That means that as physical activity increases, bone mineral density increases. There was a positive correlation between age and (BMD) in girls. There was also weak correlation between the bone mineral density and each of the anthropometric measures in boys and girls.

In conclusion the study revealed that there was a significant difference between anthropometric reading in first and second reading in both boys and girls but not (BMI) or (BMD). The comparison between average nutrient intakes and (RDA) in boys and girls showed differences either higher or lower while the comparison between boys and girls in average nutrient intakes showed differences in most of the nutrients. The (BMI) showed higher levels in girls while comparison between boys and girls in physical activities showed higher levels of physical activities in boys than girls. The number of meals outside home showed no difference between boys and girls the numbers of meals in general showed higher levels in boys and no differences in regularity of diets. There was no much prevalence of either obesity or underweight among their families. The correlation between (BMD), calcium intake, anthropometric measurements and physical activities in boys and girls showed a weak correlation between bone mineral density (BMD) and daily calcium and a positive correlation with physical exercise, while no correlation between (BMD) and daily calcium intake in girls which means that physical activity is the major factor affecting (BMD) in both boys and girls. The age factor affects (BMD) only in girls while other anthropometric measurements affect (BMD) in boys and girls.

Recommendations

1. Support the need for more effective dietary education for adolescents and for children generally.
2. Make a lifelong commitment to physical activity and exercise.
3. In terms of bone health, weight-bearing activities such as gymnastics, swimming and cycling are the most effective.
4. Intense daily activity is more effective than prolonged activity carried out infrequently.
5. Select activities that work all muscle groups like gymnastics.
6. Avoid immobilization and perform short weight-bearing movements if confined to bed.
7. Eat a well-balanced diet that is rich in calcium (milk instead of soft drinks) and protein to promote normal growth and puberty as well as regular menses for girls.

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Appendix

Annex I

دراسة تأثير الحالة الغذائية ونسبة الكالسيوم والتمرينات الرياضية على كثافة العظام في مرحلة المراهقة

رقم مسلسل:

التاريخ:

اسم المدرسة:...

اسم الطالب أو الطالبة:..

السنه الدراسية: ....

النوع: ١ـ ذكر ٢ـ أنثى

تاريخ الميلاد :

السن بالسنوات والشهور :

العنوان: .... التليفون : ....

عدد أفراد الأسرة :

السلوكيات الغذائية :

عدد الوجبات التى تقدم يوميا للأسرة :

هل يعتاد أحدكم تناول وجبات خارج المنزل : ١ـ نعم ٢ـ لا

فى حالة نعم : ١ـطاقة(دهون وكربوهيدرات) ٢ـ بناء ٣ـ وقاية (فيتامينات)

مدى انتظام الوجبات الرئيسية: ١ـ نعم ٢ـ لا

ما هى الأغذية المفضلة لديك : أذكر ٥ أغذية على الأقل

هل يجتمع مع الاسرة فى المأكل والمشرب : ١- نعم ٢- لا

فى حالة نعم : ماذا ؟ ....

هل تتناول أطعمة بين الوجبات : ١- نعم ٢- لا

وعدد المرات : ....

هل توجد حالات سمنه بين أفراد الأسرة: ١- نعم ٢- لا

هل توجد حالات نحافة بين أفراد الأسرة ١- نعم ٢- لا

هل تتناول أطعمة أو مشروبات أثناء مشاهدة التليفزيون ١- نعم ٢- لا

فى حالة نعم :ماذا؟

بيانات عن النشاط :

هل تمارس رياضة المشى معظم أيام الأسبوع ١- نعم ٢- لا

عدد مرات الممارسة فى الأسبوع : ....

فى حالة المشى طول المسافة تقريبا : ....

طريقة الوصول الى المدرسة : ١- المشى ٢- المواصلات

نوع الممارسة : ١-مشى ٢- جرى ٣- هرولة ٤- ألعاب جماعية ٥- أخرى

كم مدة الفسحة المدرسية بالدقائق :...........................

كم حصه ألعاب فى الأسبوع : ....

مدة الحصة بالدقائق : ....

هل تمارس رياضة خارج نطاق المدرسة :..

مدة التدريب بالدقائق :...

الحالة الصحية :

شكوى حالية : ١ـ نعم ٢ـ لا ☐

فى حالة نعم ما نوع المرض : ....

مدة المرض بالسنين : ☐☐

دخول الشمس بالمنزل : ١ـ نعم ٢ـ لا ☐

كيف يمضى يوم الاجازة :١ـ خارج المنزل ٢ـ داخل المنزل ☐

المقاييس الجسمية للطالب أو الطالبة :

الوزن بالكيلوجرام : ☐☐☐

الطول بالمتر : ☐☐ . ☐

قياس كثافة العظم BMD : ☐☐☐

Mid Upper Arm Circumference : ☐☐☐

Annex II

دراسة تأثير الحالة الغذائية ونسبة الكالسيوم والتمرينات الريضية على كثافة العظام في مرحلة المراهقة

اسم التلميذ: ....

المدرســة: ....

الصـــف: ....

الصنـــــــــف	الكميـــــــه	عدد المرات في اليوم
خبز بلدي Q	1,2,3,4,5,6,7,8,9	
خبز فينو Q	1,2,3,4,5,6,7,8,9	
خبز شامي Q	1,2,3,4,5,6,7,8,9	
أرز- مكرونه – شعرية plate	1,2,3,4,5,6,7,8,9	
أطعمة الطاقة		
زبده W سمن صناعي W	1,2,3,4,5,6,7,8,9	
زيت W	1,2,3,4,5,6,7,8,9	
حلاوة – مربى W	1,2,3,4,5,6,7,8,9	
طحينة W	1,2,3,4,5,6,7,8,9	
عسل اسود- حلويات W	1,2,3,4,5,6,7,8,9	
سكر spoon	1,2,3,4,5,6,7,8,9	
بقول		
فول مدمس plate	1,2,3,4,5,6,7,8,9	
طعميه pieces	1,2,3,4,5,6,7,8,9	
عدس اصفر plate	1,2,3,4,5,6,7,8,9	
عدس بجبه plate	1,2,3,4,5,6,7,8,9	
حمص الشام W	1,2,3,4,5,6,7,8,9	
ترمس W	1,2,3,4,5,6,7,8,9	
فول سوداني W	1,2,3,4,5,6,7,8,9	
أطعمة البناء		
بيض Q	1,2,3,4,5,6,7,8,9	
لبن كامل – نصف منزوع الدسم Cup	1,2,3,4,5,6,7,8,9	
جبن مطبوخ pieces	1,2,3,4,5,6,7,8,9	
لحم عجالى W	1,2,3,4,5,6,7,8,9	
لحم جملي W	1,2,3,4,5,6,7,8,9	
كبده – كلاوى W	1,2,3,4,5,6,7,8,9	
فراخ W	1,2,3,4,5,6,7,8,9	
سمك W	1,2,3,4,5,6,7,8,9	

الصنـــــــــف	الكميـــــــه	عدد المرات في اليوم
خضراوات		
جرجير-خس-بقدونس (بالحذمه)	1,2,3,4,5,6,7,8,9	
ملوخية – سبانخ plate	1,2,3,4,5,6,7,8,9	
ورق عنب plate (big or small)	1,2,3,4,5,6,7,8,9	
طماطم طازجة Q	1,2,3,4,5,6,7,8,9	
صلصه W	1,2,3,4,5,6,7,8,9	
فلفل رومي W	1,2,3,4,5,6,7,8,9	
كرنب W	1,2,3,4,5,6,7,8,9	
قرنبيط W	1,2,3,4,5,6,7,8,9	
فواكـــــه		
برتقال- يوسفي Q	1,2,3,4,5,6,7,8,9	
ليمون Q	1,2,3,4,5,6,7,8,9	
موز Q	1,2,3,4,5,6,7,8,9	
جوافة Q	1,2,3,4,5,6,7,8,9	
خوخ Q	1,2,3,4,5,6,7,8,9	
فراولة Q	1,2,3,4,5,6,7,8,9	
مشمش – مانجو Q	1,2,3,4,5,6,7,8,9	
بطيخ – شمام Q	1,2,3,4,5,6,7,8,9	
عصائر فاكهه Cup	1,2,3,4,5,6,7,8,9	
مشروبات		
شاي – قهوة spoon	1,2,3,4,5,6,7,8,9	
كاكاو spoon	1,2,3,4,5,6,7,8,9	
حلبه - ينسون spoon	1,2,3,4,5,6,7,8,9	
كركديه spoon	1,2,3,4,5,6,7,8,9	
مشروبات غازيه bottle	1,2,3,4,5,6,7,8,9	

Q : الكميه
W : الوزن
spoon : الملعقه

plate : طبق أو صحن
Cup : كوب
piece : قطعه
bottle : زجاجه

Annex III

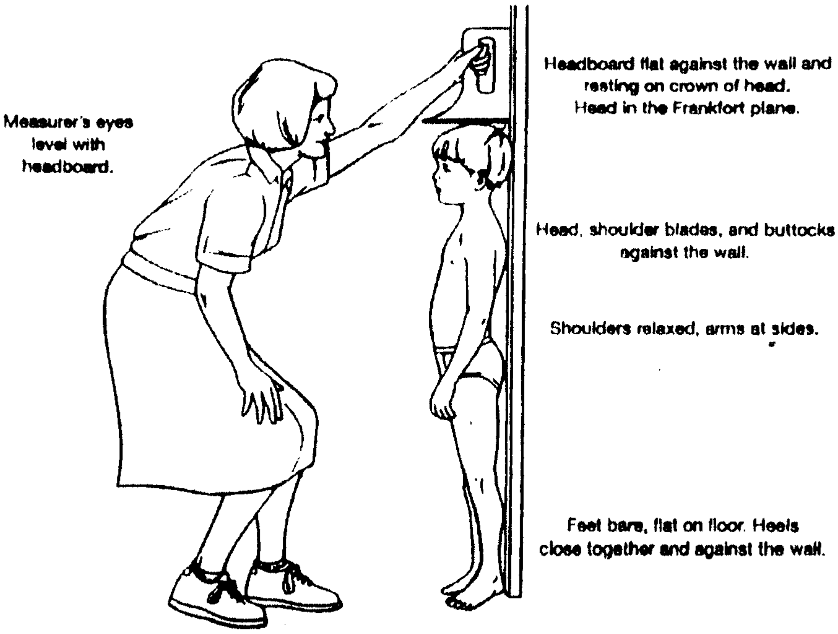

Figure 2. Body position when measuring stature.

Annex IV

Classification of Body Mass Index

Classification	BMI Category (kg/m^2)	Risk of developing health problem
Underweight	< 18.5	Increased
Normal	18.5-24.9	Least
Overweight	25.0-29.9	Increased
Obese class I	30.0-34.9	High
Obese class II	35.0-39.9	Very high
Obese class III	≥ 40.0	Extremely high

Robert and David (2003)

Annex V

Household measurements adjusted by grams according to Nutrition Institute previous studies:

.One teaspoonful of sugar = 5 gm.

.One tablespoonful of raw rice and macaroni = 10gm

.One tablespoonful of raw broad bean = 7gm

.One tablespoonful of green salad = 10gm

. One bottle of Pepsi = 150gm (small size)

=200gm(big size)

.One baladi bread loaf = 120 gm

.One French bread loaf = 100 gm

.One piece of skimmed cheese = 25 – 50 gm .

.One piece of processed cheese triangular shape = 20 gm .

.One piece of meat = 50- 100 (small and big egg size)

.One piece of poultry =125-250 gm (one quarter) .

.One piece of fish =50-100 gm.

.Meat , poultry and fish can be assessed by dividing the cooked amount over the consuming members .

- Fruits also can be assessed by the same way .

- One piece of biscuits =18 gm.

- One piece of cakes =100 gm.

- One piece of oriental sweets =100 gm

- Ice cream = 60 gm (small cup)
  = 105gm (middle cup)
  = 140gm (big cup)

- Chipsy bag = 30 gm

Note : Cereals (rice , macaroni) double their weight after cooking .
Legumes (broad bean) triple their weight after cooking .

Annex VI

The nutrient and energy standards known as the Recommended Dietary Allowances (RDA) are currently being revised. The new recommendations are called Dietary Reference Intakes (DRI) and include two sets of values that serve as goals for nutrient intake—Recommended Dietary Allowances (RDA) and Adequate Intakes (AI). The left side of this table presents the new RDA and AI for the 14 nutrients revised to date; the right side presents the 1989 RDA for the remaining nutrients and energy, which will serve until new values can be established. Chapter 1 provides many more details.

1997–1998 Dietary Reference Intakes (DRI)

Age (yr)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg NE)	Vitamin B_6 (mg)	Folate (µg DFE)	Vitamin B_{12} (µg)	Phosphorus (mg)	Magnesium (mg)	Vitamin D (µg)	Pantothenic acid (mg)	Biotin (µg)	Choline (mg)	Calcium (mg)	Fluoride (mg)
	Recommended Dietary Allowances (RDA)								Adequate Intakes (AI)					
Infants[a]														
0.0–0.5	0.2	0.3	2[b]	0.1	65	0.4	100	30	5	1.7	5	125	210	0.01
0.5–1.0	0.3	0.4	4	0.3	80	0.5	275	75	5	1.8	6	150	270	0.5
Children														
1–3	0.5	0.5	6	0.6	150	0.9	460	80	5	2.0	8	200	500	0.7
4–8	0.6	0.6	8	0.6	200	1.2	500	130	5	3.0	12	250	800	1.1
Males														
9–13	0.9	0.9	12	1.0	300	1.8	1250	240	5	4.0	20	375	1300	2.0
14–18	1.2	1.3	16	1.3	400	2.4	1250	410	5	5.0	25	550	1300	3.2
19–30	1.2	1.3	16	1.3	400	2.4	700	400	5	5.0	30	550	1000	3.8
31–50	1.2	1.3	16	1.3	400	2.4	700	420	5	5.0	30	550	1000	3.8
51–70	1.2	1.3	16	1.7	400	2.4	700	420	10	5.0	30	550	1200	3.8
>70	1.2	1.3	16	1.7	400	2.4	700	420	15	5.0	30	550	1200	3.8
Females														
9–13	0.9	0.9	12	1.0	300	1.8	1250	240	5	4.0	20	375	1300	2.0
14–18	1.0	1.0	14	1.2	400	2.4	1250	360	5	5.0	25	400	1300	2.9
19–30	1.1	1.1	14	1.3	400	2.4	700	310	5	5.0	30	425	1000	3.1
31–50	1.1	1.1	14	1.3	400	2.4	700	320	5	5.0	30	425	1000	3.1
51–70	1.1	1.1	14	1.5	400	2.4	700	320	10	5.0	30	425	1200	3.1
>70	1.1	1.1	14	1.5	400	2.4	700	320	15	5.0	30	425	1200	3.1
Pregnancy	1.4	1.4	18	1.9	600	2.6	*	+40	*	6.0	30	450	*	*
Lactation	1.5	1.6	17	2.0	500	2.8	*	*	*	7.0	35	550	*	*

1989 Recommended Dietary Allowances (RDA)

Age (yr)	Energy (kcal)	Protein (g)	Vitamin A (µg RE)	Vitamin E (mg α-TE)	Vitamin K (µg)	Vitamin C (mg)	Iron (mg)	Zinc (mg)	Iodine (µg)	Selenium (µg)
Infants										
0.0–0.5	650	13	375	3	5	30	6	5	40	10
0.5–1.0	850	14	375	4	10	35	10	5	50	15
Children										
1–3	1300	16	400	6	15	40	10	10	70	20
4–6	1800	24	500	7	20	45	10	10	90	20
7–10	2000	28	700	7	30	45	10	10	120	30
Males										
11–14	2500	45	1000	10	45	50	12	15	150	40
15–18	3000	59	1000	10	65	60	12	15	150	50
19–24	2900	58	1000	10	70	60	10	15	150	70
25–50	2900	63	1000	10	80	60	10	15	150	70
51+	2300	63	1000	10	80	60	10	15	150	70
Females										
11–14	2200	46	800	8	45	50	15	12	150	45
15–18	2200	44	800	8	55	60	15	12	150	50
19–24	2200	46	800	8	60	60	15	12	150	55
25–50	2200	50	800	8	65	60	15	12	150	55
51+	1900	50	800	8	65	60	10	12	150	55
Pregnancy	+300	60	800	10	65	70	30	15	175	65
Lactation										
1st 6 mo.	+500	65	1300	12	65	95	15	19	200	75
2nd 6 mo.	+500	62	1200	11	65	90	15	16	200	75

*Values for these nutrients do not change with pregnancy or lactation. Use the value listed for women of comparable age.
[a]For all nutrients, an AI was established instead of an RDA as the goal for infants; for the B vitamins and choline, the age groupings are 0 through 5 months and 6 through 11 months.
[b]The AI for niacin for this age group only is stated as milligrams of preformed niacin instead of niacin equivalents (see Chapter 10).
Source: Adapted with permission from *Dietary Recommended Allowances*, 10th Edition, and the first two of the *Dietary Reference Intakes* series, National Academy Press. Copyright 1989, 1997, and 1998, respectively, by the National Academy of Sciences. Courtesy of the National Academy Press, Washington, D.C.

Arabic Summary

الملخص العربي

كان الهدف من هذه الدراسة الكشف عن العلاقـة بـين كثافة العظام والوجبات الغذائية خصوصـا الكالسـيوم والفوسفور مع وضع عامل الممارسات الرياضـية فـي سن المراهقة .

بدأت الدراسة في أبريل ٢٠٠٨ وأستمرت إلى أكتـوبر من نفس العام في مدارس هـدي شـعراوي الإعداديـة للبنات والجيزة الإعدادية للبنين . وقد شملت عملية جمع المعلومات ملأ أستبيانات عن الحالة الإجتماعية والغذائية والقياسات الطولية والوزن ومحيط الذراع وكثافة العظام بالإضافة إلى تاريخ الممارسات الرياضية عند التلاميذ . وقد صممت الإستبيانات لتغطي الهدف من الدراسة من حيث الحالة الغذائية والممارسـات الرياضـية وكثافـة العظام ففي الحالة الغذائية تم جمع المعلومات عن جميع أنواع المغذيات خلال أربع أيام وأخذ متوسط الكميـات والسعرات الحرارية وكثافة العظام عن طريـق جهـاز خاص لقياس كثافة العظام في بداية الدراسـة ونهايتهـا وحساب المتوسط وممارسة التمرينات الرياضية تم بتقييم

النشاط الرياضي وممارسة المشي من وإلى المدرسة بالإضافة إلى قياسات الطول والوزن ومحيط الذراع .

وقد انتهت الدراسة إلى أن هناك زيادة ملحوظة في قياسات الطول والوزن ومحيط الذراع بيه بداية الدراسة ونهايتها في حين أن الفارق في القراءات في حالة كثافة العظام لم يكن هناك فارق ملحوظ بين القراءتين نظرا لقصر مدة الدراسة (٦ أشهر) . المقارنة بين متوسط تناول المواد الغذائية المختلفة والكمية المقررة في الجداول للحالة الغذائية المثالية في البنين أظهرت وجود فروق ملحوظة في السعرات الحرارية والكربوهيدرات والدهون (أقل من الطبيعي) والبروتين والبوتاسيوم والفوسفور (أكثر من الطبيعي) . أما في حالة البنات وجد أن متوسط المتناول من الدهون والفوسفور والكالسيوم كان أقل من الطبيعي ولكن في حالة البروتين والبوتاسيوم وفيتامين (ج) والحديد كانوا أكثر من الطبيعي .

بالمقارنة بين البنين والبنات في عدد تناول الوجبات اليومية كان هناك زيادة عند الأولاد وكذلك في حال

تناول الوجبات خارج المنزل لم يكن هناك فارق ملحوظ كذلك في تناول الوجبات مع العائلة .

المقارنة بين البنين والبنات في ممارسة المشـــي يوميـــا أظهرت أن البنين أكثر ميلا لممارسة رياضـــة المشـــي اليومية عن البنات ، بعكس المشي كوسيلة للوصول إلى المدرسة فأظهرت أن البنات أكثر ميلا لهذه الطريقة عن البنين .

العلاقة بين كثافة العظام والكالسيوم اليومي والممارسات الرياضية والقياسات في عينة البحث أظهـــرت علاقـــة ضعيفة بين كثافة العظام والكالسيوم اليومي وأخري قوية بين كثافة العظام وممارسة الرياضـــة وهـــذا يعنـــي أن بزيادة ممارسة التمرينات الرياضية يؤدي إلى زيادة في كثافة العظام وهناك أيضا علاقة ضعيفة بين المقـــاييس المختلفة وكثافة العظام .

وختاما لذلك أظهرت الدراسة وجود أختلاف كبير بـــين قراءات المقاييس بين بداية الدراســـة ونهايتهـــا للبنـــين والبنات ولكن لم يكن هناك فارق في كثافة العظام نظرا لقصر مدة الدراسة بمقارنة متوسط الأغذيـــة المتناولـــة

والكمية المثالية وجد أن هناك تباين في الاختلاف سواء بالزيادة أو النقصان في البنين والبنات ولم يكن هناك تباين أو اختلاف يذكر في معدل تناول الوجبات اليومية ومعدل تناولها مع الأسرة مع وجود زيادة طفيفة في معدل تناول الوجبات في حالة البنين . وعن علاقة كثافة العظام مع معدل ممارسة التمرينات الرياضية وتناول الكالسيوم أظهرت الدراسة وجود علاقة قوية بين كثافة العظام ومعدل ممارسة التمرينات الرياضية مع عدم وجود علاقة مع نسبة الكالسيوم في الأطعمة في البنين والبنات وكان هناك تأثير طفيف للسن ايضا على كثافة العظام في البنات أما المقاييس المختلفة فقد أثرت على كثافة العظام في البنين والبنات .

مستخلص

هدف الدراسة

الهدف من هذه الدراسة هو اختيار العلاقة بين كثافة العظام ونسبة الكالسيوم و الفسفور فى الوجبة الغذائية مع الأخذ فى الاعتبار التمرينات و الممارسات الرياضية للعينة المختارة وهى بين 11-16 سنه (سن المراهقة) لطلبه المدارس الإعدادية من الجنسين . وكذلك الكشف عن العوامل المؤثرة فى تكوين العظام و التى قد تؤثر بشكل كبير فيما بعد فى حالات الاصابه بهشاشة العظام و الكسور التى تحدث للفئة العمرية الأكثر تعرضا لهذا النوع من الاصابه و اختيار مدى تأثير التمرينات الرياضية فى الوقاية من هذه الإصابات .الدراسة عبارة عن علاقة طوليه عن مدى تأثير هذه العوامل على كثافة العظام للعينة المختارة بداية من القراءة الأولى للوزن والطول و محيط الذراع وكثافة العظام امتدادا للقراءة الثانية بعد ستة أشهر وكانت الدراسة فى مدرسة هدى شعراوى الإعدادية للبنات و الجيزة الإعدادية للبنين . بيان الحالة الغذائية للطلبة المختارين ثم عن طريق ملأ استمارة الاسئله الخاصة بنوعيات المواد الغذائية وكمياتها واخذ متوسط القراءة فى أربعة أيام.

نتائج الدراسة

زيادة من قراءات نتائج الوزن و الطول و محيط الذراع بين القراءة الأولى و الثانية للطلبة من الجنسين ولكن كثافة العظام لم تشهد فرقا ملحوظا نظرا لضيق وقت الدراسة

- العلاقة بين المواد الغذائية المتناولة و كمياتها بالمقارنة بالنسبة المطلوبة غذائيا لهذه المرحلة الغذائية بين المأخوذ و المثالى و تفاق مع الكميه المثالية فى البعض الأخر.
- المقارنة بين البنين و البنات فى متوسط تناوله المعزيات المختلفة انتهت الى وجود اختلافات كبيره فى الكربوهيدرات و الدهون و الفسفور و الحديد و فيتامين (ب) و فيتامين (ج) ولم يكن هناك اختلافات فى باقى المعزيات

- المقارنة بين الجنسين فى عدد الوجبات اظهر زيادة عند الأولاد عنهم فى حالة البنات
- زيادة فى معدل ممارسة التمرينات الرياضية عند الأولاد
- العلاقة بين كثافة العظام من ناحية وكمية الكالسيوم اليومية و ممارسة الرياضة و السن وبعض القياسات من البنين و البنات أظهرت علاقة ضعيفة مع الكالسيوم و قوية مع ممارسة الرياضة اليومية و هذا يعنى إن ممارسة الرياضة كانت العامل الأكبر فى التأثير على كثافة العظام فى الأولاد و البنات إما بالنسبة للعمر فكان له تأثير كبير على كثافة العظام فى الجنسين.

الكلمات الكاشفة:

المغذيات الدقيقة – المراهقة – كثافة العظام - الهرمونات

شكـــــــر

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سنة التخرج:	٢٠١١
سنة المنح:	٢٠١١

قسم الدراسات الطبية

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أجيزت الرسالة بتاريخ/ ٢/ ٥/ ٢٠١١

موافقة مجلس المعهد
٢٢/ ٦ / ٢٠١١

موافقة مجلس الجامعة

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قسم الدراسات الطبية

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