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EDITORIAL

Nutrition transition in India has resulted in the dual burden of under-nutrition and co-existing over-nutrition. On one hand, we are still struggling to deal with micronutrient deficiencies and develop strategies to combat such dietary inadequacies. The research papers by BhavanaVaid on low bone density and by A. Sundaravalli, R. Manjushree and Dr. G. Saraswath on serum vitamin D levels and its relation to bone mineral density deal with the problem of nutritional deficiencies with respect to the nutrients associated with bone health.

At the same time, dietary and lifestyle changes are leading to a caloric imbalance and resultant obesity. An issue of great concern is the fact that childhood obesity is becoming very rampant. This emerging problem has been the focus of research in the papers by DeepaPrakash and JamunaPrakash on gender differences in body mass index, food behaviour, cognitive performance and physical endurance in urban school children and RashmiPujara, Hasna K. and Chitra C. on metabolic risk factors among 9-12 year old children.

Food service in the school environment is an important factor that affects both the above concerns among children. In this context, the paper by N. Rema and Dr. G. Vasanthamani which analyses the functioning of food service in selected matriculation schools in Coimbatore, makes valuable reading.

Chief Editor,
Dr. MalathiSivaramakrishnan

INSTRUCTIONS TO THE AUTHORS

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RESEARCH PAPERS

LOW BONE DENSITY – AN ALARM AT 40 +

Bhavana M. Vaid
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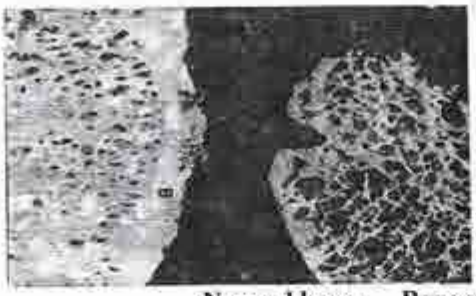
Osteoporosis is a systemic, skeletal disease characterized by low bone mass and microarchitectural deterioration of bone tissue with a consequent increase in bone fragility. The condition occurs more frequently in women. In view of high incidence of low bone density worldwide, the importance of screening and preventing the disease in smaller pockets of the country has been recognized. The present study involved screening for low bone density to identify cases of osteopenia and osteoporosis in the female population above 40 years using ultrasound densitometry of heel, and to assess the cases on the basis of BMI (Body Mass Index), income, dietary calcium intake and physical activity. The results showed high incidence of low bone density, especially among the lower income group females in the study. These women also had higher incidence of backache, or pain in knee, neck, feet, hands and shoulder. Osteoporosis was seen more in females with normal BMI, followed by those who were underweight. Osteopenic subjects were more in the underweight category followed by the overweight group, and the least in the normal weight group. Overall intake of calcium was lower than the RDA for Indian women.Physical activity in majority of cases was limited to household chores.

KEY WORDS: Osteopenia, osteoporosis, bone mineral density, T-score, BMI

Osteoporosis is a systemic, skeletal disease characterized by low bone mass and micro architectural deterioration of bone tissue with a consequent increase in bone fragility. The condition occurs three times more frequently in women than in men, mainly because of the lower peak bone mass attained by women and because of the hormonal related decline in bone mineral density (BMD) after menopause. A woman when not treated, loses 50% of the bone mass by the time she is 70 years old whereas a man loses 25% of his bone mass when he is 90 years old (Krishna U, Mehta R 2000). A hospital based study conducted by National Institute of Nutrition; India (NIN Annual Report 1998-99) revealed that in women above 40 years of age from low economic group, nearly 55 per cent of fractures were associated with osteoporosis. Chandrawati et al (2001) studied BMD in all the age groups of Indian female population to assess the level of osteoporosis in the Indian setup.

Osteoporosis is recognized as one of the major postmenopausal problems in India. Whether the best alternative for the prevention and treatment of osteoporosis could be improvement in dietary habits, or lifestyle considerations, orHormone Replacement Therapy (HRT)still remains undecided. The technique such as bone mineral density (BMD) plays a vital role in identifying the future risk of osteoporotic fractures(Teotia and Teotia 1999).



Normal bone Bone with osteoporosis

Fig. 1: Changes in bone with decrease in bone mass (Mahan and Stump 2004)

In view of high incidence of low bone density worldwide, the importance of screening and preventing the disease in smaller pockets of the country needs to be recognized. The lack of awareness of osteoporosis is a major public health problem but the importance attached to osteoporotic fracture and related complication is unfortunately low. It can be said that in India, hardly any screening / diagnosticmeasures are undertaken(Tripathi et al 2001). The present study identified women with osteopenia (condition of low bone mass at any stage of life, which is less severe than osteoporosis and can lead to osteoporosis) and osteoporosis. Theobjectives of the study were as follows-

1) To identify cases of osteopenia and osteoporosis in female population above 40 years using ultrasound densitometry of heel
2) To assess the cases on the basis of BMI (Body Mass Index), income, dietary calcium intake and physical activity

MATERIALS AND METHODS

The study was carried out in Rajkot city in Gujarat state, from August 2009 to November 2010. 1500 women, age 40 years and above attending the orthopedic departmentof two hospitals(Madhuram Hospital and G.T. Sheth Hospital)in Rajkot city for complaints such as backache, pain in knee, neck, feet and shoulders were recruited for the study using purposive sampling.

The study was done in the following steps:

Step I–Height of the respondents was measured with stature meter. Weight and BMI were measured with the help of Omron body fat analyzer.

Step II – Data on age, economic status, dietary calcium intake, pre/postmenopausal status, physical activityand complaints such as backache, pain in knee, neck, feet and shoulderswas gathered with the help of a questionnaire. Quantitative information on consumption of foods was obtained by 24 hour recall method with the aid of series of standard cups previously standardizedin the laboratory. Calcium intake was calculated using food composition tables (Gopalan C. et al 1991).

Step III - Bone mineral density (T-Score) of the respondents was measured and recorded with ultrasound bone densitometer. A study by Savardekar et al (2004) determining the diagnostic accuracy of osteoporosis by USG Ultra Sonography)vs DEXA (Dual Energy X-ray

Absorptiometry) reflected the underdiagnosis by USG in comparison to DEXA. The detection rate of osteopenia and osteoporosis is higher when done by DEXA. Low cost, lack of radiation and portability are the major advantages of USG. It may not be feasible or cost-effective to recommend DEXA for identifying women with osteoporosis. In this regard USG has emerged as an attractive screening tool because of its relatively low cost and because both USG and DEXA-assessed BMD appear to be predictive of future fracture risk.

RESULTS AND DISCUSSION

The subjects were grouped on the basis of pre/postmenopausal status. Table 1 indicates that the group comprised more of women in postmenopausal stage.

TABLE 1: Distribution of Subjects on the basis of Pre/Postmenopausal Status (n=1500)

Age group	Premenopausal group	Postmenopausal group	Total
40 – 45	556	75	613
46 – 50	104	192	296
51 – 55	37	195	232
56 – 60	---	190	190
61 – 65	---	106	106
66 - 70	---	42	42
71 - 80	---	21	21
Total	**697 (46.5 %)**	**803 (53.5%0**	**1500**

BMD of the respondents was measured as T-score with the help of Ultrasound Bone Densitometer. The total group was categorized as having normal BMD, osteopenic and osteoporotic on the basis of following WHO cut-off values (Agarwalet al 2004):

T – Score more than -1 - Normal
T – Score less than -1 and more than -2.4 - Osteopenic
T – Score less than -2.5 - Osteoporotic

TABLE 2: Distribution of Subjects on basis of T-Score (n=1500)

Age group	Normal	Osteopenic	Osteoporotic	Total
40 – 45	212 (14.1%)	401 (26.7%)	---	613
46 – 50	85 (5.7%)	169 (11.3%)	42 (2.8%)	296
51 – 55	42 (2.8%)	169 (11.3%)	21 (1.4%)	232
56 – 60	---	148 (9.9%)	42 (2.8%)	190
61 – 65	---	21 (1.4%)	85 (5.7%)	106
66 - 70	---	42 (2.8%)	---	42
71 - 80	---	---	21 (1.4%)	21
Total	**339 (22.6%)**	**950 (63.3%)**	**211 (14.1)**	**1500**

As shown in Table 2, 22.6% subjects had normal BMD, 63.3% subjects were osteopenic, and 14.1% were osteoporotic. Osteopenia leads to osteoporosis. The number of osteopenic patients was alarmingly high and stresses the need of intervention to build good dietary habits from early

age. The highest number of subjects belonged to the age group of 40 – 45, and the same group also had the highest percentage of osteopenic patients. It was also observed that with increasing age, cases with normal bone mineral density decreased, and in females above 55 years of age, all were either osteopenic or osteoporotic. In a study by Babu et al (2009) it was observed that among the osteopenic women, the maximum number was recorded between the age group of 40-49 years (35.8%) followed by 50-59 years (29.4%), whereas among the osteoporotic women, maximum numbers were observed in the age groups of 60-69 years (33.8%) followed by 50-59 years (29.5%) respectively.

The total group of 1500 was divided into three categories depending on their income - with monthly income less than Rs. 10,000 (Income Group 1), between Rs. 10,000 to Rs. 30,000 (Income Group 2) and more than Rs. 30,000 (Income Group 3). There were 864 females who belonged to group 1 and 2 and 636 belonged to group 3. Observations showed that income affected quality of diet and the bone mineral density of the subjects under study.

TABLE 3: Distribution of Subjects on the basis of T-Score (Income Group 1 & 2)(n=864)

Age group	Normal	Osteopenic	Osteoporotic	Total
40 – 45	64 (7.4%)	316 (36.6%)	---	380(44.0%)
46 – 50	---	63 (7.3%)	42 (4.9%)	105 (12.1%)
51 – 55	---	84(9.7%)	21 (2.4%)	105 (12.1%)
56 – 60	---	63(7.3%)	42(4.9%)	105(12.1%)
61 – 65	---	21(2.4%)	85(9.8%)	106(12.3%)
66 - 70	---	42(4.9%)	---	42(4.9%)
71 - 80	---	---	21(2.5%)	21(2.5%)
Total	**64(7.4%)**	**589(68.2%)**	**211(24.4%)**	**864(100%)**

TABLE 4: Distribution of Subjects on basis of T-Score (Income Group 3) (n=636)

Age group	Normal	Osteopenic	Osteoporotic	Total
40 – 45	148(23.3%)	85(13.4%)	---	233(36.6%)
46 – 50	85(13.4%)	106(16.6%)	---	191(30.0%)
51 – 55	42(6.6%)	85(13.4%)	---	127(20.0%)
56 – 60	---	85(13.4%)	---	85(13.4%)
Total	**275(43.3%)**	**361(56.8%)**	---	**636(100%)**

As shown in Table 3 and 4, subjects belonging to income group 3 showed better bone health. The percentage of cases with normal bone mineral density in this income group was 43.3%, as against 7.4% in income group 1 and 2. While there were 68.2% osteopenic females in income group 1 and 2, there were 56.8% in income group 3. 24.4% cases in income group 1 and 2 were osteoporotic, while there were none in income group 3. Another striking difference observed was that while 70% subjects from income group 1 and 2 suffered from backache, or pain in knee, neck, feet, hands and shoulder, only 20% subjects from income group 3 suffered from similar symptoms. In the group of 1500, 7% cases complained of polyarthralgia. No case had kyphosis, or fracture at any site in the past. In a study by Shatrugna et al (2005) on Indian women from low

income groups it was observed that the respondents consumed diets that had inadequate calcium coupled with too few calories, proteins and micronutrients. BMD and T scores of the subjects at all the skeletal sites were much lower than the values reported from the developed countries and were indicative of a high prevalence of osteopenia and osteoporosis.

Relationship between BMI and bone loss

Study by Agarwal et al (2004) showed that weight had a positive effect on bone mineral density as the incidence of osteoporosis was minimum in obese women (13.6% of left hip and 22.8% of lumbar spine) and maximum in normal women(19.6% of left hip and 46.7% of lumbar spine). The respondents in the present study were categorized as underweight, normal weight and overweight on the basis of WHO cut-off values for BMI as mentioned(Mahan and Stump 2004):

BMI < 18.5 – Underweight
BMI 18.5 – 24.9 – Normal weight
BMI > 25 – Overweight

TABLE 5: Distribution of Subjects on basis of BMI and BMD

BMI	Bone Mineral Density		
	Normal BMD	Osteopenic	Osteoporotic
Below normal (underweight) (148)	21 (14.2%)	106 (71.6%)	21 (14.2%)
Normal (normal weight) (338)	105 (31.1%)	148 (43.8%)	85 (25.1%)
Above normal(overweight) (1014)	232 (22.9%)	655 (64.6%)	127 (12.5%)

As shown in Table 5, osteoporosis was seen more in females with normal BMI, followed by those who were underweight. Osteopenic subjects were more in the underweight category followed by the overweight group, and the least in the normal weight group. Thus results of present study showed that weight may be having a positive effect on bone mineral density. However, further analysis needs to confirm this relationship.

Calcium intake and BMD

Calcium intakes across global populations differ to a great extent, so also there are differences in RDA of calcium which ranges from 600 mg per day for Indian women (ICMR 2010) to 1200 mg per day for an American post-menopausal woman (Mahan and Stump 2004). Calcium intake of the respondents in the present study ranged from 300 mg to1058 mg per day. Those with low calcium intake did not consume sufficient amount of milk and milk products, and green leafy vegetables.

TABLE 6: Dietary Calcium Intake (n=1500)

Age group	No. of respondents	Calcium intake (mg) Mean ± SD
40 – 45	613(40.8%)	520 ± 193
46 – 50	296(19.7%)	592 ± 109
51 – 55	232(15.4%)	514 ± 67
56 – 60	190(12.7%)	451 ± 224
61 – 65	106(7.1%)	502 ± 164
66 - 70	42(2.8%)	650 ± 79
71 - 80	21(1.4%)	600 ± 57

Mean calcium intake of subjects in the age group of 40 to 65 was substantially lower than those in the age group of 66 to 80 years. RDA for calcium for Indian women fixed at 600 mg is lower than the recommendation for American women, especially during menopausal period. Due to calcium depletion from bone and poor metabolism, a higher calcium intake is desirable even in Indian women, whether in premenopausal or postmenopausal stage.

TABLE 7: Distribution of Subjects on basis of Physical Activity

Age group	Household work	Sedentary	Exercise	Yoga (Approx. 15 min/day)	Walking (Approx. 30 min/day)	Total
40 – 45	575	38	---	---	---	613
46 – 50	119	177	---	---	---	296
51 – 55	99	87	---	46	---	232
56 – 60	76	99	---	15	---	190
61 – 80	---	113	---	---	56	169
Total	**869 (58 %)**	**514 (34.2 %)**	**0 (0%)**	**61 (4.1 %)**	**56 (3.7 %)**	**1500**

Data on physical activity in Table 7 indicates that routine household chores(cooking, dusting, mopping, and washing clothes) were the only activities in majority of cases. Women dependent on manual assistance for household work were classified as sedentary workers.Physical activity is an essential requirement for maintaining healthy bones (Deepti et al 2006), and investigation by Emiola and O'shea (1978) showed that immobility is the major cause of bone loss leading to osteoporosis. As observed in present study only small number of respondents was engaged in yoga or walking, while none in regular exercise (jogging, aerobics, gardening or swimming).

SUMMARY AND CONCLUSION

It was observed in the present study that 22.6% subjects had normal BMD, 63.3% subjects were osteopenic, and 14.1% were osteoporotic.Age group of 40 – 45 had the highest percentage of osteopenic patients.With increasing age, cases with normal bone mineral density decreased, and in females above 55 years of age, all were either osteopenic or osteoporotic.Income affected the diet and the bone mineral density of the subjects under study. Subjects with high income showed better bone health.The percentage of cases with normal bone mineral density in group with monthly income more than Rs. 30,000 was 43.3%, as against 7.4% in group with monthly income less than Rs. 30,000. There were 68.2% osteopenic females in income group 1 and 2, and 56.8% in income group 3. 24.4% cases in income group 1 and 2 were osteoporotic, while there were none in income group 3. While 70% subjects from income group 1 and 2 suffered from backache, or pain in knee, neck, feet, hands and shoulder, only 20% subjects from income group 3 suffered from similar symptoms.Osteoporosis was seen to be more in females with normal BMI, followed by those who were underweight. Osteopenic subjects were more in the underweight category followed by the overweight group, and the least in the normal weight group. In the group of 1500, 7% cases complained of polyarthralgia. No case had kyphosis, or fracture at any site in past. Calcium intake was fairly lower than RDA for Indian women, and there were several cases with calcium intake as low as 300 mg, to very few with as high as 1058 mg per day.Household chores were the major physical activity.

Low bone density is a serious problem in females which increases with age. Poor diet right from the years of growth and lack of exercise such as jogging, aerobics, gardening or swimmingcould be the major contributory factor forlow bone density. Preventing the increase in the number of cases with osteoporosis would require long term, continuous counseling of female population of all ages.

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SERUM VITAMIN D LEVELS AND ITS RELATION TO BONE MINERAL DENSITY IN POST MENOPAUSAL WOMEN IN BANGALORE CITY

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Osteoporosis becomes a serious health threat for aging postmenopausal women by predisposing them to an increased risk of fracture. Osteoporosis and fracture risk increases exponentially with age and with decrease in Bone mineral density (BMD). The main determinants of the age-related bone turnover are receding estrogen levels, changes in calcium and vitamin D metabolism and decreasing physical activity. Globally, there has been renewed concern on the mounting reports pertaining to low serum 25(OH) D - hypovitaminosis D (vitamin Ddeficiency) in children, women and the elderly. The present study aims at finding the incidence of this poor vitamin D status and its relation with BMD among post-menopausal women. One hundred and eleven healthy post-menopausal women subjects aged between 41-60 years were selected from Defence Research and Development Organization (DRDO), Bangalore. Baseline information, anthropometric measurements, Dual Energy X-ray Absorptiometry (DEXA) and biochemical parameters were collected and analysed to study the Bone Mineral Density (BMD) and vitamin D status of the subjects. Results of the study showed that there was a significant difference ($p<0.05$) between age and vitamin D status. The mean age (±) of the subjects with deficient level of serum 25(OH) D was 52.7(±3.5) and optimal level of 25(OH) D was 55.1 (±2.47). Unemployed women (female dependents of DRDO employees) had different levels of vitamin D deficiency. Overweight and obese women had low levels of serum 25(OH) D. To conclude, vitamin D deficiency [<20ng/ml of 25(OH) D] was highly (93%) prevalent among the post-menopausal women and majority (66%) had osteopenia or osteoporosis at spine as well as femoral neck, wards triangle and forearm.

KEYWORDS: Hypovitaminosis D, 25(OH)D(25hydroxycholecalciferol), Bone Mineral Density (BMD), Osteoporosis, Postmenopausal women.

Osteoporosis is becoming a serious health threat for postmenopausal women by predisposing them to an increased risk of fracture. Osteoporosis is a silent systemic skeletal disease characterized by low bone mass and micro architectural deterioration of bone tissue, with consequent increase in bone fragility and susceptibility of fracture risk.

Osteoporotic fractures are associated with substantial morbidity and mortality in post-menopausal women, especially elderly women. Estrogen deficiency during menopause has got remarkable effects on cardiovascular, skeletal, urogenital and gastrointestinal systems. Johansson (1993) pointed in his study that the decline in estrogen levels leads to low Bone Mineral Density (BMD) and a high risk of hip and vertebral fracture in menopausal women. Apart from low estrogen levels, osteoporosis is also caused due to certain other potentially modifiable and non-modifiable risk factors. The modifiable risk factors that affect bone health are food, lifestyle and exercise and

the non-modifiable risk factors which affect the same are ethnicity, age, sex, menopause and secondary cause to other diseases.

As a modifiable risk factor food plays an important role in bone health. Foods rich in calcium and vitamin D are required throughout the life cycle. In the growing years, calcium and vitamin D rich foods are required to build good bone mass and later the same is required for the maintenance. An active lifestyle and exposure to sunlight are also essential to build and protect the bone. The best recognized function of vitamin D is to support calcium absorption and thereby maintain blood calcium and phosphorus levels Masood (2008). Vitamin D is a fat-soluble vitamin. There are two major types of vitamin D. Vitamin D_2 (ergocalciferol) is the most common form used in supplements and Vitamin D_3 is synthesized upon exposure to UV light (UVB290-315nm) in the skin, or it can be obtained from the diet. Vitamin D_3 (cholecalciferol) is biologically inactive and it is metabolized to 25-hydroxyvitamin D [25(OH) D] in the liver, then to its biologically active form 1, 25-dihydroxycholecalciferol [1, 25-di (OH) D3] in the kidney Holick (2006).

Low serum Vitamin D levels (Hypovitaminosis D or Vitamin D deficiency) are widespread throughout the world. It has been estimated that almost one billion people in the world suffer from vitamin D deficiency or insufficiency. Vitamin D deficiency is associated with secondary hyperparathyroidism with consequent ill effects on bone mineral density. Para Thyroid Hormone (PTH) secretion is stimulated to maintain serum calcium levels and results in increased bone turnover and bone loss, and may lead to osteoporosis Cranney (2007). Increase in the PTH level and Vitamin D deficiency, which occurs more often in post-menopausal women, has been associated with greater incidence of hip fractures Nieves (2005). Lips (2001) had proposed a 'functional health based reference value' based on the levels of vitamin D. He defined Hypovitaminosis D as follows: severe vitamin D deficiency - <5ng/ml of 25(OH)D, moderate vitamin D deficiency – 5-10ng/ml of 25(OH)D and mild vitamin D deficiency – 10.1-20ng/ml of 25(OH)D. A recent systematic review by Gaugris (2005) concluded that the prevalence of inadequate 25(OH) D levels in serum appears to be high in postmenopausal women and especially those with osteoporosis and a history of fracture. In a study by Bruyère (2006) on 8532 postmenopausal osteoporotic European women, 79.6% were found to have vitamin D insufficiency when the serum 25(OH) D threshold was considered to be 80 nmol/l, and 32.1% if the threshold was set at 50 nmol/l (1.0nmol/l= 0.4ng/ml).

Although India is a tropical country, women—particularly those in the older age group—confine themselves indoors most of the time; minimal exposure to sunlight makes them susceptible to vitamin D insufficiency. Vitamin D deficiency is rampant throughout India. Postmenopausal women residing in Southern India showed varying degrees of vitamin D status. This ranged from severely deficient to just adequate with 52% of the population showing a mean level of 37.5 nmol/L (15ng/ ml), a conservative cut-off level for Vitamin D deficiency Bandgar (2010). According to Kalra (2011) the prevalence of vitamin D deficiency or insufficiency has been shown to be 66.67% in asymptomatic, healthy postmenopausal women in Haryana.

Prevention of osteoporosis and bone fractures requires modification of multiple risk factors one of which is Vitamin D. Evidence suggests that for the greatest reduction in osteoporosis and

fracture risk, women at increased risk should be given both calcium and vitamin D supplements, in the order of 1000 –1200 mg calcium (depending on baseline status) and 800 IU vitamin D daily Rizzolia (2008). The Dietary guidelines for Indians by, NIN, ICMR (2010) recommends 600mg of calcium and 400IU of vitamin D for Indian women.

OBJECTIVES

The objective of the study was to find out the incidence of hypovitaminosis D and its relation to BMD status in selected post-menopausal women of age 41 to 60 years.

METHODS AND MATERIALS

Selection of the subjects:

The healthy post-menopausal women aged between 41-60 years were selected from Defence Research & Developmental Organization (DRDO) labs and residents of DRDO Township in Bangalore (n=111). The women (subjects) voluntarily accepted to participate in the study giving a written consent.

Tools used in the study:

A detailed questionnaire was developed to elicit information from the subjects on the following aspects - Baseline information (age, employment status, menopausal status, no of years of menopause) and life style (dietary habits, physical activity, and exposure to sunlight). A minimum of thirty minutes is taken into consideration for physical activity (exercise) and sunlight exposure.

Anthropometric measurements like height, weight were recorded and the Body Mass Index (BMI) was computed using the formula "Weight (Kg)/Height (m^2)" and classified according to WHO 1994 & 2004. Weight in Kg of the subjects were recorded with minimum clothing and shoes to the nearest tenth of kilogram (0.1) using an adult weighing scale. The weighing machine was calibrated by using standard weight. Height in cm of all subjects was measured using a portable stadiometer height scale in cm. The subjects were made to stand on the platform straight and upright bare foot with the heels, shoulders and back of the head touching the stand.

The Bone Mineral Density (BMD) was analyzed using Lunar GE DEXA (USA) machine at the following sites viz., Lumbar Spine, Hip (Femoral neck and Ward's triangle) and Forearm. The BMD was classified according to the WHO technical report 1994 as Normal bone: t-score greater than -1, osteopenia (low bone mass): t-score between -1 and -2.5, osteoporosis: t-score less than -2.5, severe osteoporosis: t-score less than -2.5 with osteoporotic fractures.

Biochemical parameters like alkaline phosphatase, serum calcium and vitamin D[serum (25 (OH) D] were assessed by drawing 5ml of blood sample from each of the subjects and test was done according to the prescribed procedure in the kits. The automated immunoassayspecific for 25-OH vitaminD_3 (25-OH-D_3) was used manufactured by RocheDiagnostics using immunoassay analyzers. The vitamin D (25 hydroxy cholecalciferol) was determined according to the Electro Chemiluminescence Immunoassay (ECLIA) method. Both vitamin D2 and D3, from the diet or

UV-B conversion, are converted by the liver to 25(OH) D (25-hydroxyvitamin D)which is the functional indicator of vitamin D status. Ethical clearance was obtained from University of Mysore, to conduct the study.

RESULTS AND DISCUSSION

The data collected were analysed and the results are presented in the tables under the following headings: General profile and life style of the subjects, Analysed values of serum vitamin D with age, height, weight, BMD (t- score) and biochemical parameters (alkaline phosphatise and serum calcium), Relation between serum vitamin D levels and BMD and Comparison of vitamin D levels with the profile of the subjects.

General profile and Life style of the subjects

TABLE 1: Profile of the Subjects

Variables	NO	%
Age group in years		
41-45	06	05
46-50	22	20
51-55	57	51
56-60	26	24
Employment		
Scientists/Engineers	22	20
Clerical & Tech Asst	38	34
Skilled &Unskilled labourers	41	37
Home makers	10	09
Menopause		
Hysterectomy	20	18
Natural	91	82
No of years of Menopause		
≤5	59	53
6-10	33	30
>10	19	17

TABLE: 2 Life Style of the subjects

Particulars	NO	%
Vegetarian	42	38
Non vegetarian	69	62
Calcium and vitamin D3 supplement	08	07
Exposure to sunlight	71	64
Exercise –walking	54	49
Exercise -Yoga	21	19
Other exercise	35	32

Table 1 & 2 depicts the general profile and life style of the subjects. Majority (50%) of the subjects were in the age group of 51-55 years. Only 9% of the subjects were home makers (unemployed) compared to gainfully employed (scientists, clerical, technical assistants, skilled and semiskilled labourers). Women who attained menopause naturally were higher (87%) than those with surgically induced menopause.

62% of the subjects were non vegetarians and 64% exposed themselves to sunlight for at least half an hour. Only 7% of the subjects were taking calcium and vitamin D supplements. The subjects who performed exercises carried out the same for a minimum of 30 minutes.

Serum Vitamin D 25(OH)D as a function of : Age, Height, Weight, BMD and Bio chemical parameters

Table 3 reveals the mean (±) age of the subjects was 52.8 years (±3.5). The mean age (±) of the subjects with deficient level of serum 25 (OH) D was 52.7 years (±3.5) and optimal level of serum 25 (OH) D was 55.1years (±2.47). There was a significant difference ($p<0.05$) with relation to age. The study revealed that the Vitamin D deficiency was more prevalent among younger aged women than the older aged women, whereas variables like height, weight, BMI and BMD T score were not significantly different among the subjects with deficient versus sufficient levels of 25(OH) D. The mean (±) serum 25(OH) D levels of the study subjects was 10.8(±5.8). According to the study by Narang (2004) the levels of serum albumin, calcium, phosphorus and alkaline phosphorous showed no correlation with 1, 25 (OH) D_3. Similarly in the present study the biochemical parameters like alkaline phosphatase and calcium were not significantly different among the subjects with deficient versus sufficient levels of 25(OH) D.

TABLE 3: Serum Vitamin D 25(OH)D : Age, Height, Weight, BMD and Bio chemical parameters

Variables	Total (Mean ±SD)	Deficient level of 25(OH)D (≤5 -20ng/ml) Mean ±SD	Optimal level of 25(OH)D (20.1 - 32ng/ml) Mean ±SD	t-test p-value
Age in years	52.8±3.5	52.7±3.5	55.1±2.47	0.014*
Height in cm	153.1±5.8	153.1±5.8	152±6	0.849ns
Weight in kg	68.4±12.3	68.5±12.3	67.1±13.9	0.725ns
BMD (t-score)				
Lumbar spine	-1.6±1.1	-1.6±1.1	-1.1±1.1	0.373ns
Neck	-0.75±1	-0.76±1	-0.68±1	0.890ns
Wards triangle	-1.2±1.1	-1.2±1.1	-1.2±1.1	0.914 ns
Right forearm	-1.2±1.6	-1.2±1.6	-0.98±1.6	0.804 ns
Biochemical parameters				
Alkaline phosphatase IU/L	95.8± 31.8	96.6±32.4	86±20	0.183 ns
Calcium mg/dl	9.1±0.6	9.15±0.6	8.7±0.54	0.075 ns

*Significant at 0.05 level

Normal values according to Medlineplus:

Alkaline phosphatase: 44 to147IU/L, Serum calcium: 8.5 to 10.2mg

Relationship between Vitamin D[serum 25(OH)D] and BMD status

TABLE 4: Relationship between Vitamin D serum25(OH) Dand BMD status

BMD status- Site	Deficient level of ≤5 20ng/ml (25(OH)D) No (%)	Optimal level of 20.1 3ng/ml 25(OH)D) No (%)	Chi value (p- value)
Lumbar spine			
Normal	30(27)	04(04)	0.245 ns
Osteopenia /Osteoporosis	73(66)	04(04)	
Neck			
Normal	62(56)	06(05)	0.481ns
Osteopenia /Osteoporosis	41(37)	02(02)	
Wards triangle			
Normal	41(37)	03(03)	1.000 ns
Osteopenia /Osteoporosis	62(56)	05(05)	
Forearm			
Normal	51(46)	04(04)	1.000 ns
Osteopenia /Osteoporosis	52(47)	04(04)	

Table-4 shows high percentage (66%) of the subjects affected at lumbar spine were having deficient level of Vitamin D with low serum 25(OH) D followed by other sites as femoral neck (37%), wards triangle (56%), forearm (47%) age group already mentioned in methodology. Tangpricha (2004) found that there was a positive but no significant relation between 25(OH) D concentrations and BMD at both the hip and spine. Similarly in this studythere was no significance exhibited at any one site. However, the findings revealed that the spine BMD showed that more than 50% of the subjects were exhibiting low vitamin D deficiency with low serum 25 (OH) D levels if they had Osteopenia or Osteoporosis.

Comparison of Vitamin D [serum 25(OH)D] with the Profile of Postmenopausal Women

68% of the subjects, who belong to 51-60 years, had low levels of serum 25(OH) D (Table – 5). Among the working subjects 84% had vitamin Ddeficiency. All the women, who were unemployed and with less exposure to sunlight, had various degrees of hypovitaminosis D with low levels of serum 25(OH) D. This agrees with the study made by Ward (2010), where it was reported that women working in night shifts and longer hours were less exposed to outdoor activity and sunlight. These women were vitamin D deficient and had associated health hazards.

Among the post-menopausal women who had natural menopause, 75% had vitamin D deficiency with low serum 25(OH) D. According to number of years since menopause, majority (93%) of the respondents had different levels of vitamin D deficiency with low serum 25(OH)D. Among women who had attained menopause since ≤ 5 years, 51% were vitamin D deficient with low serum 25(OH)D.

According to Wortsman (2000) obese subjects had significantly lower basal 25-hydroxyvitamin D concentrations.Obesity-associated vitamin D insufficiency is likely due to the decreased bioavailability of vitamin D_3 from cutaneous and dietary sources because of its deposition in body

fat compartments. Similarly in the present study, 80% of the subjects were overweight and obese and 74% of them had Vitamin D deficiency with low serum 25(OH) D.

TABLE 5: Comparison of Vitamin D (serum 25(OH) D) with the Profile of Postmenopausal Women

Parameters	Deficient level of 25(OH)D (≤5 -20ng/ml) No (%)	Optimal level of 25(OH) (20.132ng/ml) No (%)
Age in years		
41-50	28(25)	00(00)
51-60	75(68)	08(07)
Employment status		
Gainfully employed	93(84)	08(07)
unemployed	10(09)	00(00)
Menopause		
Surgical	20(18)	00(00)
Natural	83(75)	08(07)
No of years since menopause		
≤5	57(51)	02(02)
6-10	28(26)	05(04)
>10	18(16)	01(01)
BMI		
Normal 18.5-24.99	21(19)	01(01)
Overweight 25-29.9	39(35)	03(02)
Obese >30	43(39)	04(04)
Physical activity		
Yes	64(56)	04(04)
No	39(36)	04(04)
Sunlight Exposure		
Yes	66 (48)	05(05)
No	37(34)	03(03)
Food Habit		
Veg	41(13)	01(01)
Non-veg	62(14)	07(06)

In this study, 60% of the subjects were involved in physical activity. Among the subjects who did physical activity 22% and 18% had moderate and mild vitamin D deficiency with low serum 25(OH)D. 58% of the subjects, who reported to have exposed themselves to sunlight had different levels of vitamin D deficiency with low serum 25(OH) D.

Higher percentages (61%) of the respondents were non-vegetarians. Among the vegetarians and non-vegetarians, 37% and 55% had vitamin D deficiency with low serum 25(OH) D. According to Chan (2000), 25(OH)D concentrations are not associated with vegetarian status because vitamin D from dietary sources, both naturally occurring and fortified, is limited.

SUMMARY AND CONCLUSION

To summarize, the present study was conducted in Defence Research and Developmental Organization (DRDO) labs and residents of DRDO Township in Bangalore among healthy postmenopausal women(n=111). The study reported a high (93%) prevalence of low serum 25(OH) D (vitamin D deficiency). There was a significant relation between vitamin Ddeficiencylevel and age. The mean age of women who had vitamin D deficiency with low serum 25(OH) D was 52.7 years compared to optimal level of serum 25(OH) D where the mean age was 55.1 years. All the women who were unemployed with less exposure to sunlight showed various degrees of vitamin D deficiency with low serum 25(OH) D. The prevalence of vitamin D deficiency was higher among overweight and obese subjects. The BMD status and low serum 25(OH) D levels did not show significant relationship but findings of the study indicated that more than 50% of the subjects who were exhibiting vitamin D deficiency with low serum 25(OH) D had either Osteopenia or Osteoporosis at the spine.

Although India is a tropical country, in the present working scenario, both men and women work for long hours indoor having minimal exposure to sunlight. Even women, who were not working, prefer to be indoors most of the time. This paves way to vitamin D deficient health hazards. Osteoporosis is one such health hazards which requires adequate calcium and Vitamin D intake through diet, regular physical exercise and sunlight exposure. This can reduce fracture risk as the age advances. Thus an urgent need for spreading public awareness about the benefits of vitamin D and sunlight exposure is requested.

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GENDER DIFFERENCES IN BODY MASS INDEX, FOOD BEHAVIOUR, COGNITIVE PERFORMANCE AND PHYSICAL ENDURANCE OF SELECT URBAN INDIAN SCHOOL CHILDREN

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Growth of children is a dynamic process encompassing both physical and cognitive development; food behaviour is a key influence on nutrition status and growth of children. The cross sectional study was designed as a situational analysis of nutrition status measured as Body Mass Index (BMI), food behaviour, cognitive performance and physical endurance status of six hundred and thirty Indian urban children aged between 6 and 12 years from Bangalore city. Results reveal that food behaviour in children was impacted by gender; girls selected more fruit and boys selected more energy dense foods. Family food behaviour patterns showed overall high viewing of television while eating meals and snacks by the family (92%) and high choice (73%) of unhealthy snacks while eating out. A majority of the sample had normal BMI and there was no significant difference in the BMI ranges between boys and girls ($p<1.000$). Cognitive performance and physical endurance showed linear progression with age. There was no significant difference between the genders for all cognitive performance tests and most physical endurance tests; however boys had significantly greater right hand grip strength than girls ($p<0.0001$).

KEY WORDS: Body mass index (BMI), food behaviour, cognitive performance, physical endurance, Lewis power.

The initial years oflife are a period of rapid growth which is critically dependent on nutrition as one of the essential factors. Children, who do not get the essential nutrition, have impaired physical growth (Stephen et al, 2012) and cognitive development (Arija et al, 2006). The contemporary environment of young children comprises lesser occasions for physical activity and an excess of high calorie foods (Sothern, 2004). India is experiencing rapid nutritional transition (Wasir and Misra, 2004; Misra and Khurana, 2008) and supports a cascading effect impacting obesity and its related health challenges (Gupta et al, 2010 and Wasir and Misra, 2004).

Several research studies have explored the impact of gender on growth and development; however eliciting diverse results. A few studies have indicated age and gender dependent variations in body composition and BMI in children (Srdić et al, 2011; Mohammad et al, 2010; Morimoto et al, 2007). However a twelve year study with a two year survey cycle, showed no gender depended variations in obesity and BMI in children over first ten years, whereas the last two years of the study indicated a significant increase in BMI in adolescent boys ($p<0.04$) but not in other age groups or in girls (Ogden et al, 2012). Gender differences are large in the overall physical, endurance, strength in the favour of boys; however in flexibility, and coordination dimensions, gender differences are not significant (Klomsten et al, 2004). Food behaviour shows gender dependent variations; with girls often selecting more fruits and vegetables than boys (Share and Steward-Knox, 2012; Yon et al, 2008). Research exploring the association between

memory test scores and gender in children and adolescents has produced mixed results (Vollrath et al, 2012; Rosselli et al, 2009; Temple & Cornish, 1993; Huang, 1993).

Studies have established a link between nutrition status, physical endurance and cognitive development in children (Arija et al, 2006; Diamond, 2000, Krombholtz, 1997). Currently the school academic programs in India do not address health education and the practical application of knowledge concerning health. As part of healthy growth, both physical and cognitive development happen in children, therefore it is important to study their food behaviour, anthropometry, cognitive performance and physical endurance. This information is essential to plan out education material to influence better food and exercise resulting in better growth and development. The present cross sectional study was conducted to assess the nutrition status, food behaviour, cognitive performance and physical endurance status of selected Indian boys and girls between 6 and 12 years from urban area.

MATERIALS AND METHODS

Study Design: Six hundred and thirty children in the age group 6-12 years were selected at random from two urban schools at Bangalore city. Data was collected from the subjects to address all three phases of the study. The sample comprised of 229 girls and 331 boys.

Phase I –FoodBehaviour Survey: The parents of the selected children were administered with a standardised questionnaire and the following information was elicited: (1) Socio-economic background, occupation of parents (2) Culture and ethnicity (3) Family meal pattern (4) Lifestyle (5) Food frequency data of frequently consumed foods along four categories (a) Foods consumed daily (b) Foods consumed twice a week (c) Foods consumed rarely (d) Foods never consumed.

Phase II - Assessment of nutrition status:

1. Assessment of age of subjects from schools records: Exact age was computed referring to records of date of births maintained by the school, the age in months was used to compare BMI with that of the WHO standards, as on the date of measurement of data.
2. Weight – Weight was recorded using an electronic balance (Essae Digi Scale, Model DI-20, No P2 000039667/2), to the nearest 0.1 kg by standard techniques.
3. Height – Heights was recorded with the aid of a non-stretchable fibreglass tape fixed to a straight wall to the nearest 1.0 mm on enrolment. Measurements were recorded by one investigator to avoid inter-individual variations.
4. Calculation of Body Mass Index (BMI: Using the data of height and body weight; the body mass index was calculated using the formula: BMI= Weight in kilograms / Height in meter^2 (Merlin et al, 2011).

   The weight, height and BMI data of the subjects were analysed using various indices to determine their nutrition status by comparing with 50th percentile of WHO standards and the degree of nutrition status was computed using "Z" scores.

Phase III – (a) Cognitive Development:

1. Motor Skills were assessed using the **O'Connors Tweezer Dexterity Test**. The test comprises of a wooden board with 50 holes which are 1/16" diameter. The board was placed vertically with the well holding pins facing the subject. The test required the use of tweezers

in placing a single pin in each hole. The time to fill the board was measured in seconds using a calibrated digital timer. This test recorded the eye hand co-ordination of the subjects.

2. **Digit Span Test** was assessed using the standardized sets of numbers from Prasad and Varma, PGIBBD, National Psychological Corporate, (1985) and the Bhatia Short Battery of Performance Tests of Intelligence (BSR-R). The score recorded in both Digit Forward (DF) and Digit Backward (DB) was the number of digits in the longest series of any two sets correctly reproduced respectively by the subjects. This test recorded the verbal cognitive ability of the subjects.
3. **Raven's colour matrices** an index of Intelligence Quotient (IQ) was administered as recommended in the manual. This test recorded the nonverbal cognitive ability of the subjects.

Phase III – (b) Physical Endurance:

1. **Vertical Jump Test:** This test is a measure of the elastic leg muscle strength of the subject. The subject was asked to hold a chalk at the end of his finger tips and was made to stand beside a wall, keeping both feet remaining on the ground. The highest point the subject's hand can reach was measured in meters (M1), then from a static position the subject was asked to jump as high as possible and mark the wall with the chalk on his fingertips (M2). M2 was measured as the highest from 3 jumps. The distance between M2 and M1 was the vertical jump (VJ). The average jump power was calculated using the Lewis formula (Mathews and Fox,1974):Average Power (Watts) = $\sqrt{4.9}$ x mass (kg) x $\sqrt{VJ}$ (m) x 9.81
2. **Hand Dynamometry:** It was measured using TAKEI Physical fitness test grip D TKK 5401, Japan. Right hand and left hand grip was measured using the equipment. The child had to stand straight with legs slightly apart; the child was asked to grasp the handle and was allowed to become familiar with the instrument by obtaining a good grip, squeezing lightly and watching the corresponding increase in grip strength on the digital display. When ready, the child was asked to stand straight with the instrument held alongside the body and was encouraged to squeeze as hard as possible for 10 seconds on a verbal "go" signal. Three trials for each hand were conducted, alternating hands, and always starting with the dominant hand. There was always a break of at least 2 min between the tests on the same hand. The results of each of the three tests per hand were noted in a test protocol and an average was used as the score.

STATISTICAL ANALYSIS

Data about the family food behaviour was computed as percentage of total subscription to lifestyle practices and family food preferences. The subjects were separated into two groups based on gender. The consumption of the food types was obtained from a questionnaire and an independent sample t test was performed to see if the difference in consumption of the food type between the groups was significant. Anthropometry data was computed as percentages for either gender and categorised under the set WHO standards of percentiles and Z Scores, a paired t-test was used to analyse the difference between the genders in each of the ranges specified. The normality assumption for the variables was validated by using a Q-Q plot. Cognitive development and physical endurance data was computed describing arithmetic mean and standard deviation. An independent sample t- test was used to compare each individual physical and cognitive characteristic between boys and girls.

RESULTS AND DISCUSSIONS

Phase I: Food Behaviour

The initial data about the socio-economic background and occupation of parents indicated that 95% of the families had an annual income between Rs. 1 and 5 lakh. 100% of the fathers and 55% of the mothers were employed. 96% of the employed parents worked for central government organizations. The culture and ethnicity data indicated that 45% of the families were from the North and 55% from the South of India; 27% of the families were vegetarian and 73% were non-vegetarian. The family food behaviour data in table 1 indicated 41% of the families ate 2 snacks and 3 meals a day, 73% of the families ate out once a week together, 57% of the children ate a daily snack outside home. Seventy three percent of food choices made by the family while eating out were unhealthy (with food selections comprising of deep fat fried, high cheese and high sugar content choices) and 27% selected healthy snacks (with food selections comprising of dry roasted grams, low fat snacks, vegetables, fruits and grilled foods). From table 1 we also can elicit that food practices followed by most of the family's encompassed use of convenience foods (98%) and branded foods (82%). Families subscribed to nutritional supplements (39%) for their children. Food storage and meal planning practices indicated storage of left over foods in the refrigerator (93%), use of pre-prepared foods (79%) and use of traditional food combinations (68%). Only 47% of the families ate meals and snacks together; 86% of families watched television while eating and 97% of families ate their snacks while watching television. Sport and fitness practices indicated 100% of the children played indoor games; 74% of families encouraged fitness and 83% of the children played outdoor sport at school; 90% of the families took their children along on a daily walk for fitness. Mothers did most of the cooking (96%) and serving (77%) at homes with 90% of the meals being planned jointly by the entire family. From table 2, we can elicit that the children's average daily consumption pattern showed broad average selection of potatoes (92%), dhal (76%), milk (73%), cereals (56%), and a limited diversity in consumption of vegetables (35%) and fruits (15%). Unhealthy snacks were preferred more (73%) than unhealthy beverages (10%). From this study conducted it was observed that despite most families (73%) eating out only once a week, the families were subscribing to less diverse and inadequate servings of fruits and vegetables. The consumption of ready to cook noodles showed a selection trend of either daily (45%); this selection also increases the dietary hidden fat since the noodle cakes are deep fat fried as part of the processing, rendering it an unhealthy choice. Of all foods selected largely over 60% were rich in macronutrients and calcium; however deficient in all other micronutrients. An independent sample "t" test was used to explore the difference in consumption of foods in all the defined consumption ranges between boys and girls. The results of the t test (table 2) showed statistically significant difference between the genders in a few food groups. Boys consumed more chapatti, breads, biscuits, breakfast cereals, dhals, nuts, potato, other root vegetables, apples, milk, non-vegetarian foods, eggs and adjuncts. Girls consumed more sprouts, green leafy vegetables, other vegetables, bananas, other fruit, ghee, healthy snacks and healthy beverages. There was no significant difference between the genders in the selection of rice, poori, noodles, whole gram, curd, cheese, paneer, ice cream, unhealthy snacks and unhealthy beverages by either gender. This pattern indicates a cohesive subscription to lifestyle and food behaviour practices. It also directs that any change if explored to shift maladaptive food

behaviours to better behaviour patterns needs to be addressed to both the children and their caregivers.

TABLE 1: Distribution of families by food behaviour patterns (%)
(N=630; Boys=331; Girls n=299)

Consumption/day			Eating Out		Food Choices	
Meals (n)	Snacks(n)	%	Frequency of eating out	%	Food Choice	%
3	3	3	Once a month	22	Healthy	27
3	2	41	Twice a month	4	Unhealthy	73
3	1	6	Once a week	73	--	--
2	3	34	Twice a week	1		
2	2	0	Daily snack outside home	57		
2	1	16				

Lifestyle factors		%
Food Practice	Use of convenience foods	98
	Purchase of branded foods	82
	Use of nutritional supplements	39
Food Selection	Left over foods stored in the refrigerator	93
	Use of pre-prepared foods	79
	Use of traditional food combinations	68
Family eating together and television viewing while eating	Family eats together	47
	Family watches TV while eating	86
	Family watches TV while snacking	97
Fitness activities of the children and encouragement of fitness as a family activity	Fitness activities encouraged at home	74
	Indoor Sports	100
	Outdoor Sports	83
	Walking as a daily family fitness activity	90
Cooking at home	Mother	96
Menu planning	All members of the family	90
	Mother	77

TABLE 2: Influence of gender on food frequency pattern of subjects
(N=630; Boys=331; Girls n=299).

Foods	Everyday		Twice a week		Rarely		Never Consumed		Independent sample T-Test
	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	P-value (significance level alpha=0.05)
Rice	87	90	13	10	0	0	0	0	ns
Chapatti	74	82	24	17	2	1	0	0	**
Poori*	13	15	46	45	41	39	0	1	ns
Ready to cook noodles	48	41	47	57	5	2	0	0	ns
Baked cereals	68	88	24	9	8	3	0	0	***
Breakfast cereals	30	37	24	27	42	31	4	5	*
Dhal	70	81	22	16	2	0	6	0	***
Whole Gram	4	5	35	42	55	48	6	5	ns
Sprouts	11	8	33	15	47	61	9	16	***
Nuts	2	2	27	31	56	58	15	9	*
Green Leafy Vegetables	1	1	35	39	13	21	51	39	***
Potato	88	95	8	5	4	0	0	0	**
Other Root Vegetables	51	50	20	41	29	9	0	0	**
Other Vegetables	55	49	30	25	15	26	0	0	**
Apples	9	16	49	43	20	27	22	14	*
Bananas	16	16	20	44	30	32	34	8	***
Other Fruit	19	14	24	22	45	19	12	45	***
Milk	65	81	35	19	0	0	0	0	***
Curd	71	62	26	37	3	1	0	0	ns
Processed Cheese	23	24	39	41	31	35	7	0	ns
Cottage Cheese	4	6	35	22	46	66	15	6	ns
Ice Cream	8	8	22	24	61	62	9	6	ns
Ghee	35	42	42	53	16	1	7	4	***
Meat, Fish, Poultry	1	3	58	66	5	6	36	25	**
Egg	22	32	45	47	22	18	11	3	***
Unhealthy beverages	9	10	37	33	38	40	16	17	***
Healthy beverages	7	7	40	33	49	45	4	15	ns
Adjuncts*	24	36	39	38	30	24	7	2	***
Unhealthy foods	70	75	25	22	5	3	0	0	ns
Healthy foods	6	4	36	40	54	25	4	31	***

Significance level			
*	Marginally significant	***	Highly significant
**	Significant	ns	Not significant

Phase II: Anthropometry

In the present study anthropometric assessment was done with the measurement of the subjects' height, weight and BMI was thereafter calculated. Anthropometry is an elementary tool for evaluating nutrition status, encompassing overweight, obesity, healthy weight and body thinness (World Health Organization, 1995). The resulting data was categorised into gender and age for further analysis.

Growth percentiles are indicated as average by BMI data conforming between 5th and 84th percentiles; below average by BMI data being between 1st- 4thpercentiles, overweight by BMI data being between 85th- 94th percentiles and obese by BMI data being > 95thpercentile of the WHO standards (Hammer et al, 1991; Pietrobelli et al, 1998).

From Figure I we can elicit that 57% boys and 61% girls conformed to average BMI percentiles; 19% boys and 13% girls were below average percentiles of BMI indicating underweight and 5% boys and 6% girls were above average percentiles of growth indicating overweight and 19% boys and 20% girls were above overweight percentiles of growth indicating obesity. Z Scores (figure 2) are indicated as average by BMI data conforming between -1SD to 1 SD score; below average by BMI data being -2SDindicating thinness, -3SD and below indicating severe thinness and above average by BMI data being 2SD indicating overweight and >3SD indicating obesity of the standard deviation markers of the WHO standards. From chart 2 we can elicit that 64% boys and 63% girls conformed to normal growth Z Scores;9% boys and girls respectively were thin and 7% boys and 3% girls were severely thin; 12% boys and 18% girls were overweight and 8% boys and 7% girls were obese with reference to the WHO ranges.

Average scores of the growth indices indicate normal BMI; below average scores indicate malnourished status and above normal scores indicate overweight and obesity. The majority of the children conformed to normal growth patterns. However, there were more children in the obese category than the malnourished category. The change in the growth pattern during the phase of childhood indicates the changes in the body mass of the children along with their chronological growth. A paired t test comparing the results between boys and girls showed no statistically significant differences in their BMI status ($p<1.000$) thus indicating no differences in BMI patterns between genders.

FIGURE 1: Distribution of subjects according to BMI – Z score data

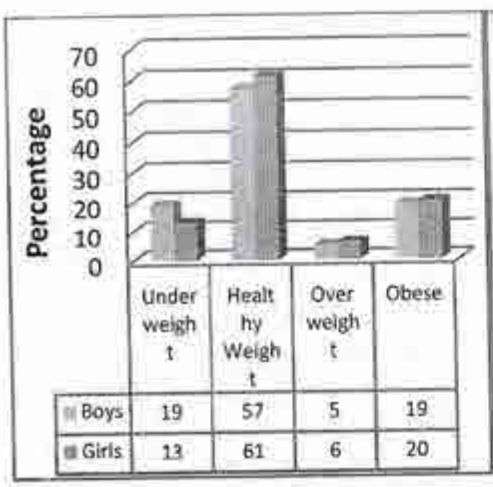
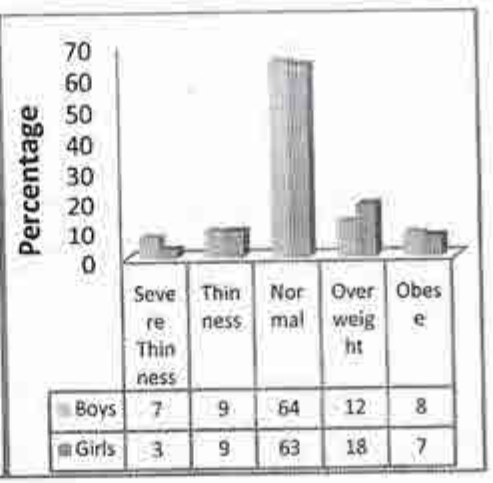


FIGURE 2: Distribution of subjects according to BMI – percentile data



Phase III: Cognitive performance and physical endurance

From the data (tables 3 and 4), we can elicit that cognitive performance and physical endurance showed a linear trend of progression with age. Lewis Power data also showed with brief plateaus in the distribution of power against age. From table 4, we can elicit that girls had reduced grip strength when compared to boys in their right hand dynamometry readings; this difference was statistically significant ($p<0.0001$). However all other cognitive development and physical endurance readings showed no statistically significant difference between the genders.

TABLE 3: Mean cognitive performance scores of boys and girls

Mid Age Month and sample size	Digit Forward		Digit Backward		Ravens Colour Matrices		Manual Dexterity (seconds)	
	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
75 Girls n=23 Boys n=26	2.91 (±0.57)	2.77 (±0.59)	1.52 (±0.53)	1.58 (±0.49)	14.72 (±4.93)	14.68 (±4.80)	989.69 (±216.51)	998.73 (±231.98)
85 Girls n=54 Boys n=55	3.29 (±0.66)	3.22 (±0.64)	1.98 (±0.51)	1.67 (±0.57)	18.5 (±4.81)	17.28 (±5.28)	982.79 (±203.63)	912.09 (±182.28)
95 Girls n=52 Boys n=74	3.45 (±0.66)	3.41 (±0.70)	1.87 (±0.63)	1.9 (±0.64)	20.05 (±4.86)	20.19 (±5.52)	839.36 (±214.58)	934.32 (±217.48)
105 Girls n=57 Boys n=63	3.4 (±0.57)	3.57 (±0.68)	1.94 (±0.67)	2.02 (±0.71)	22.32 (±4.50)	22.2 (±4.55)	864.3 (±175.71)	859.8 (±184.56)
115 Girls n=51 Boys n=53	3.62 (±0.75)	3.79 (±0.61)	2.31 (±0.71)	2.07 (±0.58)	23.93 (±5.00)	23.24 (±3.69)	811.74 (±174.80)	874.69 (±137.77)
125 Girls n=36 Boys n=37	4.00 (±0.51)	3.95 (±0.73)	2.55 (±0.50)	2.49 (±0.68)	22.84 (±5.11)	25.84 (±5.46)	789.97 (±175.25)	854.57 (±180.23)
135 Girls n=17 Boy n=20	4.27 (±0.75)	4.25 (±0.56)	2.64 (±0.88)	2.81 (±0.53)	24.27 (±6.90)	25.63 (±5.99)	526.73 (±162.46)	607.31 (±227.80)
145 Girls n=9 Boys n=3	4.50 (±0.76)	4.25 (±0.83)	3.17 (±0.69)	2.75 (±0.83)	25.5 (±4.03)	27.5 (±2.96)	473.67 (±135.74)	591.75 (±135.88)
T-Test comparing scores of girls and boys	Parameter				p value			
Cognitive Development Data	Digit Forward				0.700			
	Digit Backward				0.623			
	Raven's Colour Matrices				0.408			
	Manual Dexterity				0.365			

*at 95% confidence interval

TABLE 4: Mean physical endurance scores of boys and girls

Mid Age Month and sample size	Hand Dynamometry Right Hand		Hand Dynamometry Left Hand		Lewis Power	
	Boys	Girls	Boys	Girls	Boys	Girls
75 (Girls n=23 Boys n=26)	8.45 (±1.83)	7.97 (±1.69)	7.64 (±1.60)	7.27 (±1.78)	168.96 (±45.31)	174.49 (±44.68)
85 (Girls n=54 Boys n=55)	9.42 (±2.43)	9.25 (±1.77)	8.42 (±2.35)	8.07 (±1.70)	189.05 (±47.29)	193.10 (±50.11)
95 (Girls n=52 Boys n=74)	11.03 (±2.67)	9.73 (±2.02)	9.83 (±2.58)	8.70 (±1.95)	225.25 (±57.94)	215.55 (±46.29)
105 (Girls n=57 Boys n=63)	12.61 (±2.56)	11.17 (±2.40)	10.97 (±2.90)	9.62 (±2.41)	230.52 (±56.65)	216.88 (±42.66)
115 (Girls n=51 Boys n=53)	13.07 (±3.75)	11.34 (±3.19)	11.69 (±3.51)	10.25 (±2.95)	225.12 (±49.50)	226.15 (±59.55)
125 (Girls n=36 Boys n=37)	14.45 (±3.46)	12.71 (±2.18)	13.53 (±3.23)	11.17 (±2.02)	256.69 (±66.49)	241.66 (±46.66)
135 (Girls n=17 Boys n=20)	14.29 (±2.64)	13.82 (±3.07)	13.41 (±3.50)	12.84 (±3.26)	299.11 (±89.36)	334.29 (±86.41)
145 (Girls n=9 Boys n=3)	15.38 (±5.91)	16.07 (±3.54)	13.10 (±4.83)	14.58 (±3.32)	314.55 (±32.12)	310.41 (±74.57)

T-Test comparing scores of girls and boys	Parameter	p value
Physical Endurance Data	Hand Dynamometry: Right hand	<0.0001
	Hand Dynamometry: Left hand	0.822
	Lewis Power	0.242

*at 95% confidence interval

This study addressed the gender differences in BMI, food behaviour, cognitive performance and physical endurance of select urban Indian school children. The findings indicate behaviour patterns of concern with families selecting unhealthy foods while eating out, and watching television during meals and snacks. Most families did not eat together. The concerns of this behaviour pattern is endorsed by studies indicating that watching television while eating shows reduced consumption of fruit and vegetables and increased consumption of energy dense food in children (Matheson et al, 2004). More soda, snack foods and pizza were consumed by children in households in which the television was on for >2 meals/day (Coon et al, 2001).Studies have also reported that families stereotypically eat dinner out 2 times a week, choosing meals with reduced options for fruits and vegetables (FV) and parents seem less inclined to encourage choice of FV at home, consequently resulting in lower overall FV intake (Epstein, 2001). An ICMR study indicated that substantial television viewing by adolescents would put them at three times the risk of becoming overweight (Laxmaiah et al, 2009).

The results of the food frequency survey showed average high daily subscription of foods rich in staplecereals, processed ready to cook noodles, vegetable proteins, milk, potatoes, unhealthy snacks and the selection of unhealthy beverages twice a week but showed a poor diversity in fruit and vegetable selection. Consistent with this study; a study conducted at Hyderabad by Vijayapushpam et al (2003) indicated that, all children (aged 12 to 14 years) consumed rice daily. The study group had other daily choices of foods viz. wheat (62%), root vegetables (90%), milk (83%), corn flakes and processed noodles (39%). Carbonated beverages were consumed by 50% of the subject group at least twice a week.

An independent sample "t" test studying the difference between the genders with reference to their food frequency (table 2); showed a difference between boys and girls in a few food groups. Girls showed significantly more choice in sprouts, fruits, vegetables, ghee, healthy snacks and healthy beverages; whereas boys showed significantly more choice in cereals, dhals, nuts, root vegetables, milk, non-vegetarian foods, eggs and adjuncts. Consistent with this study, a study on gender difference in food selection of British school children (4-16 years) showed girls showed significantly more choice in fruit ($P< 0{\cdot}05$) and vegetables ($P< 0{\cdot}001$); boys selected significantly more fatty and sugary foods ($P<0{\cdot}005$), meat ($P<0{\cdot}001$), processed meat products ($P<0{\cdot}001$) and eggs ($P<0{\cdot}05$) (Cooke and Wardle,2005); another study also indicated increased preference for meat, fish, and poultry foods by boys over girls; girls preferred fruits and vegetables over boys (Caine-Bisch and Scheule,2009).A Korean study indicated that girls select more healthy foods than boys (Yon et al, 2008). However contradictory results were found showing no influence of gender on food frequency (Schlegel-Zawadzkay et al, 2002). Boys tend to select more foods dense in carbohydrate and protein than girls due to their association of these foods with better body growth. Girls tend to eat less dense and more fruit and vegetables to avoid becoming overweight.

In the present study we observe that most of the boys and girls had normal BMI; the children who fell under the "thin" category are just as much a concern as the children who were overweight. There was no significant difference in the BMI of girls and boys. Consistent with these results; in a study of growth parameters and prevalence of overweight and obesity in school children from Delhi by Marwaha et al, (2006); a prevalence of overweight and obesity in upper socio economic status children was found to be 16.75% and 5.59% in boys and 19.01% and 5.03% in girls respectively. There was no difference in BMI between the genders. The concern of the overweight and obese boys and girls increasing with chronological time is indicated in a study by Manu Raj et al (2007); the study examined a total of 24,842 children in 2003 and subsequently 20,263 children in 2005 in Kerala district, India and found the incidence of obesity to increase from 5.17% to 7.17% in 2005. Ergo, it is essential to work on helping overweight children lose weight and ensure normal children do not tend towards obesity.

Childhood cognitive performance is an established developmental cascade, with increasing chronological age there is faster processing speed, which influences improved cognition and reasoning ability (Nettelbeck and Burns, 2010).The present study shows linear progression of cognitive performance scores with age. Research exploring the association between cognitive test scores and gender in children and adolescents has produced mixed results (Vollrath et al, 2012; Rosselliet al, 2009; Temple and Cornish, 1993; Huang 1993). Studies have indicated normal

variations in patterns of cognitive tests across genders indicating relative strengths for girls in verbal tasks (Vollrath et al, 2012; Rosselli et al, 2009: Temple & Cornish, 1993) and boys in spatial tasks (Vollrath et al, 2012; Rosselliet al, 2009; Huang, 1993). In contrast, several studies have established no impact of gender on cognitive performance of children (Forrester and Geffen, 1991). Given the narrow bandwidth of the tests used; it cannot be conclusively established if gender plays a strong role in cognitive performance. From this study we established that there is no significant difference in the genders in cognitive performance.

Studies have established with increase in chronological age, total scores of physical endurance improved linearly. This linear progression is also an indicator establishing the adequate sensitivity of the test battery for the age range (Fjortoft et al, 2011). From this study we determined that physical endurance progressively improved with age; with no significant difference between the genders in explosive muscle strength. However, boys had significantly better right hand grip than girls. Consistent with this study; a study done on 1,417 healthy, urban school children from Brisbane, established that at all ages girls had reduced grip strength compared with boys and boys manifested a continual, approximately linear increase in grip strength through all age groups. The vertical jump (VJ) test studies explosive muscle strength of the legs, this test also factors speed and agility. Several kinematic studies have assessed the vertical and horizontal jumping performance of young children. The power output from the jump distance was calculated using the Lewis Power Equation (Mathews and Fox, 1974). The Lewis formula was developed to obtain a true measure of power output, where body weight and jump speed were taken into consideration (Johnson and Bahamonde, 1996). Studies have established that the gender difference in vertical jump test in children only set in at the onset of puberty; due to physiological changes boys outperform girls (Quatmanet al, 2005).

CONCLUSION

Growth and development is not entirely gender dependent. Good nutrition and a healthy lifestyle can promote optimal growth in either gender. Nutrition education is essential for both the children and their families to ensure reduction of maladaptive food behaviour patterns viz. unbalanced food selection and watching television while eating. Children with BMI both above and below normal ranges need to subscribe to better eating habits and lifestyle practices. Physical endurance and cognitive performance is dependent on chronological age and are impacted by nutrition status of the children notwithstanding the gender.

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METABOLIC RISK FACTORS AMONG 9-12 YEAR OLD CHILDREN IN COCHIN

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The rapid economic development along with increased urbanization and impact of market globalization over the last few decades have brought about considerable changes in diet and lifestyle of the people all around the world. Children with metabolic syndrome are two to three times as likely to have a heart attack or stroke and five times as likely to develop type II diabetes in their later life compared with children without the syndrome. This study was undertaken with the following objectives - to assess the nutritional status of school going children, estimate the incidence of overweight and obesity and to compute % body fat of the subjects, assess the pattern of energy expenditure and study the metabolic risk factors. 63,9 to 12 year old children were purposively selected from two urban schools in Ernakulum district, Kerala and based on BMI percentiles the subjects were grouped as underweight, normal weight, overweight and obese and were later broadly classified into non overweight and overweight for ease of studying the metabolic risk factors. The subjects were assessed for the risk of the metabolic components using criteria proposed by American Dietetic Association (ADA, 2004) and categorized in to normal and high risk respectively.The study revealed that majority of the overweight subjects had increased levels of all investigated risk factors compared to non- overweight subjects. Serum insulin and systolic blood pressure show a highly significant correlation ($p<0.001$) with weight status. The overall metabolic risk of subjects by weight status shows that 66.7 % of the overweight children had clustering of one or two risk factors of metabolic syndrome when compared to 46.3 % of non-overweight subjects. The frequency of clustering of metabolic risk factors is higher among the overweight subjects compared to their non- overweight counterparts.

KEY WORDS - Overweight, metabolic syndrome, serum insulin, systolic blood pressure.

The rapid economic development along with an increased urbanization and impact of market globalization over the last few decades has brought about considerable changes in diet and lifestyle of the people all around the world. Changes in the world food economy are reflected in shifting dietary patterns like increased consumption of energy dense diets high in fat- particularly saturated fat- and low in unrefined carbohydrates. These patterns are combined with a decline in energy expenditure that is associated with sedentary lifestyle (WHO/FAO, 2003). It is believed that these changes in dietary and lifestyle patterns are the major factors for increasing the prevalence of obesity associated with non- communicable chronic diseases such as diabetes mellitus, cardiovascular disease, hypertension and stroke (Khongsdier, 2005).

Obesity is characterized by an excess of Body Fat, which is defined conventionally as BF>25% in males and >35% in females (young adults aged <31 years). In girls, % total fat increases from an average of 20 to 26 % between nine and twenty years, while in boys it decreases from 17 to 13 % after thirteen years of age as Fat Free Mass increases (Butte, 2000).

Obesity is a disorder of positive energy balance, with energy intake exceeding energy expenditure. In addition to genetic predisposition, an inactive lifestyle and high caloric intake are the overriding causes of excessive weight gain (Radulian, 2009). Thus lifestyle changes affecting dietary habits and physical activity are essential to promote weight loss (Masley, 2008).

The metabolic syndrome has been defined as cluster of most dangerous risk factors for cardiovascular diseases and type II diabetes and includes abdominal obesity, high cholesterol, high blood pressure, and raised fasting plasma glucose (Alberti et al, 2005).
Already, a quarter of the world's adult population has metabolic syndrome and this condition is appearing with increasing frequency in children and adolescents due to the growing obesity epidemic within this young population (Weiss et al., 2004). In western countries, the incidence of childhood obesity has more than doubled over the past generation, as a consequence, the prevalence of metabolic syndrome and type II diabetes mellitus is rapidly increasing in pediatric population (Cook et al., 2003).

Children with metabolic syndrome are two to three times as likely to have a heart attack or stroke and five times as likely to develop type II diabetes in their later life compared with children without the syndrome. The risk factors associated with metabolic syndrome in children can be extended to adulthood and causes many cardio metabolic complications. So, early identification of children at risk of metabolic syndrome will be crucial to the prevention of chronic disease during childhood and in later life (Zimmett, 2007).

MATERIALS AND METHOD

The study was conducted in two private schools of Ernakulam. From the two schools with parental consent, 63 healthy children (39 boys and 24 girls) between the ages of nine to twelve years were recruited for the study. The two urban schools were selected by convenience sampling; the sub sampling was done by voluntary presentation for a blood draw in the prescribed age group after dissemination of the study information. Children with systemic illness or on medication were not included in the study. The tools for the study included interview schedule and questionnaire. Details such as dietary habits, socio economic background were collected using the interview schedule. Data on three (consecutive) day dietary intake was collected using a questionnaire on 24 hours dietary recall.

The overall nutritional status of the subjects under study were assessed using anthropometric measurements such as height, weight, body mass index, mid upper arm circumference, waist hip ratio, body fat percent using Siri's equation and skin fold thickness. Based on the BMI percentiles the subjects were broadly classified initially into four groups namely underweight, normal weight, overweight and obese and were later grouped into two categories namely Non overweight and Overweight for ease of studying the metabolic risk factors. The energy expenditure of the subjects was assessed by calculating the two components namely Basal Metabolic Rate and Physical Activity Energy Expenditure (calculated using Mets value proposed by WHO).The energy balance of the subjects was also studied.

The biochemical measurements were done at Amrita Institute of Medical Sciences (AIMS), Cochin. The blood pressure was measured using a standardized mercury sphygmomanometer and

recorded by a trained nurse. Serum Insulin assay was done by chemiluminescence method to reduce the chance of erroneous variable, and Fasting Blood Glucose (FBG) was measured using Photometric method. The Lipid profile was assayed using spectro photometric method using the instrument Olympus 2700. Lipid profile included total cholesterol (TC), High density Lipoprotein cholesterol (HDL-C), Trigylceride (TG), Low density lipoprotein cholesterol (LDL-C) and very low density lipoprotein cholesterol (VLDL-C).

Nutritive value of the diet was computed by referring to Nutrient Data base released by ICMR and USDA. Thus, energy, protein, fat, carbohydrate, fiber and fat composition of the diet was calculated. Then the subjects were studied for the risk of the metabolic components proposed by American Dietetic Association (ADA, 2004) given in Table (1) and categorized in to normal and high risk. Body Mass Index (BMI) reference was taken from Centre for Disease Control (CDC) and prevention (2000) data set for children and adolescents. Blood pressure was measured using mercury sphygmomanometer and as recommended by the fourth report on the diagnosis, evaluation and treatment of high blood pressure in children and adolescents.

TABLE 1: Definitions of risk for metabolic components

Component	Risk Category definition
BMI	Not at risk : <85thpercentile Overweight: ≥ 95thpercentile
HDL cholesterol	Normal > 35 mg/dL Low : ≤ 35 mg /dL
Triglycerides	Normal : ≤110 mg/dL High : >110 mg/dL
Insulin	Normal: <15 µU/L High : >20 µU /L
Glucose	Normal : <100 mg/dl Impaired fasting glucose: 100-125mg/dL
Systolic blood pressure	Normal: <90thpercentile Hypertension: ≥ 95percentile
Diastolic blood pressure	Normal: <90thpercentile Hypertension: ≥ 95thpercentile

Reference: American Diabetic Association (2004)

The data obtained was subjected to appropriate statistical analysis (SPSS 11.0 Version) like Pearson's correlation co-efficient and 't' test and the results were interpreted to reach the study objective.

RESULTS AND DISCUSSIONS

On assessing the weight status of subjects, although a vast majority, 71% belonged to normal weight category, 14% were found to be underweight, 11% were overweight and 3 % belonged to obese category. Gender based segregation of subjects revealed a higher prevalence of overweight among girls at 21 % compared to boys at 10.3 %.

The % body fat of the subjects by weight status Table (2) shows a progressive increase with increasing weight in the study population.

TABLE 2: Percentage Body Fat with respect to weight status (N=63)

Weight status	n	Weight (Kg) Mean(SD)	PBF* Mean(SD)
Underweight	9	24(3.3)	14.6 (3.8)
Normal weight	45	35.5 (6.8)	22.1 (5.4)
Overweight	7	49 (9.5)	27.8 (3.2)
Obese	2	60.2 (14.4)	32.7 (7.37)

* % Body Fat (PBF) by Siri's equation (1991)

Components of Energy Expenditure with respect to weight status Table (3) shows an increase in the total energy expenditure with increase in the weight of the subjects calculated as a sum of basal metabolic rate and physical activity energy expenditure.

TABLE 3: Components of Energy Expenditure with respect to weight status (N=63)

Weight status	n	Wt (Kg) Mean (SD)	BMR* (Kcal/day) Mean(SD)	PAEE** (Kcal/day) Mean(SD)	TEE*** (Kcal/day)Mean(SD)
Under weight	9	24(3.3)	951.5(87.8)	988.4(219)	1940(303)
Normal	45	35.5(6.8)	1088(147)	1294.7(389)	2382(532)
Overweight	7	49(9.5)	1271.6(193)	1721(531)	2992(721)
Obese	2	60.2(14)	1413(61.2)	2028(142.6)	3441(204)

*Basal Metabolic Rate as per ICMR equation **Physical Activity Energy Expenditure
***Total Energy Expenditure

The energy balance calculated as the difference between energy intake and total energy expenditure is also studied with respect to weight status of the subjects. The results are listed in Table 4. Underweight subjects had a negative energy balance which explained their underweight status. The high negative energy balance in obese and overweight subjects could be related to the high total energy expenditure which in turn can be explained by increased BMR in these subjects. However, the number of subjects in both these categories is too small to infer anything.

TABLE 4: Energy Balance with respect to weight status of subjects (N=63)

Weight status	n	Wt (Kg) Mean(SD)	EI* (Kcal/day) Mean(SD)	TEE** (Kcal/day)Mean(SD)	Energy Balance (Kcal/day)Mean(SD)
Underweight	9	24 (3.3)	1613 (268.7)	1940 (303.1)	-326 (380)
Normal	45	35.5 (6.8)	1770 (310)	2382 (531)	-612 (523)
Overweight	7	49 (9.5)	1867 (215)	2992 (721)	-1125(642)
Obese	2	60.2 (14)	1459 (188)	3441 (203)	-1981 (15)

*EI – Energy Intake **TEE – Total Energy Expenditure

The subjects are then classified into the broad category of Non overweight (includes underweight and normal weight) and Overweight (includes overweight and obese). Anthropometric data of the subjects by weight status Table (5) shows a significant increasing trend with increasing BMI percentiles in the study population and also the independent t test shows a significant difference between overweight and non-overweight groups.

TABLE 5: Anthropometric parameters of subjects by weight status (N=63)

Anthropometric parameters	Means (SD)		t value
	Non overweight	Overweight	
Height (cm)	141.6 (9.8)	148.4 (9.7)	1.922*
Weight (kg)	33.6 (7.7)	51.5 (10.8)	6.050**
BMI (kg/m^2)	16.6 (2.3)	23.1 (2.4)	7.569**
Waist (cm)	62.8 (7.4)	79.9 (8.6)	6.245**
Hip(cm)	73.3 (5.3)	88.5 (5.7)	6.567**
WHR	.857(.044)	.906 (.057)	3.758**
Sum of skin folds (mm)	36.1 (14.5)	65.3 (15.9)	5.513**
MUAC(cm)	19.7 (3.9)	25.8 (4.1)	4.452**
Body fat %	20.5 (3.1)	26.6 (3.56)	2.231*

**Highly significant *significant

The biochemical profile of the subjects by weight status depicted in Table (6) shows that the systolic and diastolic blood pressure were gradually escalating from non-overweight to overweight subjects, the increase being more evident for systolic blood pressure. Serum insulin level was observed to be low in non-overweight subjects, compared to overweight subjects. Interestingly, triglyceride levels and C-reactive protein also increased progressively from non-overweight to overweight subjects. Further studies using inferential statistics needs to be done to confirm these findings

TABLE 6: Biochemical parameters of subjects by weight status N=63

Biochemical parameters	Means (SD)	
	Non overweight	Overweight
Systolic BP (mmHg)	90 (8.6)	113.7(11.6)
Diastolic BP (mmHg)	65.9 (7.2)	75.5 (6.3)
Serum Insulin (µU/L)	7.5 (4.6)	19.8 (15.0)
Fasting Blood glucose(mg/dl)	90 (5.9)	94 (7.8)
Apo A (mg/dL)*	126.1 (18.5)	125.4 (15.6)
Apo B (mg/dL)**	83.1 (20.2)	78.7 (11.7)
T-Cholesterol (mg/dL)	184.9 (33.5)	179 (17.2)
HDL (mg/dL)***	49.3 (8.9)	46 (8.1)
LDL (mg/dL)****	109.4 (22.6)	106.7 (15.3)
VLDL (mg/dl)*****	17.9 (7.8)	24.2 (4.0)
TG (mg/dl)******	94 (44.6)	120.8 (58.4)
CRP (mg/L)*******	1.3 (6.0)	2.9 (4.4)

*Apo A-Apo lipoprotein A, **Apo B-Apo lipoprotein B,***HDL-High Density lipoprotein, ****LDL-Low Density Lipoprotein, *****VLDL-VeryLow DensityLipoprotein, ******TG-Triglycerides, *******CRP-C-Reactive Protein.

On studying the nutrient intake pattern of the subjects by weight status Table (7), energy and carbohydrate intake was seen to be gradually escalating from non-overweight to overweight subjects. The mean energy intake is high (1776.5 Kcal) in overweight subjects than Non overweight subjects (1718.5 Kcal) and there is a difference of 58 Kcal between the two groups. The difference is only marginal, and it may be explained by the fact that some of the overweight

subjects had already initiated downsizing their portion size and there was some under reporting too. Protein and fat intake was observed to be similar for both groups.

TABLE 7: Nutrient intake pattern of subjects by weight status (N=63)

Nutrients	Means (SD)	
	Non overweight	Overweight
Energy (Kcal)	1718.5 (220.6)	1776.5 (267.6)
Protein (g)	47 (9.8)	47.4 (10.5)
Carbohydrates (g)	260.7 (40.6)	280.5 (46.9)
Fat (total) (g)	52.3 (7.8)	52.5 (6.5)
Visible fat(g)	29.8 (5.5)	29.6 (7.9)
SFA (g)*	37.3 (8.9)	35.4 (10.3)
MUFA (g)**	8.6 (2.5)	8.5(2.6)
PUFA(g)***	5.1 (4.1)	5.9 (6.7)
Fiber (g)	3.6 (.98)	3.9 (1.1)

*SFA-Saturated Fatty Acid, **MUFA-Mono Unsaturated Fatty Acid, ***PUFA-Poly Unsaturated Fatty acid

The Table (8) shows the distribution of metabolic risk factors of subjects stratified by weight status. It is evident from the table, that compared to non-overweight subjects majority of the overweight subjects had higher incidence of metabolic risk factors like elevated serum triglycerides, insulin, fasting blood glucose and systolic and diastolic blood pressure.

TABLE 8: Distribution of metabolic risk by weight status (N=63)

Risk components	Non overweight		Overweight	
	Normal (%)	High (%)	Normal (%)	High (%)
Triglycerides (mg/dL)	76	24	44	56
Insulin (µu/L)	92	8	44	56
Fasting blood glucose (mg/dL)	69	31	67	33
Systolic blood pressure (mmHg)	100	-	67	33
Diastolic blood pressure (mmHg)	89	11	44	56

On analyzing the serum triglyceride and insulin levels of the subjects by weight status, it was found that 56 % of overweight subjects had high level when compared to 24 and 8% respectively of non-overweight counterparts. The fasting blood sugar levels of subjects shows that 33% overweight subjects had high level when compared to 31% of non-overweight subjects. The blood pressure components of study subjects show that a greater number of overweight subjects (33and 56 %) had high level of systolic and diastolic blood pressure when compared to (0 % and 11%) of non-overweight subjects.

On analyzing the overall metabolic risk factors of study subjects by weight status, it reveals that 66.7 % of the overweight children had clustering of one or two risk factors of metabolic syndrome when compared to 46.3 % Non-overweight subjects.

Table (9) depicts Pearson's correlation of metabolic risk factors with weight status. It shows that only the insulin levels and systolic and diastolic blood pressures shows a significant correlation ($p<0.001$) with weigh status.

TABLE 9: Pearson's correlation coefficient for metabolic risk with weight status (N=63)

Parameters	Weight status		P values
	Non overweight	Overweight	
	Means ± SD	Mean ± SD	
TG (mg/dL)	94 ± 44.6	120.8± 58.4	.109
Insulin (μU/L)	7.5 ± 4.6	19.8± 15.0	. 006*
FBG (mg/dL)	90 ± 5.9	94± 7.8	. 033
SYS – BP (mmHg)	90± 8.6	113.7± 11.6	.000*
DIA – BP (mmHg)	65.9 ± 7.2	75.5 ± 6.2	.001*

TG-Triglycerides, FBG-Fasting Blood Glucose *Significance <0.001
SYS-BP-systolic Blood Pressure, DIA_BP-Diastolic Blood Pressure

CONCLUSION

In conclusion, 86 % of the study subjects belong to non-overweight category and 14 % to overweight category. The % body fat of the subjects was seen to increase progressively with increasing weight in the study population. The total energy expenditure in these subjects also increased with increase in weight which could be attributed to the increase in basal metabolic rate. On studying the energy balance of these subjects, calculated as the difference between energy intake and total energy expenditure, it was observed that the high negative energy balance in obese and overweight subjects could be related to the high total energy expenditure which in turn can be explained by increased BMR in these subjects. However, the number of subjects in both these categories is too small to infer anything.

Anthropometric data of the subjects by weight status shows a significant increasing trend with increasing BMI percentiles in the study population and the biochemical profile of the subjects shows that the systolic and diastolic blood pressure, serum insulin, triglycerides and fasting blood glucose were gradually escalating from non-overweight to overweight subjects. On analyzing the distribution of metabolic risk on the basis of weight status, it was found that majority of the overweight subjects had increased levels of all investigated risk factors as compared to their counterparts. Serum insulin and systolic blood pressure show a significant correlation with weight status. Overall 66.7 % of the overweight children had clustering of one or two risk factors of metabolic syndrome when compared to 46.3 % of non-overweight subjects. Thus it can be concluded that the frequency of clustering of metabolic risk factors is higher among overweight subjects increasing their risk of chronic degenerative diseases.

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ANALYSIS OF FUNCTIONING OF FOOD SERVICES IN SELECTED MATRICULATION SCHOOLS

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With the burgeoning rate of obesity and overweight among children, it is imperative that the food consumed at school, which forms a major part of their lifestyle behaviors be determined. The present study was undertaken to find out the functioning of the food service in selected schools with the objectives of analyzing the types of foods served,examining the sanitary and hygienic practices inthe food service and personnel hygienepractices, and offering educationto the food service personnel on sanitation and hygiene. Using purposive sampling technique threeMatriculation schools in Coimbatore city which had functional food service outlets were chosen. Using well framed questionnaire information on the management and functioning of the food services were recorded. A pre tested checklist was used to record the sanitation and hygienic practices followed. The school managed the food service in two cases while private management was seen in one. Leaf or plate service was followed in one and counter-service in the remaining two. Lunch, snacks and beverages were served in all three.Depending upon the type of meal served, the number of personnel varied. Daily, weekly and spring cleaning techniques were adopted in all the food services as part of the sanitation measure. Usage of disposables was not present in any of the food services,while clean and operable separate employee restrooms were not present in any of the schools. The personnel failed to follow correct pre-preparation methods. Education was offered on food pre-preparation as well as in hand washing and other sanitary practices and the importance of serving food at correct temperatures. The impact of education was assessed and the results were statistically analyzed.

KEY WORDS: Food Service Systems, Sanitation, Personnel hygiene, clientele to the food service, Education, Impact of Education.

It is a common notion that children are the living messages we send to a time we will not see. This gives us the necessity of fostering healthy children to build a strong future. The importance of nurturing our children tobecome better citizens of tomorrow rests inthehands of the parents and teachers. According to the Health Promotion Board (2010), food preferences are generally acquired during childhood and eating habits acquired after adolescence are more resistant to change. The school environment plays an important role in nurturing and sustaining good eating habits.

Diet plays a major role in determining the body weight of children and obesity which is an ever increasing phenomenon in our country is attributable to erratic eating habits of children. The dietary patterns of children are determined by social, psychological, and economic factors.
According to Kepos (2011) in recent years, public health officials and school administrators have come to realize that schools are frequently working against the cause of sound nutrition in children and adolescents. Many school districts have negotiated exclusive contracts with fast food and beverage companies to provide their products to students, with a portion of the revenues

going to the schools(Kepos,2011). As a result, cafeteria and vending machine lunches commonly include pizza, burgers, chips, soda, candy, and ice cream.

Globalization and free trade have brought fast-food eating establishments to most countries, especially to developing nations. McDonalds, Pizza Hut, Burger King, and places like these are commonly found in Europe, Asia, Australia, the Caribbean, and Latin America. Vegetable oils and fats are cheap and easily available, and more food products high in fats are accessible even to low-income persons in developing countries. Consequently, even poorer nations are no longer immune to the ills of Westernization, including obesity.

The shrinking world brought about by satellite television and the Internet has created apopular culture among teens around the world—a culture inundated by junk snacks, sodas, pizzas, and convenience foods. Eating a meal at the table is no longer a tradition, as nuclear families are rare. Teens are used to "grab and run" eating styles, as are many adults. Food manufacturers and franchisers take advantage of this profit-making opportunity to produce more convenience foods, snacks, and beverages that are high in fats and calories. Teens prefer popular, tasty, and easy-to-findjunk foods. These types of junk foods and fast foods as preferred by the children and adolescents are consumed not only at the home environment, but also at schools, where such foods are stacked in school canteens to cater to popular demands.

Not only the nature of foods, but also the mode of preparation as well as the hygiene and sanitation of the surroundings affect the children and adolescents who consume fast foods from the school canteens. Hence the present research was undertaken to analyze the type of food service in schools, to identify the students who patronize the canteens, to study the types of foods served as well as the sanitation and personnel hygiene practices adopted. For this purpose three matriculation schools were chosen with the following objectives:

1. Tostudy their food service
2. Obtain a knowledge of the students patronizing the food services
3. Scrutinize the sanitation and hygienic practices followed in the food services
4. Educate the personnel on the flaws in the sanitation and hygienic practices
5. Assess the impact of the education

METHODOLOGY

1. Selection of area and samples

Threematriculation schools from Coimbatore city were chosen for the study. These schools were chosen based on the permission given by the respective schools on a purposive sampling basis. These threeschools had full-fledged functional canteens which catered to the needs of the students as well as teaching and non-teaching staff in terms of providing breakfast or lunch and snacks.

2. Study of the functioning of the canteens

The functioning of the canteens in terms of the management and the number of staff were determined using a questionnaire in which the duties of the staff were also recorded. The menus offered by the canteens and the mode of service, whether self-service or waiter services were also found. All the questionnaires were pre-tested prior to administration and suitable changes adapted.

3. Knowledge of the clientele to the canteen

An account of the students visiting the canteen on a daily, weekly and on a rare basis was done and the popular menus among the students were also identified.

4. Sanitation and personnel hygiene

Sanitary practices followed in the canteens were observed and recorded on a checklistin terms of sanitation of the premises, food preparation and service, equipment and personal hygiene of the workers. The personal hygiene of the workers in the canteen along with the facilities available for maintaining personnel hygiene were also recorded on a checklist in all the three canteens.Scores were allotted for the individual activities with five marks for 100 per cent compliance, followed by four for between 80 and 99 per cent, three for between 60 and 79 per cent, two for between 40 and 59 per cent, one for between 20 and 39 per cent and zero for between zero and 19 per cent compliance. The total scores were calculated and the level of hygiene and sanitation was adjudged.

5. Education of the food service personnel

Education of the food service personnel was carried out using charts and black boards. Daily half-an-hour sessions lasting for three months were carried out in order to educate the food service personnel.Pamphlets were prepared in local language (Tamil) covering topics on food preparation, food service and sanitation and hygiene and circulated among the food service personnel to have a direct impact on their daily activities.

6. Impact of education

A check list with scores was used to evaluate the personnel hygiene and sanitary practices of the workers before and after education No control group was involved. A comparison of the scores obtained before and after education was done and the results analyzed statisticallyusingstudent's't'test of significance.

RESULTS AND DISCUSSION

The results of the study 'Analysis of Functioning of Food Service in selected Matriculation schools'is discussed as follows:

I. Staff to student ratio in theselected schools

TABLE 1: Distribution of students and teaching staff in the schools(N = 5865)

Table I shows the frequency distribution of staff and students in the various schools. Considering

Type of school	Total number of students	Teaching staff	Ratio of students to staff
Matriculation -1	1260	121	10.41: 1
Matriculation- 2	2904	295	9.9:1
Matriculation– 3	1170	115	10.17:1
Total	5334	531	

the proportion of staff to students, it could be deciphered that there was a better ratio of staff to students found in Matriculation school 2 compared to the other two schools. According to Maben et al (2007) there may be link between staff student ratio and quality management in schools.

II. Functioning of Canteens in the selected Matriculation schools

1.Type of management of the canteens and their menu

TABLE 2: Management and Type of menu in the Matriculation school Food Service outlets (N = 3)

Type of management	Frequency	Type of foods served
Private parties	1	Meals, snacks and beverages
School management	2	Meals, snacks and beverages

From table 2, it is evident that two food service outlets were managed by the school authorities while one school leased the functioning of the food service to a private party. Food services in Matriculation schools 1 and 3 were managed by the school authorities while that in Matriculation school 2 was under private management.

All the three canteens served lunch, snacks and beverages during school hours. All threecanteens hadthe policy of serving pre-ordered foods also. The students could order foods in the morning and procure tokens so that they could have food without having to wait for the tokens during lunch.

2. Type of food service in the canteens

TABLE 3: Types of service followed in the matriculation school food service outlets(N =3)

Type of service	Number of canteens
Leaf/Plate service (lunch)	1
Counter service (snacks, meals and beverages)	2

Table 3 shows the type of food service in the school canteens. It is evident that leaf/plate service was followed in the canteen of Matriculation school 1while the remaining two had counter service. In Matriculation school 1, where lunch was served, plate service was followed for students on a regular basis, while for high school students leaf service was adopted on festive occasions like founder's day, teachers' day and children's day. The menu served was South Indian.

In case of other two schools offering counter service, pre plated fixed menu was followed for lunch while there were choices in the snacks served.

3.Frequency of patronization of food service outlets in the Matriculation schools

TABLE 4: Frequency of patronization of the food service outlets (N = 5334)

Patrons	Frequencyof visit	Matriculation1 (N=1404)		Matriculation2 (N= 3109)		Matriculation 3 (N=1305)	
		N	%	N	%	N	%
Students	Daily	559	44	889	31	488	42
	Weekly	458	37	1512	52	336	28
	Rarely	243	19	503	17	346	30
	Total	**1260**	**100**	**2904**	**100**	**1170**	**100**

Table 4shows the frequency in which the students consumed food in the canteen. In Matriculation schools 1 and 3, daily consumption of food from the canteen was on a higher side with 44 per cent and 42 per cent while in Matriculation school 2, weekly consumption was high with 52 per

cent students, thus bringing out the students preferences for foods served in the canteen and the permission given by the parents to eat outside.The canteens managed by schools enrolled students for the lunch programme by providing tokens for lunch and mid- morning snacks which were paid by the parents three months in advance. Hence the turnover in school managed canteens was steady and higher(on a daily basis) compared to that managed privately.

4.Types of foods served

TABLE 5: Types of foods served in the food service outlets (N = 3 canteens)

Lunch	Snacks	Beverages
- Noodles - Fried rice - Curd rice - Ricewith sambar and poriyal - Poori with channa - Chicken fry - Egg biriyani - Egg (boiled) - Chappathi - Barota - Oothapam with kuruma - Vegetable biriyani - Tomato rice - Lime rice - Coconut rice - Idly with chutney and sambar	- Bajji - Bonda - Vadai - Samosa - Puffs–egg and vegetable - Ragipakoda - BhelPuri - PaniPuri - PavBhaji - Cutlet - Spring Rolls - Aloo Chat - Ice creams - Fruit salads - Vegetable salads - Sprouted grams - Chocolates - Cookies	- Fruit juices - Carbonated beverages - Hot beverages (milk, tea, coffee, chocolate and malt based beverages)

Table 5 brings out the types of food served in the canteens of the selected schools. In Matriculation school 1, where South Indian lunch was served, a five day cyclic restricted table d'hote menu was followed with no choice offered between menu items.

In the other two Matriculation schools snacks, breakfast and lunch items were served in a pre-plated manner with fixed rate. These included breakfast items like chappathi, barota and poori and idliand lunch items like fried rice, noodles and variety rice and snacks like spring rolls, cutlet, samosa and puffs which were popular among the students.

According to Australian nutritional guidelines,(Verity et al., 2004) when planning school menus, emphasis should be given to the following foods that contribute significantly to meeting students' nutritional needs:

- Breads and cereal foods, e.g. rice, pasta, especially wholegrain varieties
- Fruit - preferably fresh, but including frozen and canned
- Vegetables - fresh, frozen and canned
- Reduced fat varieties of milk, cheese, yoghurt
- Lean meats, skin-free poultry, fish, eggs, baked beans and other legumes
- Plain water

In comparison with the guidelines laid out by the Australian nutrition society, the nature of foods served in the school canteens in the present study were foundto be predominantly cereals and fatty foods, while providing less amount of vegetables, and even if they were provided, they were less in quantity and given in fried forms. Whole fruits were not included in the menu. Milk was provided only in one of the school canteens managed by the school, while other two provided only coffee and tea.

Carbonated beverages formed a major part of the menu and 80 per cent of students who visited the canteen showed preference for the same in comparison with fruit juices. Thus junk foods and carbonated beverages dominated the menu and were preferred highly by the students. Even during lunch time, students showed a liking towards consumption of fried snacks.

5. Menu items in the canteen of the selected schools

Table 6 brings out the menu items in the canteens of the selected schools according to the processing involved. The complexity of cooking is considered in classification of the food items with items involving no cooking being classified under the same category and items involving detailed menus and previous pre-preparations being classified under complex. Those items which were prepared without involving much pre-preparation were classified under process 2

TABLE 6: Menu items sorted by complexity of cooking(N = 3 canteens)

PROCESS 1 No cooking	PROCESS 2 Cook and serve the same day	PROCESS 3 Complex food preparation
Fruits	Bread omelet	Egg biryani
Salads	Noodles	Sambar rice
Sandwich	Fried rice	South Indian Breakfast items
Juices	Snacks except salads	Parathas, Barota
Ice creams	Chappathi, idli	

Table 6 shows the sorting of menu by process. Certain items like fruits, salads and sandwich involvedno cooking, certain foods like omelet and noodles had to be cooked and served the same day, while certain foods like egg biryani and sambar rice involved complex preparation techniques based on recipes. Quality control plays a major role in every step of food preparation and this sorting out of menu items helped in better quality control in kitchen as well as serving areas in the canteens of the various schools.

6. Distribution of personnel in the canteens

Table 7 shows the number of cooking and serving personnel in each canteen.It can be seen that in Matriculation School 1, the number of cooking personnel were five as all the menu items were prepared in the canteen premises.In Matriculation school 3, the ten personnel involved in serving worked in shifts for serving lunch and snacks. Ratio of number of employees to total work output would relate to the efficiency of the personnel. If the ratio of employee to work hours is less, then the organization is heading towards better employee work output as opined by Buchanan (2002). In the case of school food service, each employee puts forth an average of 8 hours a day with a five-day week schedule in all the food service outlets, thus having a lesser ratio of employees to work hours, thereby leading to better employee work output.All the schools employed workers

only for eight hours a day, irrespective of the number of employees. If there were more personnel, they worked in shifts.

Table 7 brings out the number of personnel present in the cooking and serving areas of the canteens in the selected schools.

TABLE 7: Number of personnel in the food service of the selected schools(N = 36)

Type of school	Personnel present		Total working hours of all employees/day	Ratio of employees to working hours/day
	Cooking	Serving		
Matriculation 1	5	9	112	1:8
Matriculation 2	3	7	80	1:8
Matriculation 3	2	10	96	1:8
Total	10	26	288	

III. Sanitation and Hygiene in the Food Service Outlets of the Selected Schools

1. Sanitary Practices

TABLE 8: Sanitary practices followed in the food service outlets(N = 3 canteens)

Type of canteen	Sanitation of canteen		
	Daily	Weekly	Spring cleaning
Counter service	Counters Table tops Floors Equipment Shelves	Chairs Display boards Mopping of floors	Fans Ceiling Large vending machines Windows and doors
Leaf/Plate service	Floors Plates Equipment Shelves Work surfaces Drawers and racks	Floor cleaning Tables Storage areas	Fans Ceiling Stoves and gas tops Exhaust hood Windows and doors

Table 8 brings out the cleaning practices followed in the food service outlets as part of maintenance of sanitation. Daily cleaning was followed for food contact surfaces while others where dust accumulation was foreseen were cleaned weekly or by spring cleaning. Cleaning was adopted as a measure of maintaining sanitation in the canteens. Disinfectants were used for floors and tiles, while cooking and serving equipment as well as utensils were cleaned using dish washing liquids.During all hours of operation, food service personnel should visually and physically inspect food contact surfaces of equipment and utensils to ensure that the surfaces are clean is one of the recommended HACCP based sanitation procedures of USDA (2010)A thorough checking of premises was done in all the three food services as laid down by USDA guidelines.

2. Personnel Hygiene

TABLE 9: Personal hygiene of workers(N = 36)

Checklist	Compliance					
	Matriculation 3 N = 12		Matriculation 2 N = 10		Matriculation 1 N = 14	
	Yes	No	Yes	No	Yes	No
Employee uniform	2	10	1	9	3	11
Hair restraint	0	12	0	10	1	13
Trimmed nails	2	10	0	10	2	12
Limited jewelry	12	0	10	0	14	0
Proper hand washing	2	10	3	7	5	9
Usage of disposables when coughing and sneezing	0	12	0	10	0	14
Employee in good health	12	0	10	0	14	0
Facilities for hand washing utilized by personnel	2	10	3	7	5	9
Employee restrooms operational, clean and used	0	12	0	10	0	14

Table 9 depicts the checklist of hygienic practices observed among the canteen workers. In the Matriculation schools, employees' health and wearing limited jewelry were followed as laid down by the rules of the management of the schools. However, facilities for hand washing and restrooms were limited and they were forced to use either the restrooms of the students or that of the school staff. While stressing the need for hand washing in food service establishments, Ramos (2010) opines that only through frequent and appropriate hand washing one can assure that hands are free of deadly bacteria and other contaminants. In the food service industry, appropriate hand washing procedure is one of the single most effective tools in reducing the risk of cross contamination. It is also important for the employees to keep their fingernails cut short, kept clean, and not wear nail polish.

3. Hygiene followed by personnel in food preparation and service

Table 10 brings out the compliance to hygiene in procedures followed in the pre-preparation, preparation and service of food in the food service outlets. Certain employees followed norms in preparation and service while certain did not follow principles of sanitation and hygiene. Scores were allotted for individual activities as described earlier. It was revealed from the total scores that there was not much difference in the scores between the three school food service outlets. HACCP procedure recommends washing of fruits and vegetables before they are cut to prevent the risk of food borne illnesses through contamination (USDA, 2010). However, in the present study it was found that vegetables were cut before washing, which was applicable even to green leafy vegetables, cutting was done long before commencement of preparation and the practice of washing knives and cutting boards prior to and after cutting was followed to a lesser extent in the food services.Moreover, foods were not kept warm prior to service, no hand gloves were worn while serving, only limited personnel washed their hands prior to serving food items and foods were served with bare hands by most food service personnel.

TABLE 10: Hygiene in preparation and service of food(N =36)

Checklist	Compliance scores					
Food pre-preparation	Matriculation 3 N = 12		Matriculation 2 N = 10		Matriculation 1 N = 14	
Cutting of vegetables	%	Score	%	Score	%	Score
Cleaning cutting boards and knives	58	2	80	4	43	2
Washing vegetables before cutting	17	0	10	0	7	0
Cutting only prior to preparation	0	0	0	0	0	0
Dough and batter preparation						
Usage of clean vessels and utensils	100	5	80	4	86	4
Using clean potable water	100	5	100	5	100	5
Washing hands prior to mixing	50	2	40	2	36	1
Cleaning the grinder or dough mixer	100	5	100	5	100	5
Food preparation						
Clean utensils	100	5	100	5	100	5
Cleaning of hands	17	0	20	1	14	0
Tasting of food while cooking	100	5	100	5	100	5
Thorough cooking of food	100	5	100	5	100	5
Service of food						
Food served at right temperature	0	0	0	0	0	0
Service with properly cleaned utensils	100	5	100	5	100	5
Hands cleaned before and after service	50	2	40	2	36	1
Wearing gloves while serving	0	0	0	0	0	0
Use of ladles to dish out items	42	2	30	1	43	2
Total scores		43		44		40

4. Education of the food service personnel

The type of education given to food service personnel could be categorized into the following categories

TABLE 11: Types of education imparted to food service personnel(N = 36)

Type of education	Type of schools		
	Matriculation 3	Matriculation 2	Matriculation 1
Posters	6	7	7
Lecture method	2	3	5
Demonstrations	2	2	2

Three types of education methods were followed among the food service personnel in the three Matriculation schools. Posters pertained to the methods to be followed in kitchen hygiene in the form of proper hand washing techniques, disposal of waste in waste bins, using aprons while cooking and preparation of food, hair restraints while cooking and pre preparation. Lecture method consisted of providing information on food borne illnesses, better storage and cooking of foods, necessity of keeping food at the right temperature till serving. Demonstrations consisted of

practical methods of food sanitation like cleaning of work surfaces, methods of food preparation and types of personal hygiene to be followed.

Poster method of education was done for those with limited education and who formed the lower category of employees like helpers and cleaners as they would understand information much better through pictures. Demonstrations were done for cooking and serving personnel to instill better cooking and serving habits through practice. Lecture method was followed for supervisors and those who had basic education so that they were able to grasp the points in a better manner.

5.Impact of Education

The impact of education was assessed using the same checklist used to assess the work pattern of the workers before educationcovering personnel hygiene as well as sanitation in food preparation and service. Scores were totaled and the mean scores were compared to find out the impact of education. The mean scores before and after education is depicted in Table 12

TABLE 12: Mean scores on hygiene and sanitation before and after education (N = 36)

Food service	Mean compliance scores				p value
	Before education Mean ±S.D	Standard Error	After education Mean ± S.D	Standard Error	
Matriculation 3 N = 10	2.69±2.24	0.56	4.88±0.34	0.08	0.0014
Matriculation 2 N = 12	2.75±2.18	0.54	4.81±0.40	0.10	0.0018
Matriculation 1 N = 14	2.5±2.25	0.56	4.63±0.5	0.12	0.0019

Table 12 shows the mean and standard deviation of the scores obtained by evaluating the hygiene and sanitation of the food service personnel before and after education. It could be seen from the p values that a high level of significance was observed between the practices of the workers before and after education. Education of the workers did have an impact on their food preparation, service and personnel hygiene practices in the selected three food service outlets.

SUMMARY

The study carried out among three Matriculation schools found an average 10:1 student staff ratio patronizing the school food service. School authorities managed two school food services while one was under private management. Lunch, snacks and beverages were served in all the three food services. Counter service was followed in two food services, while it was leaf/plate service in one of them. Daily patronization was 44 per cent in Matriculation school 1 while it was 42 per cent in Matriculationschool3 and 31 per cent in Matriculation school 2. Table d 'hote menu was followed in all the three food services, with South Indian meals served in one of the Matriculation schools following plate/leaf service, while those following counter service had tiffin items like chappathi, dosai and snack items served during lunch time. The food service personnel had eight hours of working per day with better work output. The school food service premises were cleaned daily, weekly and by spring cleaning techniques. Personnel hygiene was on a low level with less compliance for trimming nails, wearing hair restraints, uniforms and usage of restrooms and hand-washing facilities.The compliance scores for adherence to food safety were similar in

all three food services, calling for improvement in basic handling of food by the personnel and also during cooking.Posters, lecture method and demonstration were the three methods through which education was imparted to the personnel and the effect of education was statistically significant when compliance scores were compared before and after education.

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