RESULTS AND DISCUSSION

The results of the present study are presented under the following headings

4.1 Socio Demographic Profile

4.2 Dietary diversity Food security

4.3 Physical activity in school age children and adults

4.4 Nutritional Status of all members of Family

4.5 Intra-family differences in nutrition status between the under five child and other members of the family

4.5.1 Under five child and mother

4.5.2 Under five child and father

4.5.3 Under five child and other woman

4.5.4 Under five child and other man

4.5.5 Elder and younger under five children

4.5.6 Under five child and 5-9 age child

4.5.7 Under five child and 10-18 aged child

4.6 Intra-family differences in the nutritional status among adults in the family

4.6.1 Mother and father of under five child

4.6.2 Mother of under five child and other woman

4.6.3 Mother of under five child and other man

4.7 - Differences in nutritional status of all family members in a household

4.1 - Socio Demographic Profile

The socio demographic profile of the households is presented in Table 4.1. Socio-economic and demographic data was collected from the primary caregiver (mother/ father/adult who was present in household) at the time of enrolment of the children in the study and was updated during each visit. The data was collected on family type, family size, religion, education level, occupation, per capita income, type of house, source of drinking water and toilet facility. The economic status was assessed by obtaining information on assets like ownership of house, mode of transport, cooking utensils, and mode of entertainment accessed by the families of the subjects.

Table 4.1-Socio Demographic Profile of Participants					
Household(n=5148)	**No.**	**%**	**Ownership of house**	**No.**	**%**
Joint	**2135**	**41.5**	**Own**	**2353**	**45.7**
Nuclear	**3013**	**58.5**	**Rented**	**2795**	**54.3**
Household Size			**No. of rooms in House**		
3	**883**	**17.2**	**1**	**2936**	**57.0**
4	**1424**	**27.7**	**2**	**2074**	**40.3**
5	**950**	**18.5**	**≥3**	**138**	**2.7**
> 5	**1891**	**36.7**	**Toilet facility in household**		
Caste			**No.facility**	**77**	**1.5**
SC	**1613**	**31.3**	**Sulabh**	**184**	**3.6**
ST	**71**	**1.4**	**Shared toilet**	**2888**	**56.1**
OBC	**2125**	**41.3**	**Own flush**	**1999**	**38.8**
Others	**1339**	**26.0**	**Drinking water source**		
Dietary habits			**Public tap**	**4004**	**77.8**
Vegetarian	**1272**	**24.7**	**head pump**	**477**	**9.3**
Non-vegetarian	**3876**	**75.3**	**Water tanker**	**667**	**13.0**
Income			**Means of entertainment**		
below 5000	**250**	**4.9**	**T.V(colour)**	**4985**	**96.8**
5000-10000	**1459**	**28.3**	**None**	**163**	**3.2**
more than 10000	**3439**	**66.8**	**Means of transport**		
Type of house			**Public transport**	**1600**	**31.1**
Kuttcha	**158**	**3.1**	**Bicycle**	**751**	**14.6**
Semi pucca	**813**	**15.8**	**Scooter/ Moped**	**2477**	**48.1**
Pucca	**4177**	**81.1**	**Any other**	**320**	**6.2**

i.Type of the Family

The definition of nuclear household used in NFHS 4 (2015-16) a "Nuclear households are households comprised of a married couple or a man or a woman living alone or with unmarried children (biological, adopted, or fostered) with or without unrelated individuals." According to (Niranjan et.al. 1998) —joint family includes both lineally extended and collaterally extended families. The term 'extended family' in

anthropology usually referred to a family including three or more generations. Lineally extended family has head and spouse with married son(s)/daughter(s) and their spouses and parents with or without other not currently married relation(s) or head without spouse but with at least two married son(s) and daughter(s) and their spouses and/or parents with or without other not currently married relations. Collaterally extended family has head and spouse with married brother(s)/sister(s) and their spouses with or without other relation(s) [including married relation(s)] or head without spouse but with at least two married couples. Based on this definition the proportion of nuclear families in the present study was 58.5 percent and the percentage of joint families was 41.5 per cent.

ii. Household size

The mean size of family was 5.4 persons. Only 36.7 per cent household had more than 5 members. Majority of families had two children

iii. Caste distribution

Nearly three fourth of households belonged to OBC or SC. Only 1.4 per cent were ST and one fourth households were Others (General, Muslims etc)

iv. Dietary habits

About three fourth was non-vegetarian (75.3 per cent) and 24.7per cent was vegetarian in the study population.

v. Income of the household

The study's subjects were from a low socioeconomic group: in 29 per cent of households income was between Rs 5,000/- and Rs10,000/- per month, 70% of the families had monthly income of more than Rs10,000/-.

vi. Features of housing

Over 80% of families lived in pucca houses; 15.8% lived in semi-pucca houses, and only 3.1% lived in kutcha houses. Almost all families had access to flush toilets. Over 38 % of families had their own flush toilet, while 56.1% used a shared flush toilet. More than 77 % of households got their drinking water from public sources; 9.3% of families accessed water from public hand pumps, and about 13% got water from water tankers especially in summer and when there was water scarcity. The majority of families owned (96.8%) colour television which was the major source of their entertainment.

Educational status of parent of under-five child

Fathers had higher literacy rates as compared to mothers. One tenth of the fathers (11.2%) were illiterate; 14.2% of the fathers had had primary education, 57.8% had a secondary schooling and 16.3% had college education. Among mothers one fifth (22.1%) were illiterate,19.5% of women had completed primary school, and 41.5% had completed secondary school and 14.8% had college education (Figure 4.1).

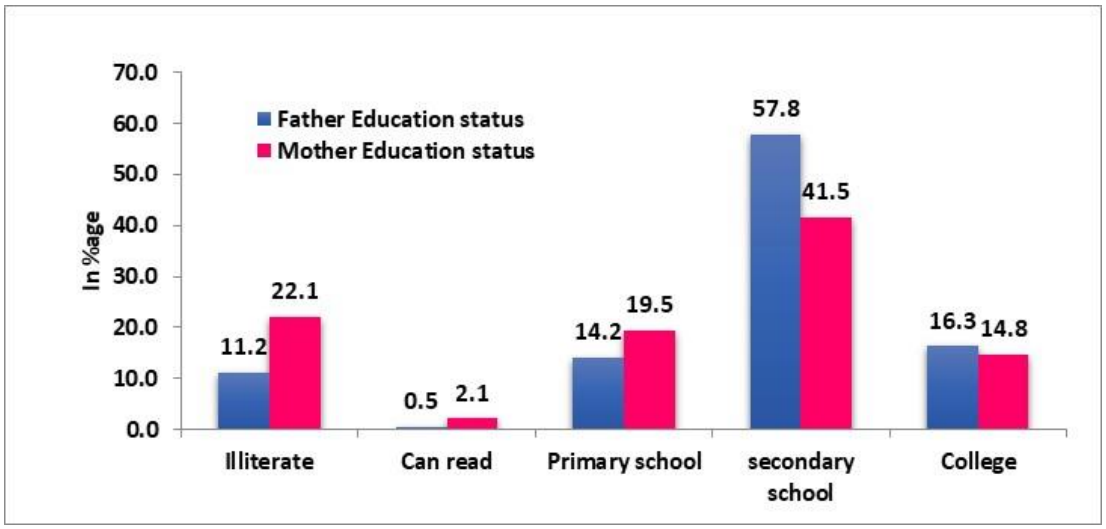


Figure 4.1 Educational status of Parent of under-five child

Working status of parent of under-five child

The majority of the study families were migrants who had come to Delhi in search of employment; 37.6% of fathers were white collar workers: employed as clerks or owned petty businesses. Over 60% were semiskilled workers, who were employed as cleaners in stores, drivers, cooks in small hotels, and worked in small factories. The majority of the mothers were home -makers (93.6%). 6.4 percent of mothers worked out side home mostly as maid servants in houses. (Figure 4.2)

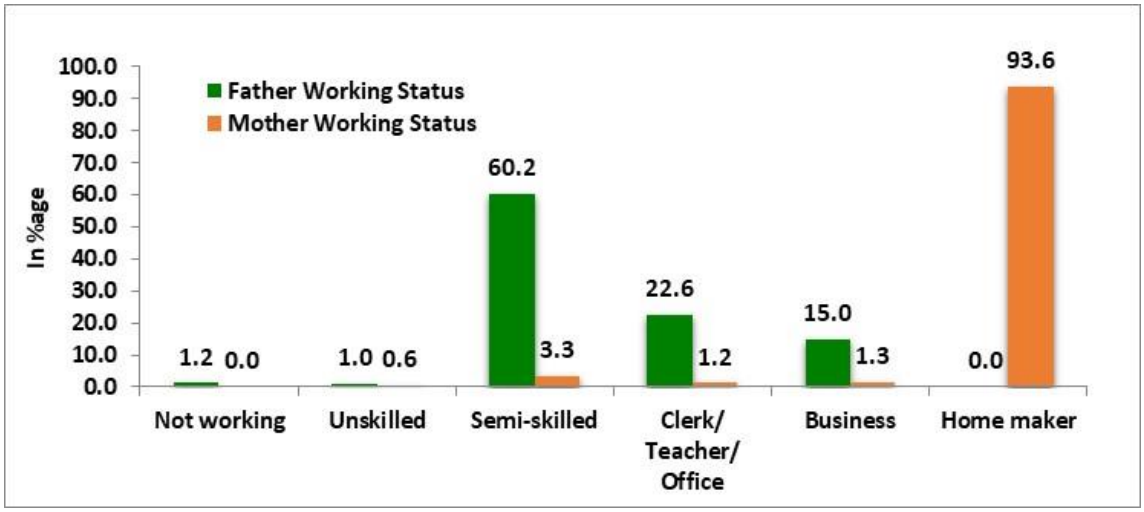


Figure 4.2 Working status of parent of under-five child

Nutritional Status of all members of household

COMPOSITION OF FAMILY

Between 2015 and 2019, 5148 families were enrolled for the study anthropometric measurement were taken in

- 6539 under-five children (some families had more than one under-five child),
- 5303 mothers (some mothers had more than one preschool child).

We were able to get height and weight measurements in

- 734 children between the age group of 5-9 years and 376 children of 10-18 years who were sibling of the under five children
- 1288 women in the families (mostly grandmothers and aunts),
- 636 fathers of under-five children, and
- 465 other men, mostly grandfathers and uncles of the under five children.

4.2 Food security and dietary diversity

Information of the amount of foodstuffs purchased and consumed by the families in major food groups computed by NSSO method is given in Table 4.2.

Table 4.2 Amount of food stuffs consumed/CU/day (NSSO method)

Food Groups	% families who had purchased	Amount/CU/Day	Balanced diet for sedentary man (Gms)	
			Ref. men (65 kg) (g)	Men (55 kg) (g)
Cereals	100 (547)	256.7±055.1	275	232.7
Pulses & legumes	99.9 (546)	36.5±021.0	80*	67.7*
Roots & tubers	100 (547)	155.4±066.2	100	84.6
Other veg	100 (547)	174.0±084.8	200	169.2
GLV	70.2 (384)	33.4±29.0	150	126.9
Fruits	91.9 (503)	90.0±072.8	150	126.9
Milk	100 (547)	361.5±183.2	300	253.8
Animal products	72.5 (396)	54.7±048.4	-	-
Fat & oil	100 (547)	34.8±006.2	25	21.2
Sugar & jiggery	100 (547)	32.9±016.4	-	-
***Included animal products**				

All families had purchased cereals, pulses, roots and tubers, other vegetables milk, oil and sugar during the reference period. About 1/4th were vegetarians and did not buy any animal products. Computed amount of foodstuff consumed/CU/day were compared with the balanced diet for sedentary reference man (wt. 65 kg) and average Indian man (wt. 55kg). Roots and tubers, milk, oil consumption was higher than the balanced diet for reference sedentary man. Except pulses, GLV and fruits the consumption per CU/day was equal to or higher as compared to the balanced diet for the average sedentary man (Table 4.2).

Table 4.3 Amount of food stuffs consumed /CU/day (NNMB method)

Food groups	% families who cooked	Amount cooked	Balanced diet for sedentary man (gms)	
			Ref. men (65 kg) (in gm)	Men (55 kg) (in gm)
Cereals	100 (547)	252.6±054.7	275	232.7
Pulses & legumes	72.9 (399)	53.9±032.1	80*	67.7*
Roots & tubers	99.5 (544)	119.5±071.8	100	84.6
Other veg	96.0 (525)	148.5±101.7	200	169.2
GLV	9.7 (53)	151.5±078.1	150	126.9
Fruits	52.1 (285)	129.1±082.3	150	126.9
Milk & milk products	99.5 (544)	352.3±185.2	300	253.8
Animal products	22.5 (123)	122.4±097.4	-	-
Fat & oil	100(547)	38.2±013.2	25	21.2
Sugar & jiggery	100 (547)	027.7±017.5	-	-
***Included animal products**				

Information of the amount of foodstuffs cooked/CU on the previous day and consumed by the families computed by NNMB method is given in table 4.7. There was good concordance in the amount of food stuffs consumed/CU/day between the NSSO method and the NNMB method in those food stuffs consumed every day. Consumption of roots and tubers, milk and oil were much higher than the balanced diet for reference sedentary man. Except for pulses, GLV and fruits the consumption per CU/day was equal to or higher as compared to the balanced diet for the average sedentary man (Table 4.3).

Based on the data on food stuffs consumed per consumption unit carbohydrate protein fat and total energy consumption/consumption unit/day was calculated using the Nutrient composition tables (ICMR-NIN, 2020) and the results are shown in table 4.4. There was very good concordance between the carbohydrate, protein, fat, and energy consumption computed by NSSO and NNMB methods. The differences in the mean carbohydrate, protein and energy consumption between the two methods were small but were statistically significant however, the magnitude of difference was too small to be physiologically significant.

Table 4.4 Macro-nutrient consumption/CU/day (NSSO and NNMB methods)

	Carbohydrate	Protein	Fat	Energy
NSSO method	310.1±57.29	63.9±16.29	61.6±12.33	1974.7±318.47
NNMB method	291.7±56.28	60.2±21.77	62.8±18.00	1900.6±347.95
Student-test p-Value	0.0001 (S)	0.0015(S)	0.1986 (NS)	0.0003(S)

The expert committee on nutrient requirements took the mean +2 SD of the height from NNMB surveys both for men and women and BMI of 21 for both men and women to compute the weight of reference man and women (ICMR-NIN 2020).The mean energy consumption by both the methods was lower than the EAR for reference man (2110 Kcal/day) but higher than the EAR for average Indian (1760Kcal/day). About one-fourth of the families consumed ≥ 2110 Kcal/CU/day (EAR for energy for sedentary reference man); over 75% of the families consumed ≥ 1760 Kcal/CU/day (EAR for energy for sedentary average Indian).

4.3 Physical activity in school age children and adults

Physical activity in the persons was assessed using a modified WHO physical activity questionnaire (WHO 2003). WHO Global physical activity questionnaire is used in surveys conditions for assessing the NCD risk. It does not provide detailed information of the type the 24 hour physical activity. The 24 hour questionnaire administered by the research scholar to the individuals in the family. Time spent and intensity (sedentary, moderate, and vigorous) of activity in the household, occupational, transport, personal/ grooming, entertainment and discretionary activity domain was ascertained in detail. Time spent sleeping was also recorded. Based on this 24-hour physical activity recall hours spent in sleep, sedentary, moderate and

vigorous activity was computed. This 24 hour questionnaire administered by the research scholar to the individuals in the family provided more detailed and accurate information on the activity pattern as compared to the WHO Global physical activity questionnaire.

Activity during week and weekend days was also assessed. In men working in jobs which has a weekend off, physical activity was lower on weekends. The majority of housewives spent more time on household chores during weekends when children and men folk stayed at home. Children played for a longer time during the weekends. The data was collected before Covid -19 period when the situation in Delhi was pleasant and conducive to outdoor play. This may not be true after the lockdown.

Data on time spent (in min) in sleep, sedentary activities and moderate physical activity in individuals belonging to the four groups were analysed. The four groups were

a. 5-18 years children (99)
b. Mothers of under-five children (285)
c. men (87)
d. other women (81)

In all four groups, the mean sleeping time was over 500 minutes. The mean sleeping time was higher in other women and high in 0-18 year's children. Mother and men's sleeping times were more and less similar (Figure- 4.3).

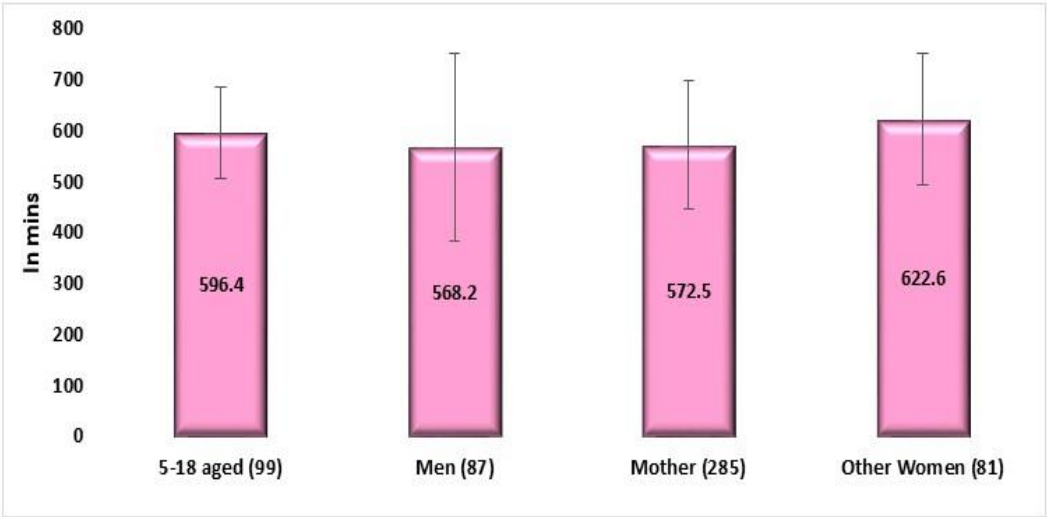


Figure 4.3 Sleeping (in mins) in different aged groups

All the groups spent over 75% of their waking time in sedentary activity. Men spend more time in sedentary activity because they slept for shorter duration as compared to women (Figure-4.4).

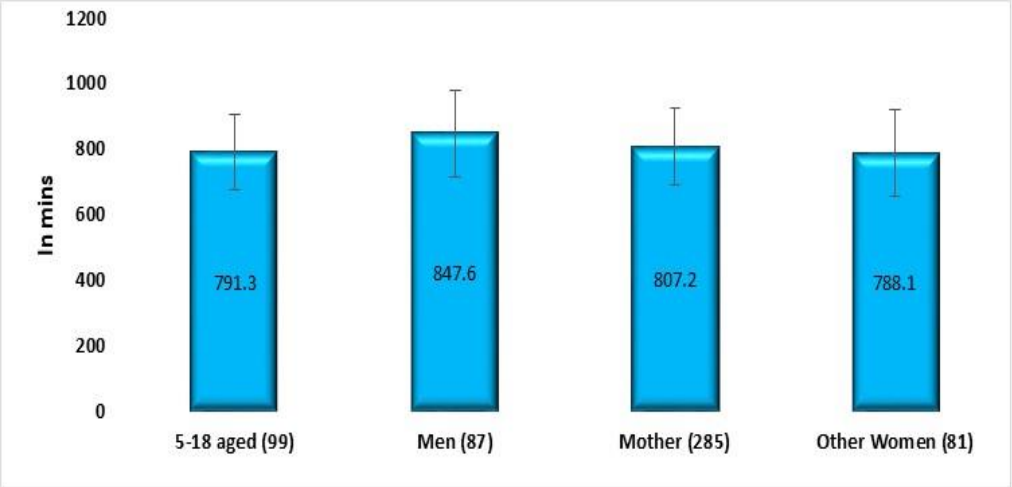


Figure 4.4 Sedentary activity (in minutes) different aged groups

The majority of the persons in all the groups spent less than 60 minutes a day in moderate physical activity. The mothers showed a maximum mean of moderate activity of around 60 minutes because they were involved in household chores and care of their children. Mean time spent in moderate activity was lower in other women (Figure- 4.5) because they were older and the household chores and child care were no longer their responsibility.

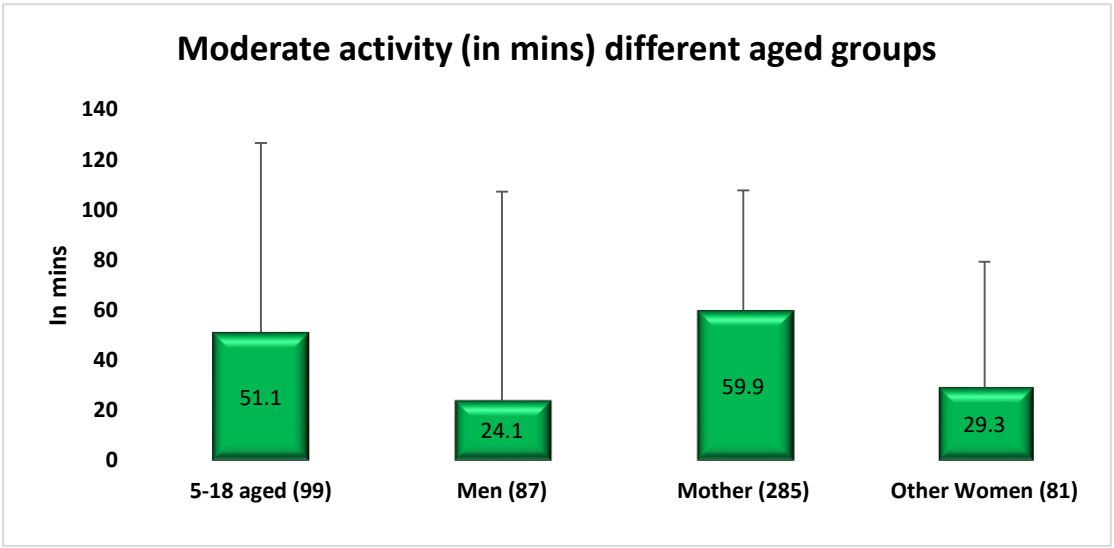


Figure 4.5 Moderate activity (in minutes) in different aged groups

In these areas, there were occasions when piped water supply was not available and women had to fetch water from water tankers to their households. This accounted for the higher moderate activity in mothers. During the study the weather was pleasant; school children played outside the home and hence had moderate physical activity.

Data clearly indicate a steep reduction in moderate physical activity in the occupational, domestic and transport domains in the urban low middle income group families and the population had a sedentary lifestyle. Lack of moderate physical activity is the major factor responsible for the rising over-nutrition rates in urban adult men and women.

4.4 ASSESSMENT OF NUTRITIONAL STATUS OF ALL FAMILY MEMBERS

a. Nutritional status of 0-18 years children

A total of 7649 children between the age of 0 to 18 were enrolled in the study. The largest group (6539) was under five children who were our study group. We were unable to take anthropometric measurements in majority of school age children because they were not available at home during our visits. By undertaking repeated visits we were able to obtain measurements in 376 children between 10 to 18 years of age and 734 children between 5 to 9 years of age.

For the description of the anthropometric indicators of the study population (children 0-18 years, men and women) the mean and standard deviation of the height, weight and BMI was calculated and is presented in tables.

For assessment of nutritional status of children height for age, weight for age and BMI for age are used. For adults BMI is used for assessing nutritional status.

The mean age, weight, height, BMI and z scores of the three anthropometric parameters of children between 0-18 years of age is given in (Table 4.5) and (Table 4.6). The mean weight and height showed a progressive increase with increase in age. Mean BMI was similar in 0 to 4 and 5 to 9 year children. Mean BMI for age was higher in 10 to 18 year children. This might be due to e increase in muscle and fat mass in older children. AHS CAB (RGI AHS-CAB 2014) and DLHS 4 both showed similar patterns of changes in BMI with age (IIPS DLHS 4 2012-13).

Table 4.5 : Nutrition Profile of the Children					
Aged groups	**Number**	**Age(months)**	**Weight (kg)**	**Height (cm)**	**BMI (kg/m^2)**
Under-five (0-4 years) child	**6539**	**23.1±16.53**	**09.7±03.44**	**77.7±14.55**	**15.5±01.95**
5-9 years children	**734**	**86.9±16.38**	**21.0±05.52**	**117.6±10.63**	**15.0±02.23**
10-18 years children	**376**	**158.1±27.43**	**39.0±10.53**	**146.4±12.16**	**17.9±03.16**

The mean HAZ, WAZ and BAZ in children belonging to the three age groups are shown in Table 4.6. Indian children are short-statured, and the median values of their weight and height for age are close to the WHO -2SD. However, Indian children's median BMI for age between mean and -1SD WHO standards (Ramachandran & Gopalan, 2011).

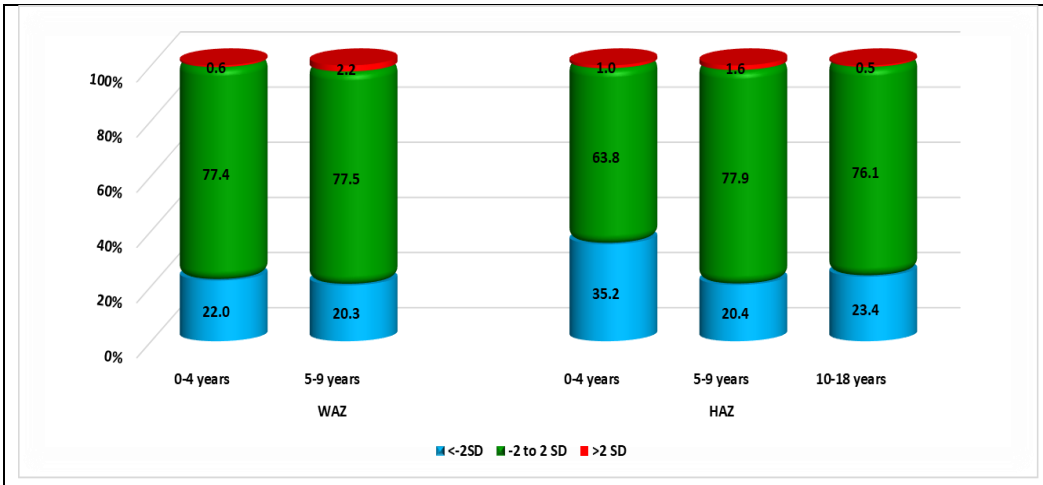
Table 4.6: Mean z score of the Children				
Aged group	**Number**	**HAZ**	**WAZ**	**BAZ**
Under-five (0-4 years) child	**6539**	**-1.5±01.44**	**-1.1±01.16**	**-0.3±01.33**
5-9 years children	**734**	**-0.9±01.39**	**-1.0±01.29**	**-0.6±01.35**
10-18 years children	**376**	**-1.2±01.30**	**NA**	**-0.5±01.29**
t-test p value 0-4 yrs & 5-9 years HAZ <0.001; WAZ 0.0287;BAZ <0.001				
t-test p value 0-4 years & 10-18 years HAZ 0.001;BAZ 0.0045				
t-test p value 5-9 years & 10-18 years HAZ 0.0005;				

The mean HAZ, WAZ, and BAZ values were negative. The negative mean z scores for weight (-1.1 to -1.0) and height (range -1.5 to -0.9) were higher than the negative mean z scores for the BAZ (range -0.6 to -0.3). Student t-test showed that the differences in mean WAZ, HAZ, and BAZ between 0 to 4 years and 5 to 9 years were statistically significant. The difference in the mean HAZ and BAZ between 0–4 years and 10–18 years children were statistically significant. The mean HAZ was significantly different between children aged 5–9 and those aged 10–18.

Nutritional status of children were assessed using the z scores for height, weight and BMI for age computed using WHO anthro and WHO anthro plus software. Using

HAZ children were classified as: stunted HAZ< -2 SD, normal HAZ -2 SD to +2 SD, and tall HAZ >+2 SD. Using WAZ children were classified as, underweight WAZ <-2 SD, normal WAZ -2 SD to +2 SD and overweight WAZ >+2 SD (Figure 4.6).

Stunting rate was lowest in 5 to 9 years of age, lower in 10 to 18 years children, and highest in under five children. The differences in stunting rates between the 0-4 and 5-9 years children and the 0-4 and 10-18 years children were statistically significant, but differences between the 5-9 and 10-18 years children were not statistically significant. The difference in the underweight rates between 0–4 year children and 5–9 year children were not statistically significant (Figure 4.6).



Chi-Square Test (p-value)	
<-2SD & other 0-4 vs 5-9 Years (HAZ)	**<0.001**
>2SD & other 0-4 vs 5-9 Years (WAZ)	**<0.001**
<-2SD & other 0-4 vs 10-18 years (HAZ)	**<0.001**

Figure 4.6 Nutritional Status of Preschool and school-age children (Cross-sectional)

Figure 4.7 (a)

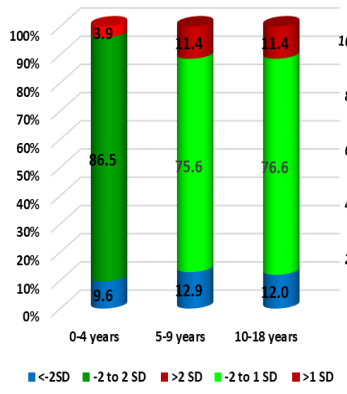


Figure 4.7 (b)

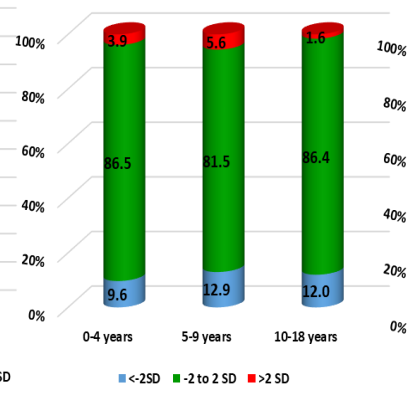
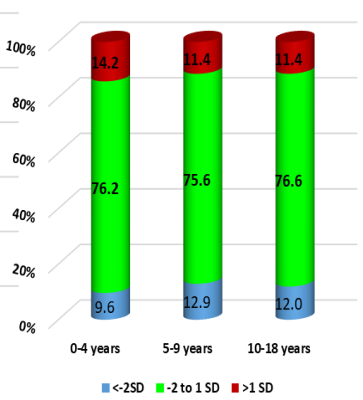


Figure 4.7 (c)



Chi-Square Test (p-Value) <-2SD & other 0-4 vs 5-9 year 0.004		
ON & other 0-4 vs 5-9 years 0.001	**ON & other 0-4 vs 5-9 years 0.023**	**ON & other 0-4 vs 5-9 years 0.043**
ON & other 0-4 vs 10-18 years 0.001	**ON & other 0-4 vs 10-18 years 0.024**	
	ON & other 0-4 vs 10-18 years 0.001	

Figure 4.7 Variation in Over-nutrition Rates in Different Age Group Due To Differences in BAZ Cut-off

In the dual nutrition burden era, BMI-for-age is the most appropriate indicator for assessing the nutritional status of children especially in countries like India with high stunting rates in children. The wasting rate across age groups is computed using BAZ -2SD as the cut-off point .Wasting rate between 0-4 and 5-9 years were statistically significant (p=0.004). The differences in undernutrition rates between 0-4 and 10-18 years and 5-9 and 10-18 were not significant

The WHO Anthro classifies 0-4 year children as over-nourished if BAZ was >+2SD; WHO Anthro Plus has classified 5-18 year children as over-nourished if BAZ was >+1SD.The overnutrition rates in 0-18 years were classified in three different cut off for BMI for age

0-4 years :BAZ + 2 SD;5 -9 and 10-18 BAZ +1 (Figure 4.7 a)

0-4 years :BAZ + 2SD;5 -9 and 10-18 BAZ +2 (Figure 4.7 b)

0-4 years :BAZ + 1SD; 5 -9 and 10-18 BAZ +1 (Figure 4.7 c)

If the classifications of over-nutrition suggested by WHO Anthro for 0-4 years and WHO Anthro plus 5-18 years were used (Figure 4.7 a), there were substantial and statistically significant differences in over-nutrition rates as assessed by BAZ between 0-4 and 5-9 year as well as 0-4 and 10-18 year age groups. However, the differences in over-nutrition between the 5-9 and 10-18 year age groups were small and statistically not significant. When uniform criterion was used across age groups BAZ of +1 (Figure 4.7 b) there were significant differences in over nutrition across all the three age groups. When BAZ + 2SD cut- off used for all the three groups (Figure 4.7 c). There were significant differences in over nutrition rates showed between 0-4 and 5-9 years age groups. However, the differences in over nutrition rates between 0-4 and 10-18 years and 5-9 and 10-18 years showed not significant.

Nutritional status of adults

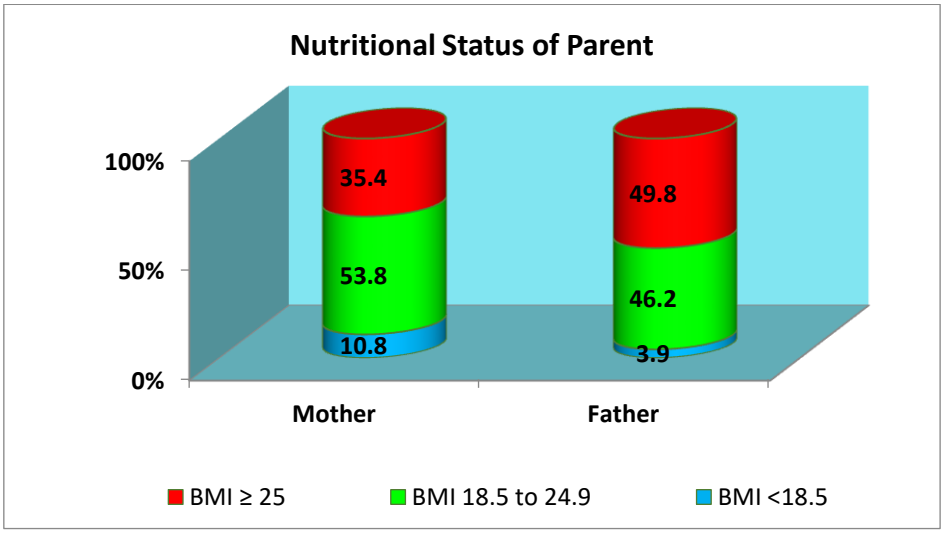
Indians have a higher body fat for any given BMI. Epidemiological studies have shown that Indians develop cardiovascular disease and diabetes at a lower BMI as compared to the Caucasians. There had been discussions whether a lower BMI cut off should be used for overweight and obesity in in Asian and Based on these findings the consensus statement of was drafted in 2009 suggesting that has suggested that the BMI cut-off for Asians for overweight should be 23 (Misra et al 2009) . However, all of India's national surveys and published research studies have so far used the WHO cut off of 25 for overweight and 30 for obese. The data from the present study has to be compared with these surveys and published research studies the WHO BMI cut-off for overweigth and obesity was used in the present.

For assessment of nutritional status of adults BMI was used; persons with BMI <18.5 were classified as undernourished. Those with BMI between 18.5 and 24.9 were classified as normal; those with BMI between 25 and 29.9 were classiificed as overweight and those with BMI ≥ 30 were classified as obese. Prevalence of overweight (BMI 25-29.9) was 26.2%, 38.8% 34.4% and 31.9% in mothers, fathers, other women and other men respectively. Prevalence of obesity (BMI≥30) was 9.2% 11.0% 22.2% 13.5% in mothers, fathers, other women and other men respectively.

Nutritional Status of Parents

Table 4.7 Nutrition Profile of Under-five Child's Parents					
	Number	Age (Years)	Weight (kg)	Height (cm)	BMI (kg/m^2)
Under-five child's Mother	5303	26.6±04.21	54.5±11.33	151.6±05.78	23.7±04.54
Under-five child's Father	636	31.2±05.52	68.9±13.29	164.8±07.53	25.3±04.37
p value of t-test mother vs father age <0.001. Weight <0.001, Height <0.001, BMI, <0.001					

The mean age of fathers was higher by five years as compared to the age of the mothers. Fathers were taller by 13.2 cm and heavier by 14.4 kg as compared to the mothers. Fathers had a higher mean BMI as compared to mothers. The higher body weight and BMI in the fathers in whom we were able to take anthropometric measurements might in part be due to the fact that they were older by five years and many of those whom we measured had sedentary jobs near home or were not working full time.



Chi square test of nutritional status (BMI)-mother vs father
p-value of UN vs other 0.0001(S)
p-value of ON vs other 0.0001(S)
p-value of UN vs ON 0.0001(S)

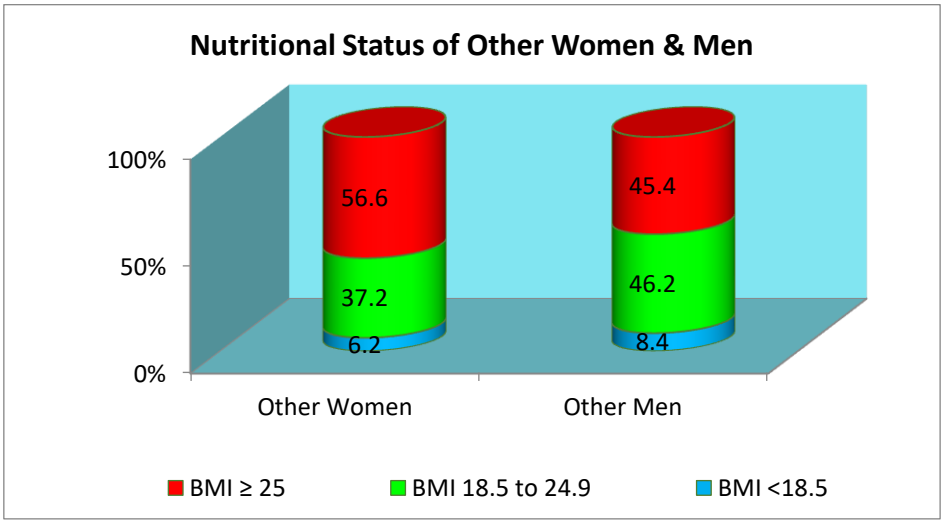
Figure 4.8 Nutritional Status of Parent

The nutritional status of the parents is given in Figure 4.8. Only 10.8 % of the mothers and 3.9% of the fathers were under-nourished. About half of the mothers and fathers were normally nourished. Prevalence of over-nutrition in fathers and mothers was high, over a third of the mothers and half of the fathers were over-nourished. (Figure 4.8)

c) Nutritional Status of other men and women

Table 4.8 Nutrition Profile of The Other Women and Men					
	Number	**Age(Years)**	**Weight (kg)**	**Height (cm)**	**BMI (kg/m^2)**
Other Women	**1288**	**45.0±15.48**	**60.1±13.15**	**151.6±05.92**	**26.1±05.36**
Other Men	**465**	**45.7±17.79**	**68.1±13.55**	**165.1±07.51**	**25.0±04.93**
t-test other women vs other men: Weight <0.001 , Height , <0.001 ,BMI, <0.001)					

The under-nutrition rate in other women and other men were 6.2% and 8.4% respectively. Only about a third of the other women and 46.2% of the other men were normally nourished. The prevalence of over-nutrition in both group were high was about 50 percent (Figure 4.9).



Chi square test of nutritional status (BMI)-other women vs other men
p-value of UN vs other 0.109(NS)
p-value of ON vs other 0.0001(S)
p-value of UN vs ON 0.0001(S)

Figure 4.9 Nutritional Status of Other Women & Men

4.5 Intra-family differences in nutrition status between the under five child and other members of the family

4.5.1 Under five child and mother

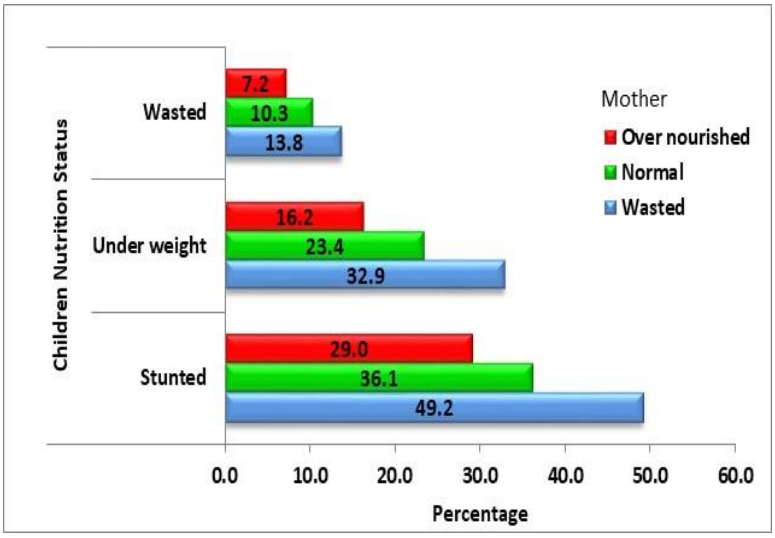


Figure 4.10 Effect in Maternal Nutrition Status on Child Under-nutrition (6539 pairs)

Comparison between nutritional status of the mother and her preschool child for all the 6539 mother-child pairs is shown in figure 4.10.

When the mother was under nourished 49.2% of the children were stunted but when mother was normal or overnourished the stunting rates in under five children were lower (36.1 %and 29% respectively. When the mother was undernourished 32% of the under five children were underweight; when the mother was normally nourished or overnourished underweight rates in children were lower (23.4% and 16.2% respectively). If the mother was undernourished 13.8% of the under five children were wasted; if the mother was normally nourished or overnourished wasting rates in children were lower (10.3 and 7.2 % respectively)

There was a gradient between maternal nutritional status as assessed by BMI and the nutritional status of the under five child. Stunting, underweight and wasting rates in children were highest when the mothers were under-nourished and least when the mother was over-nourished. However, even when the mother was under-nourished less than one-fifth of the pre-school children were wasted and over 80% were normally nourished.

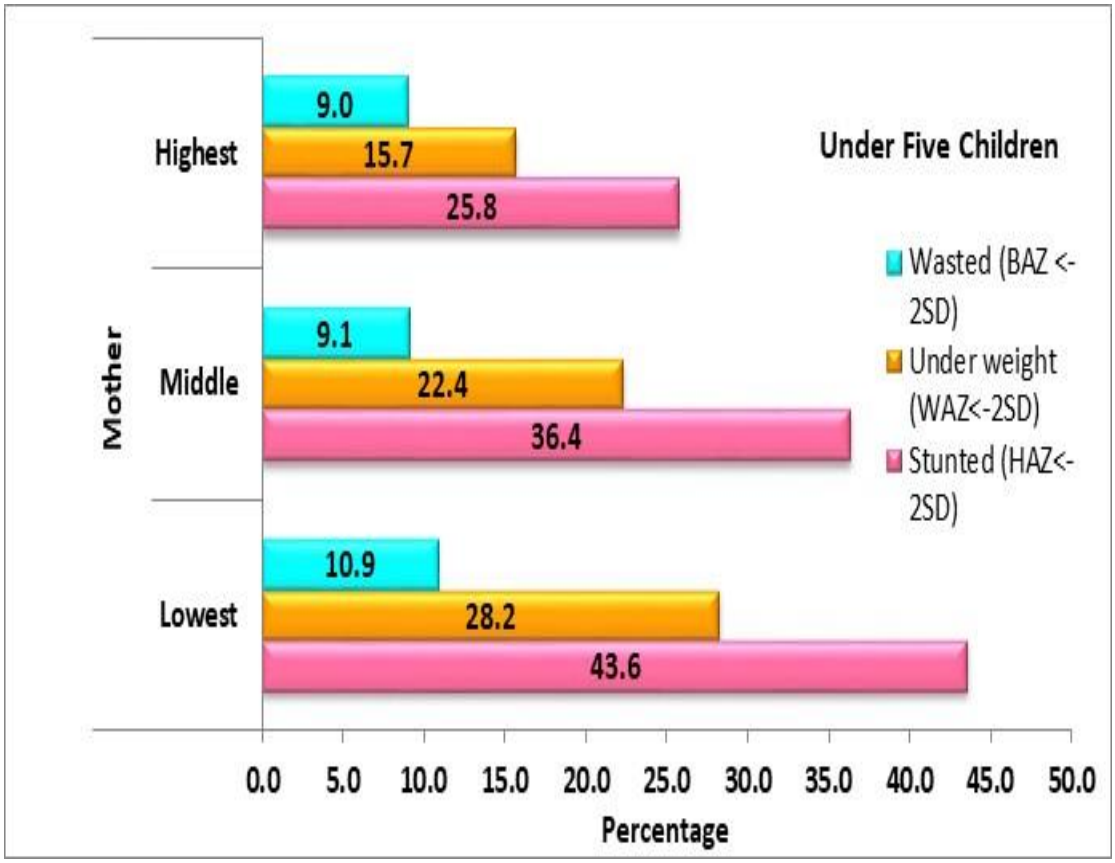


Figure 4.11 Under- nutrition rates in pre-school children in relation to maternal Height tertiles (6539 pairs)

Under-nutrition rates in children were computed in relation to maternal height tertiles (Figure 4.11) to explore the effect of maternal height on the nutritional status of the preschool child. If the mother was in the lower tertile of height, over 43 % of the children were stunted. When the mother was in middle or highest tertile stunting rates in under five children were lower(28.2 and 10.9% respectively) There was a gradient in stunting rates in children in relation to maternal height tertiles suggesting that the height of mother does have some impact on children's linear growth. A similar gradient was seen between maternal height tertiles and underweight and wasting rates in preschool children. These data suggest that maternal stature is one of the important determinants of nutritional status of under five child.

4.5.2 Under-five children and father (636 pairs)

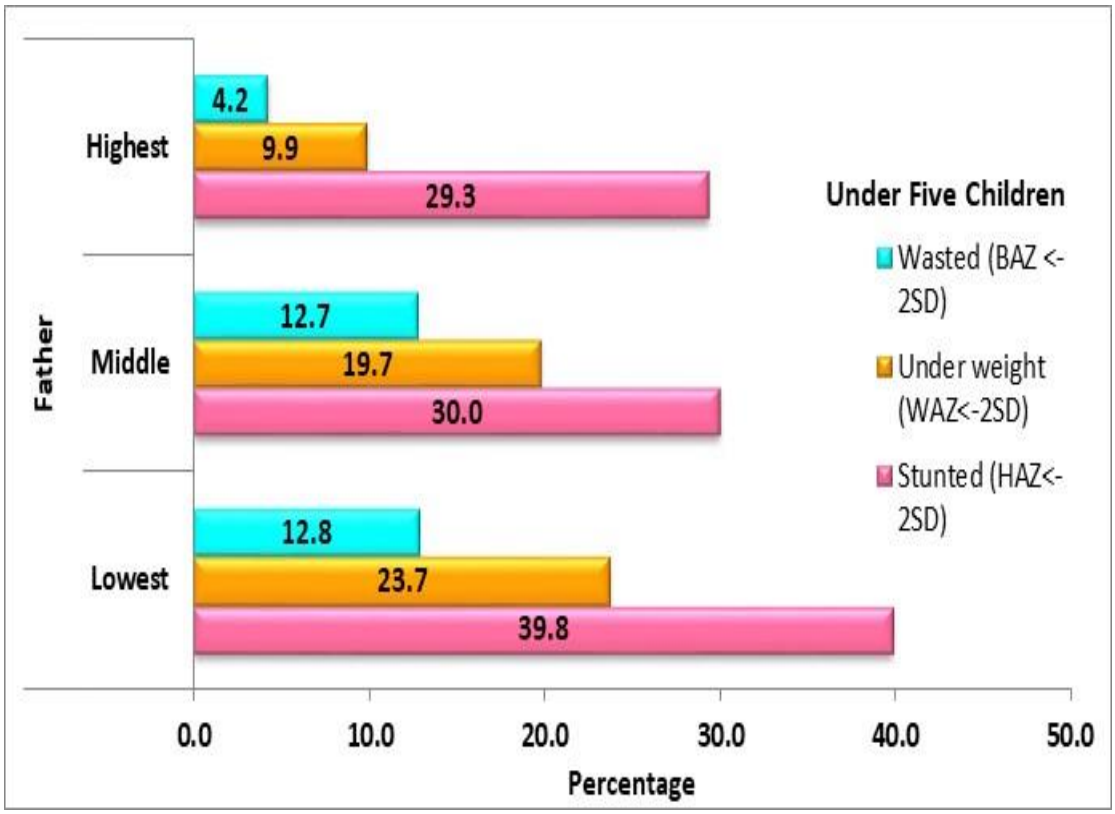


Figure 4.12 Effect in Paternal Nutritional Status (BMI tertiles) on Child Under-nutrition (636 pairs)

There were very few fathers in the under-nourished group. Therefore it was not possible to compute the relationship if any between paternal nutritional status as assessed by BMI and nutritional status of the preschool child. Stunting, underweight and wasting rates in preschool children were computed in relation to paternal BMI tertiles to assess the child under-nutrition rates in relation to paternal nutritional status (Figure 4.12). If the fathers BMI was in the lowest tertile the prevalence of stunting, underweight and wasting rates in preschool children was higher as compared to the children if fathers BMI was in the other two tertiles. There was a small gradient between paternal BMI tertiles and increasing under-nutrition rates in children. However, even when fathers were in the top tertile, some of their children were stunted, underweight and wasted.

Undernutrition rates in children were estimated in relation to father height tertiles to investigate the impact of father height on the nutritional condition of the pre-school child (Figure 4.13). If the father's height fell into the lowest tertile, more than 44.8%

of the children were stunted. However there was no gradient between child undernutrition and paternal height tertiles.

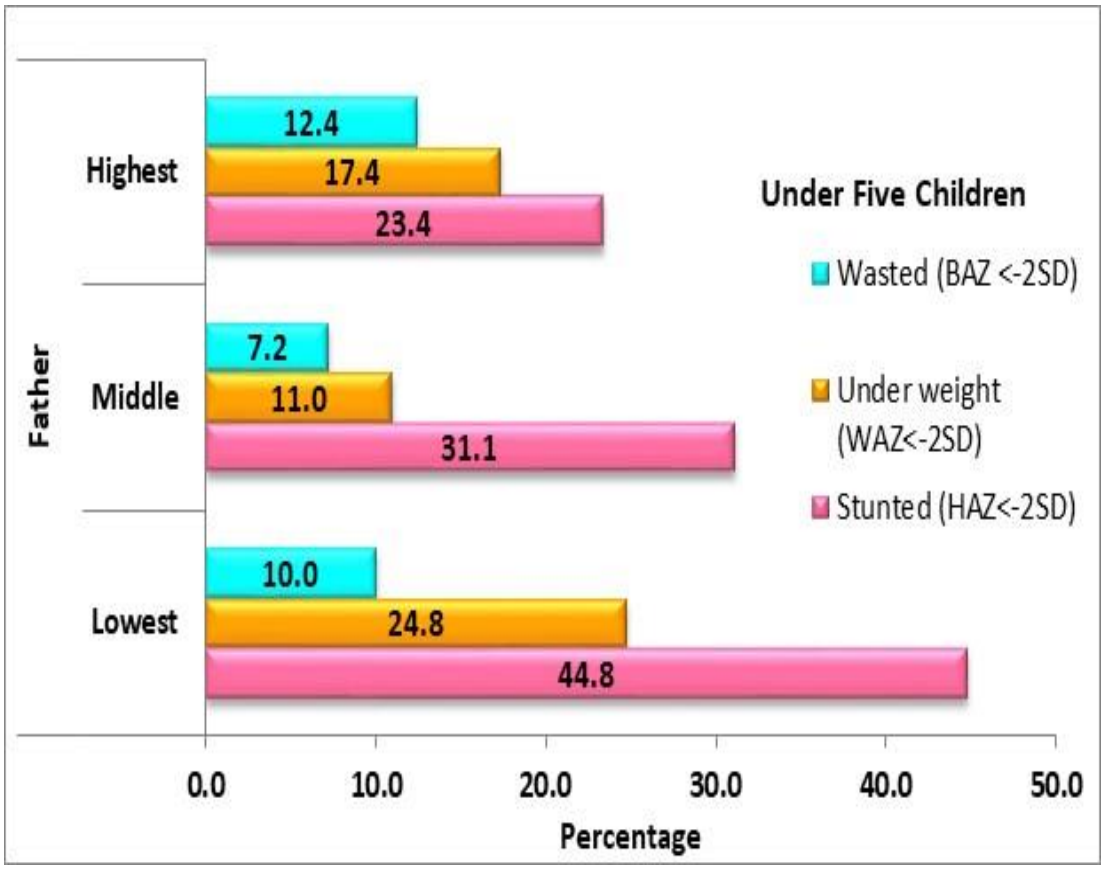


Figure 4.13 Under- nutrition rates in pre-school children in relation to paternal Height tertiles (636)

Under-nutrition rates in children were computed in relation to paternal height tertiles (Figure 4.13) to explore the effect of any paternal height on the nutritional status of the preschool child. If the father was in the lower tertile of height, over 40% of the children were stunted. There was a gradient in stunting rates in children in relation to paternal height tertiles suggesting that the height of both the parents does have some impact on children's linear growth. Underweight and wasting rates in pre-school children showed a gradient was not seen between child under-nutrition and paternal height tertiles.

4.5.5 Under-five child and other woman (2054 pairs)

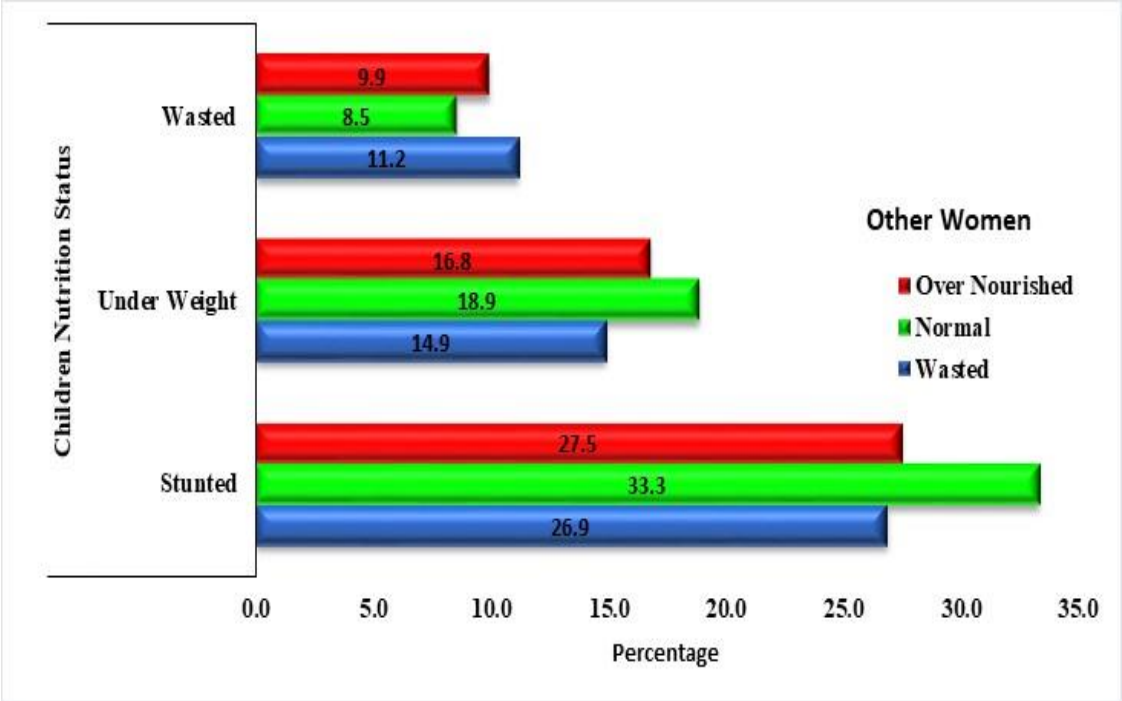


Figure 4.14 Comparison of nutritional status between under-five and other women (2054 pairs)

Comparison of nutritional status of under-five children with nutritional status of other women (BMI) in the same family is shown in figure 4.14. Unlike the situation in relation to maternal nutritional status and child nutritional status ,there were no clear cut trends in the nutritional status of the child in relation to the nutritional status of the other woman in the family. When the other woman was undernourished 26.9% of the under five children were stunted. When the other woman was normally nourished 33.3% of children were stunted and when the other woman was overnourished 27.5 % were stunted.The relationship between other woman's nutritional status and underweight and wasting rates in under five children did not show any clear gradient. This is perhaps because stature and nutritional status of other women do not have any direct relationship to the child's nutritional status . (Figure 4.14).

Under-five children and other men (BMI) (670 pairs)

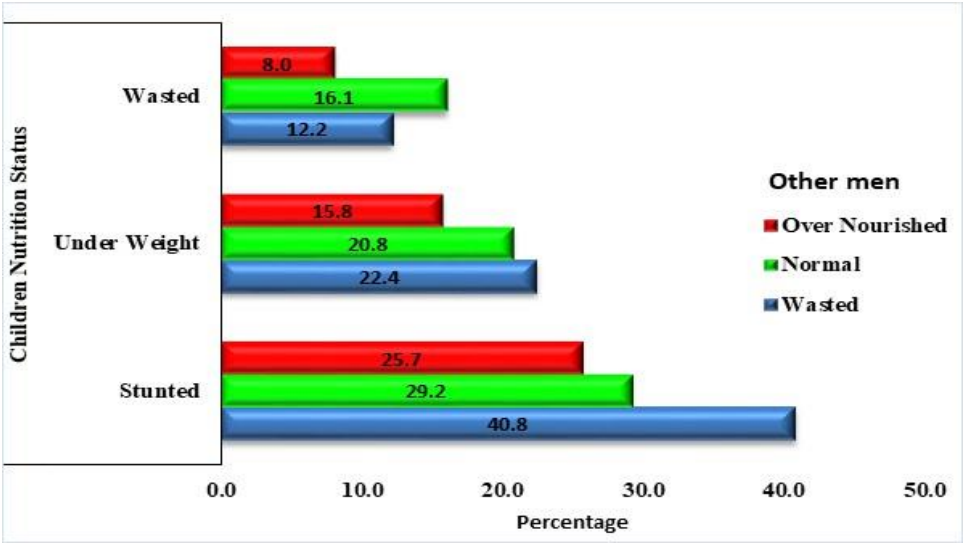
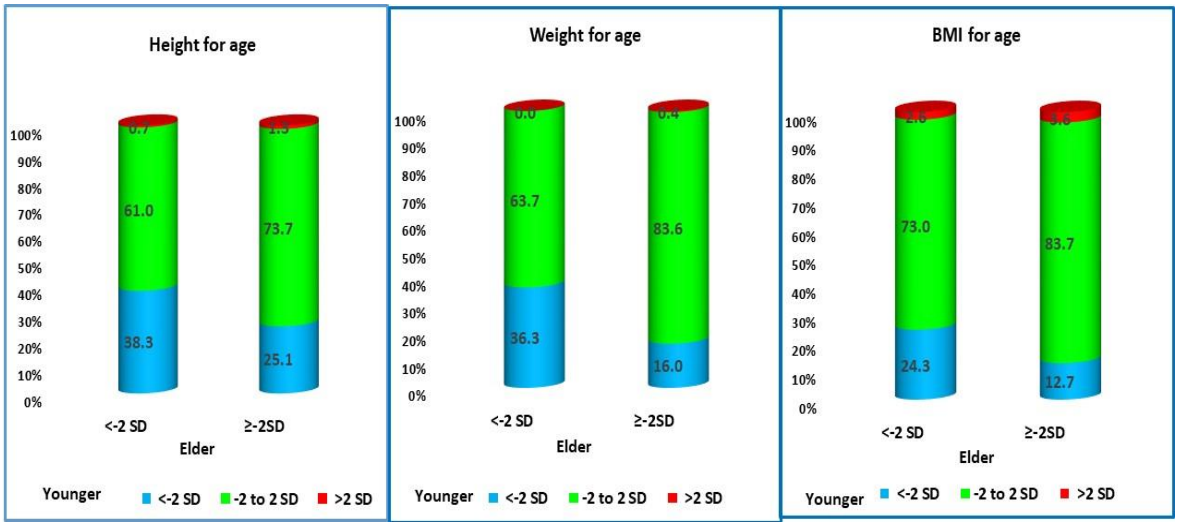


Figure 4.15 Comparison of nutritional status between Under-five and other men (670 pairs)

Nutritional status of the other men as assessed by BMI and preschool children in their family is given in figure 4.15. There was no clear-cut tends between BMI of other men and nutritional status of the under-five children.

4.5.6 Elder and younger under-five children (1590 pairs)



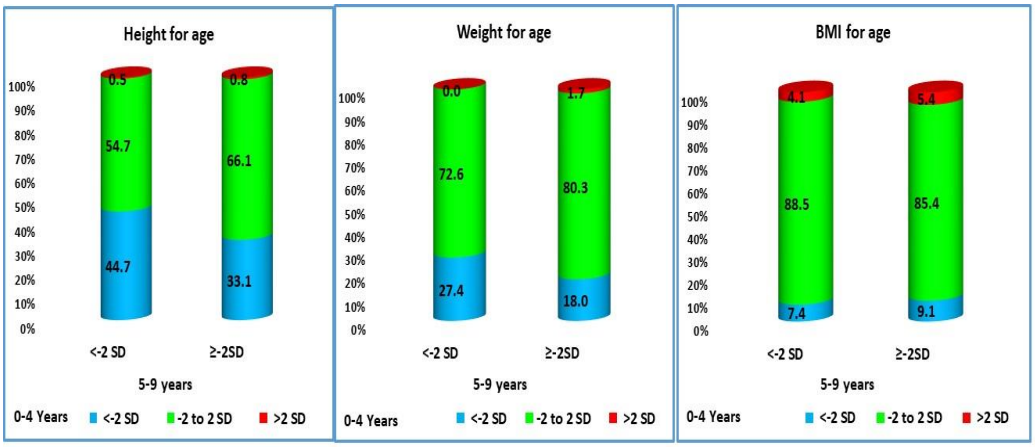
Chi-Square test p value WAZ <-2SD <0.001, HAZ <-2SD <0.001, BAZ<-2SD <0.001

Figure 4.16 Nutritional status differences between elder and younger under five siblings (1590 pairs)

If the elder of the 0-4 year sibling was underweight, stunted or wasted, the prevalence of underweight, stunting and wasting rates were higher in the younger 0-4 year

siblings, (Figure 4.16). These differences were statistically significant for stunting, underweight and wasting. However, majority of the younger siblings of the under five children were normally nourished even when their elder siblings were undernourished.

Under-five and 5-9 aged children (931 pairs)



Chi-Square test p value WAZ <-2SD <0. 003, HAZ <-2SD <0.003

Figure 4.17 Nutritional Status Differences 0-4 years and 5-9 years Siblings

If the 5-9 year child was stunted, underweight or wasted, the prevalence of underweight, stunting and wasting was higher in the 0-4 year sibling (Figure 4.17). These differences were statistically significant for WAZ and HAZ but not for BAZ. However majority of the younger siblings of the under five children were normally nourished even when their 5-9 year elder siblings were under nourished.

4.5.9 Under-five and 10-18 aged children (472 pairs)

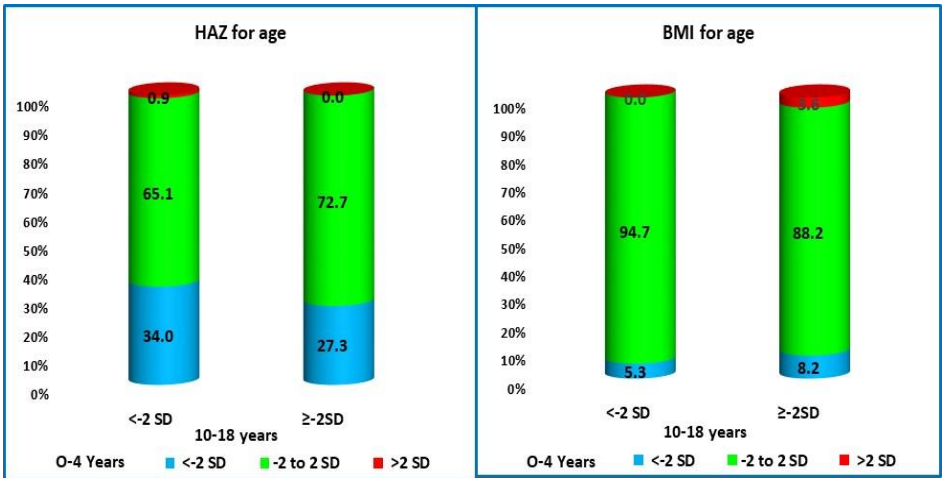


Figure 4.18 Nutritional Status Differences Between 0-4 years and 10-18 years Siblings

The differences in stunting and wasting rates between 10-18 and 0-4 years children were small and not statistically significant. (Figure 4.18).

Comparison of the prevalence of under- nutrition between children from the same family showed some interesting findings. Irrespective of the parameter (stunting, underweight or wasting) or the age group (0-4, 5-9 or 10-18 years), if the elder sibling was stunted, underweight or wasted, the prevalence of stunting, underweight and wasting in the younger sibling was higher. This is because the siblings share some of the major factors responsible for under-nutrition in children such as small parental stature, low parental weight, low dietary intake and poor environmental sanitation. However, the majority of the younger siblings of under-nourished elder siblings were normally nourished and the majority of the elder siblings of under-nourished younger siblings were normally nourished. Over-nutrition rates in 0-4, 5-9 and 10-18-year-old children were low. It was therefore not possible to compute over-nutrition rates in the younger siblings of over-nourished older children. The majority of the younger siblings of under-nourished elder siblings and the majority of the elder siblings of under-nourished younger siblings were normally nourished. In view of this, it is imperative that all children in the family and community are screened to ensure that under-nourished children across the age spectrum are identified and appropriate intervention provided.

4.6 Intra-family differences in the nutritional status among adults in the family

4.6.1 Mother and father (636 pairs) –

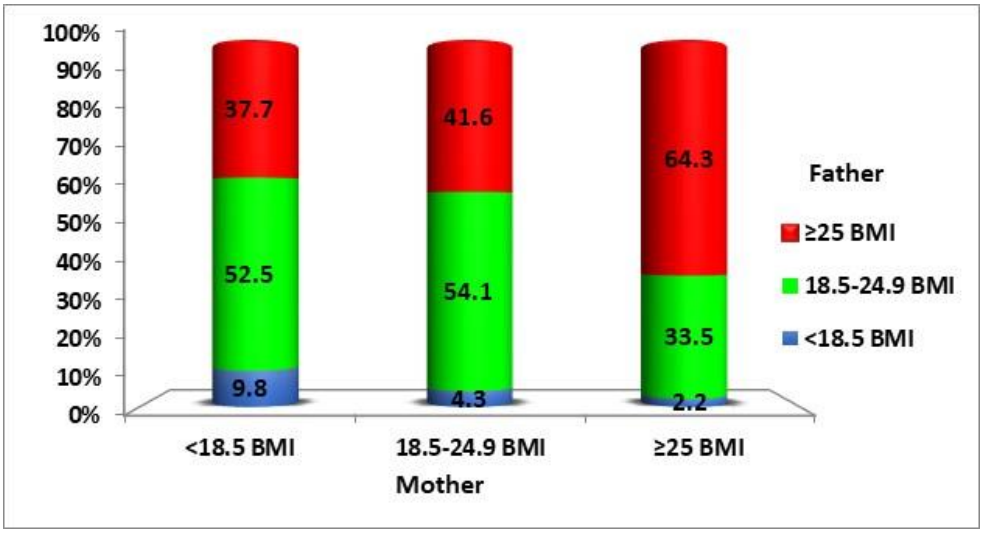


Figure 4.19 Comparison of Nutritional Status of Parents of under five (636 Pairs)

A comparison of the nutritional status of mothers and fathers (as assessed by BMI) is shown in Figure 4.19. Prevalence of under-nutrition in fathers was higher if the mother was under-nourished. Prevalence of over-nutrition in fathers was higher if the mother was over-nourished. However, even if the mother was under-nourished more than one-third of the fathers were over-nourished. Even when the mother was over-nourished about 2% of the fathers were under-nourished.

4.6.2 Mother and Other women (1689 pairs)-

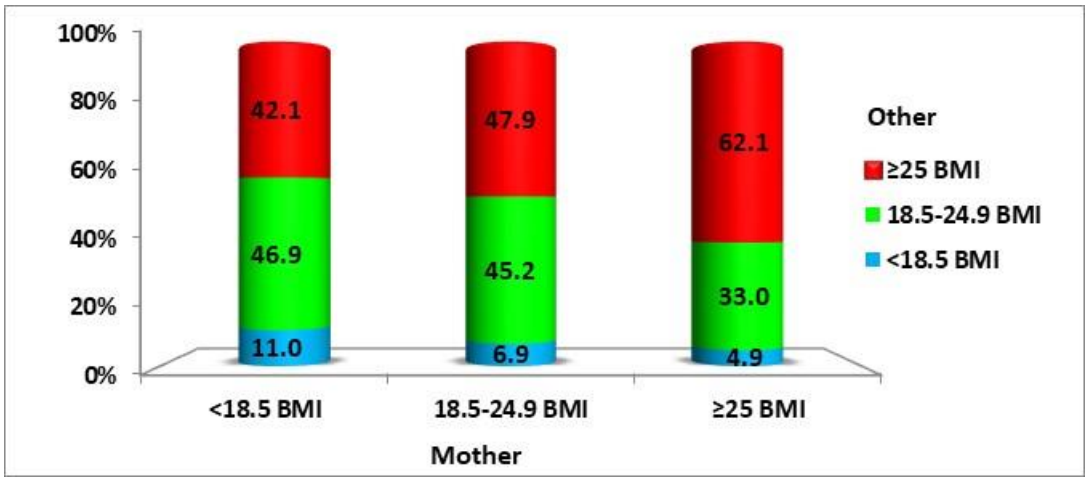


Figure 4.20 Comparison of Nutritional Status of Mother and Other Women (1689 Pairs)

A comparison of the nutritional status of mothers and other women is shown in Figure 4.20. Under-nutrition rates in the other women were higher when the mother was undernourished; however, even when the mother was undernourished 42.1% of the other women in the family were over-nourished. When the mother was normally nourished 45.2% of the other women were normally nourished and 47.9% of the other women were over-nourished. If the mother was over-nourished, 62.1% of the other women were over-nourished. All these differences were large and significant.

4.6.2 Mother and other men (670 pairs) –

Intra family difference in nutrition status of mother and other men shown in Figure 4.21. Under-nutrition rates in the other men were higher when the mother was undernourished; however, even when the mother was undernourished one third of the other men in the family were overnourished. When the mother was normally nourished 45.7% of the other men were normally nourished and 46.0% of the other men were

overnourished. If the mother was over-nourished, around half of the other men were over-nourished.

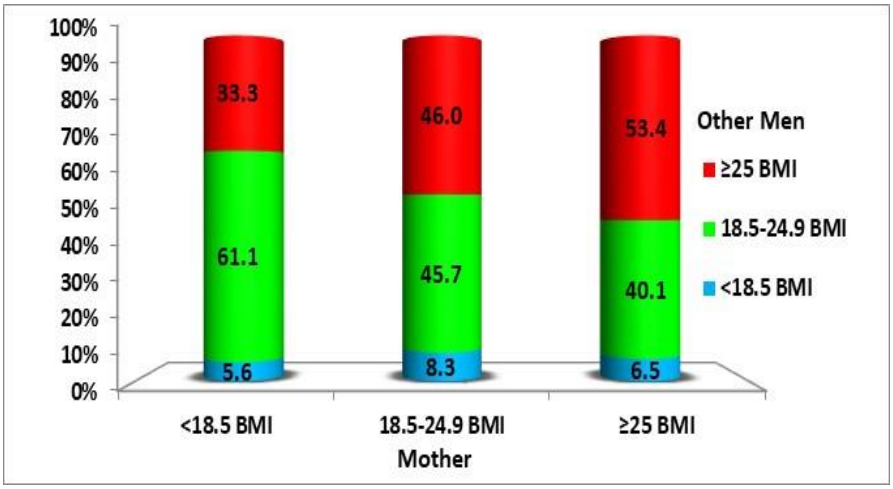


Figure 4.21 Comparison of Nutritional Status of Mother and Other Men (670 Pairs)

4.6 Differences in nutritional status between all family members in a household

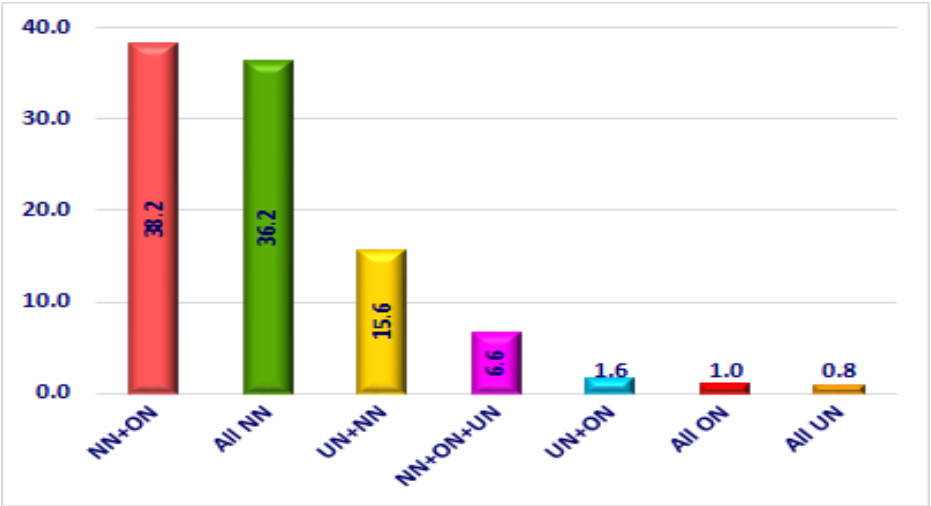


Figure 4.22 Nutritional Status of all Family Members

Based on the data on nutritional status as assessed by BMI in adults and BMI for age in children, families were classified into different categories. All members of the family were normally nourished (NN) in over a third of the families. All members of the family were under-nourished (UN) or over-nourished (ON) in 1% or less of the families. In over 60% of families, there were undernourished, normally nourished and over nourished persons within the family. The context of dual nutrition burden within families, there is an urgent need to add to a component of screening all members of the family to identify and manage both under- and over-nutrition in all ongoing programmes aimed to improve nutritional status (Figure 4.22).

DISCUSSION

Seven decades ago, the country was not self-sufficient in food production. Over three quarters of the population was poor, food-insecure and under-nourished. Under-nutrition, poor environmental sanitation and poor access to health services resulted in high mortality rates; the life expectancy at birth was 33 years. The country invested in planned development, utilized technology and human resources as change agents to hasten nutrition and health transition and improve the nutritional status and quality of life of citizens. Given the vast and varied regions, limited economic and natural resources, the country faced many challenges in its efforts to improve food security and nutritional status of the citizens especially women and children from the poorer segments of the population. As a result of all these initiatives, there had been a slow but steady improvement in the household food security and nutritional status of women and children (Ramachandran, 2013). But prevalence of undernutrition in Indian children have remained the highest in the world (NNMB, 1979; IIPS NFHS 3, 2005-06; IIPS NFHS 4, 2015-16; NFHS-5, 2020-21); NNMB,1996-97;NNMB-2012). Concurrently there was a slow but progressive increase in overnutrition rates mostly in the adults, increase in overnutrition rates were also reported from preschool and school age children and adolescents especially those from urban affluent segments population. Available data suggest that the major factor responsible for overnutrition in adults and children is the steep decline in physical activity.

Currently India is the home of the largest number of undernourished as well as overnourished children. The number of undernourished and overnourished adults is also large. As result of the high prevalence of undernutrition both in children and adults and high overnutrition rates in adults but low overnutrition rates in children there are substantial intrafamily differencing es nutritional status not only between children and adults but also between adults from the same family. In the past almost all Intervention programmes aimed at improving food security and reducing under nutrition have so far used family below the poverty line as the unit for interventions. This approach may no longer be sufficient to address both under and overnutrition in adults and children because of the substantial intrafamily differences in nutritional status across all age groups and in both the sexes. The present study was community-based cross-sectional observational study to assess the magnitude of intra family differences in the nutritional status of the between under-five children, their mothers

and other members of the family, explore some the factors responsible for these observed differences.

The study was conducted in the anganwadis of Neb Sarai, Lado Sarai and Anderia Mod in South Delhi from 2015 to 2019. A complete door-to-door census had been carried out and families with under-five children who were likely to stay in the locality for at least one year were identified. The details about the study were explained to these households and the Hindi version of the study information sheet was provided. One week later households were revisited; families who were willing to participate in the study were given the consent form. Family from the low- middle-income group, have at least one under-five child, likely to continue to reside in the area for at least 1 year and is willing to participate in the study were enrolled. In all enrolled families, anthropometric measurements were carried out on all available and willing under-five children, their mothers and other family members and their nutritional status was computed. Food security status of the family was assessed in a subsample of the families using the NSSO method and NNMB method. A sub-sample of families data was collected on physical activity adults and school age children using the 24 hour physical activity recall method. Time spent in various domains of activity duration of activity and intensity of activity (sedentary, moderate or vigorous) was calculated.

Socio demographic profile of the study families

The total number of households enrolled for the study was 5148. The demographic profile of these households revealed that the men were employed as semi-skilled employees or had white collar employment, and that 3/4 of the adults in these families had attended school. The families felt that their income was sufficient to cover their basic requirements like food, shelter, education, and healthcare. They were forced to live in cramped, overcrowded tenements in unhygienic areas due to urban housing shortages. Nearly all families had ration cards and got subsidised food grain from Public distribution system with subsidies and, they had a Mother Child Protection Card and were registered with Anganwadi. When the family required they accessed available ICDS food supplements.

Dietary diversity

Dietary diversity was assessed by food frequency questionnaire. Even though the data on food purchased/consumed by the family per consumption unit per month was

sufficient to meet the energy needs of the family; pulse, green leafy vegetables and fruits consumption were low (unpublished data). As a result micronutrient deficiencies were common among all the members of the family. In the present study food frequency survey was used to assess the dietary diversity among the families studied. In these families cereals and roots and tubers (mainly onions and potatoes), other vegetables (mainly tomatoes which were tasty), milk (for tea) and milk products (curd), fats and oils, and sugar were consumed every day. Pulses/legumes were consumed daily by over 70% of the families; in many families, pulses were not cooked when two vegetables or vegetable and animal products were cooked. Fruits (mainly bananas) are consumed every day by about 1/2nd of the families. Animal products were never consumed by about a fourth of the families who were vegetarian. About 10% of families consumed eggs daily or on alternate days. Fish, meat, and poultry were consumed weekly in one-fourth of the families; less than 5% consumed these fortnightly or monthly once. When animal food was consumed, adequate quantitates were cooked to meet the requirements of the family. The families followed a three-meal pattern with some biscuits or rusk and tea in the evening. Families did consume energy-dense snacks once or twice a week and sweets once a fortnight or month. But these were not habitually consumed every day. It is obvious that these families are not consuming a diverse diet with adequate vegetables and fruits. As a result there are widespread micronutrient deficiencies. Data from other ongoing studies in these communities indicate that anaemia and iron deficiency are widely prevalent in these families. As a part of our study we have been giving nutrition education on importance of consuming adequate quantities of seasonal vegetables which are not very expensive as a part of daily diet. The families do consume higher amount of vegetables when fresh vegetables are available at reasonable cost (especially in winter). However, majority revert to tomato, onion, potatoes for daily consumption through most of the year. High cost, not being tasty and time taken for cooking are cited as the major factors that come in the way of regular consumption of adequate quantity vegetables.

Food security

Food security status of the family was assessed in a subsample of the families using the NSSO method (based on food stuffs purchased and used /consumption unit /day) and NNMB method (based on food cooked and consumed by the family/consumption unit/day). There was excellent concordance in the amount of foodstuffs

consumed/CU/day between the computation by the NSSO and NNMB methods when the foodstuff was consumed daily (eg cereals 256.7g vs 252.6g). There were substantial differences between the two methods in the amount consumed when the foodstuff was consumed once in fortnight or month (eg animal food 54.7 vs 122.4g). This is because, on the day when animal foods were prepared, adequate amount needed for the family was cooked and shared; but since animal foods were consumed infrequently, the computed consumption of animal food per capita per day was very amount was low.

There was good concordance between NSSO and NNMB methods in terms of computed nutrient consumption: carbohydrate, protein, fat and energy consumption/CU/day. The energy intake/CU/day computed using 24-hour dietary recall was lower by 210 Kcal as compared to the EAR of sedentary reference man but higher by 140 Kcal when the EAR for average weight sedentary man was considered. One-fourth of the families had energy intake ≥ 2110kcal/CU/day (CU1 is EAR for sedentary reference man) and 75% of the families had energy intake ≥ 1760 kcal/CU/day (CU1 is EAR for sedentary average man). Data from diet surveys using 24-hour dietary recall in women from this community had also shown that the energy intake was higher than the requirements and over time there was an increase in body weight in these women. The small but sustained higher intake of energy as compared to the requirement might be responsible for the rising over-nutrition rates in adults.

The differences in socio-demographic profile of families and nutritional status of members of families whose energy consumption/CU/day was equal to or more than 1760 Kcal/CU/day and those whose energy consumption was less than 1760 Kcal/CU/day were small. Only about one fourth of the families are identified as being below poverty line on the basis of energy intake. National Food Security Act (2013) entitles 2/3rd of Indians to get subsidised food grains through PDS, all children and women from families enrolled in ICDS and children studying in government and government aided schools to get food supplements.

Maternal under-nutrition could be due to failure to take additional food to meet the requirements during pregnancy and lactation. Maternal short stature and under-nutrition have been known to have an impact on intrauterine growth and result in low birth weight. Birth weight and length which are important determinants of growth and nutritional status during infancy and early childhood may be important factors responsible for the observed high stunting and underweight rates in pre-school

children. It is also possible that in some families sub-optimal infant and young child feeding and caring practices may contribute to inadequate dietary intake resulting in higher under-nutrition rates in pre-school children. It is important to undertake diet surveys to assess the extent of the intra-family disparity in dietary intake between parents and their children and invest in nutrition education to optimise dietary intake in all persons in the family.

Physical activity in school age children and adults

NNMB surveys in the nineties had highlighted the low physical activity level even among rural low income families. Physical activity surveys in India and elsewhere have documented the association between low physical activity and over-nutrition, adiposity and non-communicable diseases in adults.

Physical activity in the persons was assessed using a modified WHO physical activity questionnaire (WHO 2003). Time spent and intensity (sedentary, moderate, and vigorous) of activity in the household, occupational, transport, personal/ grooming, entertainment and discretionary activity domain was ascertained in detail. Time spent sleeping was also recorded. Based on this 24-hour physical activity recall hours spent in sleep, sedentary, moderate and vigorous activity was computed. Activity during week and weekend days was also assessed. In men working in jobs which has a weekend off, physical activity was lower on weekends. The majority of housewives spent more time on household chores during weekends when children and men folk stayed at home. Children played for a longer time during the weekends.

Data on time spent (in min) in sleep, sedentary activities and moderate physical activity in individuals belonging to the four groups were analysed. The four groups were

a. 5-18 years children (99)
b. under-five's mothers (285)
c. men (87)
d. other women (81)

In all four groups, the mean sleeping time was over 500 minutes. The mean sleeping time was higher in other women and high in 5-18 year's children. Mother and men's sleeping times were more and less similar (Figure- 4.7).

Available data on physical activity from the study indicate that children men and women in these families have sedentary lifestyle. All the groups spent over 75% of their waking time in sedentary activity. The school age children are not physically

active because the schools are nearby and they do not have space to go out and play Most of them spend their time at home either studying, playing mobile/computer games or watching television. However the prevalence of overnutrition in the school age children is also low. There are very few surveys on physical activity levels in pre-school children, perhaps because of the difficulty in documenting the pattern of activity. However, we observed that there was no space in the two room tenements for running and plying. In these localities preschool children do not go out, run around and play for a long time outside the house. Despite low physical activity in children, the prevalence of over-nutrition in preschool and school age children is low perhaps because of the high energy requirement for growth in children.

The majority of the persons in all the groups spent less than 60 minutes a day in moderate physical activity. The mothers showed a maximum mean of moderate activity of around 60 minutes and the least mean of moderate activity was seen in other women. (Figure- 4.5) In these areas, there were occasions when piped water supply was not available and women had to fetch water from water tankers to their households. This accounted for the higher moderate activity in mothers. Data clearly indicate a steep reduction in moderate physical activity in the occupational, domestic and transport domains and the population has adopted a sedentary lifestyle. Lack of moderate physical activity is the major factor responsible for the rising over-nutrition rates in urban populations of all age and sex groups.

Nutritional status of the members of the family

There were 5148 families with 6539 under-five children (some families had more than one under-five child), 5303 mothers (some mothers had more than one preschool child), 636 under-five's fathers, 1288 other women (mostly grandmothers and aunts), 465 other men (mostly grandfather and uncle). 734 children between the age group of 5-9 years and 376 children of 10-18 years. Height and weight measurements were taken in all available and willing adults. Length/ height and weight measurements were taken in all available and willing children in the family. The nutritional status of adults was assessed using BMI. The nutritional status of children were assessed using WHO Anthro and WHO Anthroplus software. Based on height for age children were classified as stunted (HAZ <-2SD), normal (HAZ-2SDto +2SD) and tall (>+2SD),based on weight for age as underweight -(WAZ <-2SD,), normal (WAZ-

2SDto +2SD) and overweight (WAZ >+2); and based on BMI for age wasted (BAZ<-2), normal (BAZ-2SDto +2SD) and overnourished BAZ >+2SD).
In a selected subsample of the families, physical activity of school age children and adults were assessed using a 24 hour physical activity recall questionnaire. Based on the intensity and duration of the physical activity persons were classified as sedentary, moderate or vigorously active.

Intrafamily differences in nutritional status between preschool children, their mothers, their fathers, elder siblings, other women and other men in the family were assessed. In addition, the differences in nutritional status of father, mother, other men and other women in the family of the preschool child were assessed.

An earlier NFI study on morbidity nutrition interactions in the same community showed that the least intra-family difference in nutritional status of 10% was seen in wasting between two under-five children in the same family. The sample size was calculated using a 10% difference in wasting in under-five children, a margin of error of 5% confidence level of 95% and a design effect of 2. The sample size was 1000 children.

Nutritional status of children

Indian children are small statured; their median height-for-age and weight-for-age were near -2SD of WHO standards for height- and weight-for-age. However, the median BMI-for-age of Indian children was around -1SD WHO standards for BMI-for-age. This difference between indicators used for assessment of nutritional status in children is reflected in the mean z scores for height, weight and BMI.

In all three age groups the mean HAZ, WAZ and BAZ were in the negative range. The negative mean z scores for height (range -1.5 to -0.9) and weight (-1.1. to -1.0) were higher as compared to the negative mean z scores for the BAZ (range -0.6 to -0.3). The differences in the mean HAZ, WAZ and BAZ between 0-4 and 5-9 year children were statistically significant. The differences in the mean HAZ, and BAZ between 0-4 and 10-18 year children were statistically significant. The difference in the mean HAZ between 5-9 and 10-18 year children was statistically significant.
Stunting rate was lowest in 5 to 9 years of age, lower in 10 to 18 years children, and highest in under five children. Underweight rates were available only for under five

and 5-9 years age groups. The difference in the underweight rates between 0–4 years children and 5–9 years children were not statistically significant.

In the dual nutrition burden era, BMI-for-age is the most appropriate indicator for assessing the nutritional status of children, especially in countries like India with high stunting rates in children. Wasting rates ranged between 9-13% in children Wasting rates were lowest in the preschool children and showed a small rise thereafter. The differences in wasting rates between 0-4 years and 5-9 years were statistically significant assessed by BAZ<-2 SD. The differences in wasting rates between 0-4 and 10-18 years and 5-9 and 10-18 years were not statistically significant (Figure 4.7 a to c).

The WHO Anthro classified 0-4 year children as over-nourished if BAZ was >+2SD; WHO AnthroPlus has classified 5-18 year children as over-nourished if BAZ was >+1SD. If the classifications of over-nutrition suggested by WHO Anthro for 0-4 years and WHO Anthro plus 5-18 years were used (Figure 4.7 a), there were substantial and statistically significant differences in over-nutrition rates as assessed by BAZ between 0-4 and 5-9 year as well as 0-4 and 10-18 year age groups. However, the differences in over-nutrition between the 5-9 and 10-18 year age group were small and statistically not significant (Figure 4.7 a). NNMB survey (NNMB 2012) and CNNS (MWCD CNNS 2016-18) reported over-nutrition rates using BAZ >+1SD for over-nutrition in 5-18 year age group and BAZ >+2SD for under-five children; both these surveys reported a higher over-nutrition rate in the 5-18 year age group as compared to overnutrition rates in preschool children. Several of the small studies which have reported a high prevalence of over-nutrition in urban high-income group children had also used the WHO Anthro-Plus cut off of >+1SD for defining over-nutrition in school-age children. Based on all these data recommendations has been made that the focus of interventions to combat over-nutrition in children should be mainly focused on school-age children. The WHO Anthro-Plus manual states that this modification was done because BMI-for-age for +1 SD for 19 years, coincided with the cut-off of BMI of 25 kg/m^2 in adults (overweight adults), +2 SD coincided with the adults cut-off of BMI of 30 kg/m^2 (obese adults) and +3 SD cut-off corresponded to an adult BMI of above 35 kg/m^2 (severely obese adults) (WHO 2007).

But using different cut-offs for defining over-nutrition in 0-4 and 5-18 year age groups leads to problems in defining the age group of children at higher risk of over-nutrition. This is essential for focussing interventions to halt further increase in over-nutrition in the high-risk age group. Data from the present study indicate that the reported higher over-nutrition rates in school age children is mainly due to differences in cut off used to define over-nutrition in 0-4 year (BAZ >+2 SD). Overnutrition rates in under five was 3.9 % if BAZ >+2SD is used. If BAZ +>1SD is used overnutrition rates were 11.4% in 5-18 years. Therefore overnutrition rates in school age children were higher than the overnutrition rates in preschool children.

If over-nutrition across 0-18 years were computed using BAZ>+2SD (Figure 4.4 b), the overnutrition rate in 0-4 is 3.9% in 5-9years 5.6% and in 10-18 years 1.6% the difference in over-nutrition rate were significant between 0-4 and 5-9, 0-4 and 10-18 and 5-9 and 10 -18 years. If overnutrition across 0-18 years were computed using BAZ >+1SD (Figure 4.4.c) the overnutrition rate in under five is 14.2 % in 5-9years 11.4% and in 10-18 years 11.4%. The difference in over-nutrition rate were significant between 0-4 and 5-9, and not significant between 0-4 and 10-18 years and 5-9 and 10 -18 years. AHS CAB (RGI AHS-CAB, 2014) and DLHS 4 (IIPS DLHS-4, 2012-13) which defined over-nutrition in 0-18 year children as BAZ of >+2SD z scores, reported similar findings. These data suggest that if uniform criteria are used the prevalence of over-nutrition between pre-school and school age children were not high. Interventions to halt the rise in over-nutrition have to begin right from infancy and early childhood and continue thereafter during school-age children.

Over-nutrition rates both in pre-school and school children were low despite their sedentary lifestyle. This might partly be due to the energy need for growth and partly because most children do not habitually consume high fat, salt, sugar snacks. Efforts have to be focussed on identifying the small number of over-nourished children and changing their dietary intake, increasing their physical activity and improving their lifestyle. This will enable halting and later reversing over-nutrition in these children.

In India both undernutrition and over nutrition in childhood had been shown to be associated with overnutrition and increased risk of non-communicable diseases in adult life. Over years Infrastructure and manpower to screen all children to identify those with under-nutrition and overnutrition have been created. It is essential that optimal use of these both in the health and nutrition sector are made so that it is

possible to detect under and overnutrition early; focussed intervention and monitoring for improvement can bring about sharp decline in under-nutrition and halt the rise in over nutrition

Nutritional status of the adults

Prevalence of undernutrition in parents, other men and women in the family were low, only 10.8 % of the mothers and 3.9% of the fathers were under-nourished. The under-nutrition rate in other women was 6.2% and in other men 8.4%. Prevalence of undernutrition in women and men was low because these were from food secure families and had low physical activity. About half of the women and men in the household were normally nourished.

The prevalence of overnutrition in men and women was high 35.4% of the mothers and 49.8% of the fathers were over-nourished. The prevalence of overnutrition in other women was 56.6% and in other men was 45.4%. These families were food secure and habitually consumed home-cooked cereal, pulse-based diets, the amount of vegetables consumed was low. By and large, the families did not habitually consume energy-dense, processed foods, fried food and sweets. The energy intake/CU/day computed using 24-hour dietary recall was lower by 210 Kcal as compared to the EAR of sedentary reference man but higher by 140 Kcal when the EAR for average weight sedentary man was considered. One-fourth of the families had energy intake ≥ 2110kcal/CU/day (CU1 is EAR for sedentary reference man) and 3/4th of the families had energy intake ≥ 1760 kcal/CU/day (CU1 is EAR for sedentary average man). Data from diet surveys using 24-hour dietary recall in women from this community had also shown that the energy intake was higher than the requirements. The small but sustained higher energy intake in these sedentary persons is the factor responsible for the progressive increase in body weight in adults.

The lifestyle of these women and men was sedentary. Physical activity was low because these families lived in small single or two room tenements, had access to piped water and used LPG for cooking. Mothers had higher physical activity because they were involved in child care. Older women participated less in household chores and child care; they spent more time watching TV and talking to friends. Access to food with adequate energy and low physical activity appear to be the major factors responsible for over-nutrition in mothers. Older women do not get involved in

household chores and child care and therefore prevalence of overnutrition in them was higher than the overnutrition rates in younger mothers who performed household chores and looked after their children. As transport and occupation related physical activity was low, men were also sedentary in their life style; higher than required energy consumption in them results in progressive increase in overnutrition with increasing age. Though energy consumption in these families were higher than required for consumption unit pulse, vegetable and fruit consumption were low. As a result micronutrient deficiencies were common among all the members of the family.

Small but sustained higher energy intake as compared to the requirement due to sedentary lifestyle and lack of any discretionary physical activity appears to be the major factor responsible for the creeping increase in body weight and over-nutrition in adults. Moderate physical activity is essential not only for maintaining optimal body weight but also for maintaining muscle and joint health and prevention of cardiovascular diseases. It is therefore essential that discretionary activity mainly walking should be increased even though it is difficult in these over-crowded localities with poor roads; walking inside the house poses problems because of the small rooms in the house. It is imperative that innovative methods to increase the discretionary activities of the adults are explored, appropriate ones developed and popularised among these literate and aware families so that further increase in over-nutrition and risk of non-communicable diseases is prevented. It is essential to screen these young adults, identify both under and overnourished persons and provide them with appropriate advice regarding dietary intake and physical activity. Persons who were normally nourished should be reassured that they were normally nourished and requested to continue their dietary intake and physical activity patterns. They may be requested to have their weight checked at least once a year and if there is any reduction or increase in weight seek advice from the health and nutrition service personnel. Overnourished persons require addition, annual screening for hypertension and diabetes may help early diagnosis of NCDs.

Intra-family differences in nutrition status

There had been numerous studies both Indian and global on regional, national differences and time trends in the prevalence of undernutrition, nutrient and food intake and factors affecting nutrition status of children especially during the critical first five years of life. India has been having high prevalence of child undernutrition

and concurrently high prevalence of overnutrition in adults. In this context it is inevitable that there will be high intrafamily differences in nutritional status. However there are very few studies exploring the intrafamily differences in nutritional status between under five children and other family members.

Using data from a cross-sectional survey undertaken in 1990 in rural central Guinea, Mock et al 1994, (Mock, Magnani, et al,1994) investigated the nature of within-household relationships in maternal and child nutritional status and considered the implications for programme screening strategies. Mothers and their surviving children under 5 years of age were the focus of the analysis. Correlations between maternal and child nutritional levels were assessed and the performance of maternal-child nutritional indicators as screening tools for household nutritional risk were evaluated by analysing the sensitivity, specificity, and positive-negative predictive values of various indicators. They however did not assess the magnitude of intrafamily differences between the mother and the under five child or factors which might be responsible for the difference.

In 1990s NNMB surveys (NNMB,1995) high lighted the intrafamily differences in energy intake between adults in the family and children in the family. In a third of the families both adults and children had adequate energy intake but in about 40% of the families adults had adequate energy intake but children did not. This was attributed mainly due to poor child caring and feeding practice in food secure families. Subsequent NNMB surveys have indicate that there has been a progressive increase in the proportion of families where adults had adequate energy intake but children did not. The NNMB surveys did not assess the difference in nutritional status between the adults and children.

Dahal et al, (Dahal, Amita, Chand, et al, 2023)) undertook a study the determinants of nutritional status among mothers and their children aged 6–59 months in Nepal's Panauti municipality. The study found that the prevalence of maternal underweight was low (2.7%) whereas the prevalence of overweight and obesity was 36.7% and 13.7%, respectively. Around 27.9% of the children were severely stunted, 3.6% underweight, and 3.5% wasted, whereas 22.1% of the children were overweight. About 54% of the mothers and 57.52% of the children were malnourished. Ethnicity was significantly associated with mothers' nutritional status and factors such as ethnicity, pre-lacteal feeding, and cultural practices of the mother were significantly associated with the nutritional status of children. Demographic factors-like ethnicity

were significantly associated with the nutritional status of mothers and children, whereas factors like pre-lacteal feeding and cultural practices of the mother were significantly associated with the nutritional status of the childrenThe study did not analyze and report the magnitude of intrafamily difference in the nutritional status in mother child pairs or factors responsible for the differences.

NFHS3 was the first national survey to report differences in nutritional status between mother and her under five children (IIPS 2006). Data from all the subsequent national survey report high overnutrition rates in adults and high undernutrition rates in under five children and other children but have not analysed and reported the data on intrafamily differences in nutritional status between adults and children in the same family.

Intrafamily differences computed between under five child and other members of the family shown in below

Under five child and mother (6539 pairs)

Under five child and father (636 pairs)

Under five child and other woman (2054 pairs)

Under five child and other man (670 pairs)

Elder and younger under five children (1590 pairs)

Under five child and 5-9 year child (931 pairs)

Under five child and 10-18 year child (472)

Intra-family differences in the nutritional status among adults in the family

Mother and father of under five child (636 pairs)

Mother of under five child and other woman (1689 pairs) 2

Mother of under five child and other man (670pairs)

Intrafamily differences in nutritional status between adults and under five children

NFHS 3 was the first national survey to undertake computation of intra-family differences in the nutritional status of the mother-child dyad and show that the prevalence of under-nutrition was higher in pre-school children if the mother was under-nourished. Data from the present study showed that there was a gradient in the under-nutrition rates (stunting, underweight and wasting) in pre-school children in relation to maternal nutritional status as assessed by BMI (thin, normal and overweight). Under-nutrition rates in the pre-school child were highest when the mother was thin and lowest when the mother was overweight. But even when the

mother was under-nourished, the majority of her pre-school children were normally nourished (50.8% normal height-for-age, 67.1% normal weight-for-age and 86.2% normal BMI-for-age).

Under-nutrition rates in children were computed in relation to maternal height tertiles (Figure 4.11) to explore the effect of maternal height on the nutritional status of the pre-school child. If the mother was in the lower tertile of height, over 40% of the children were stunted. There was a gradient in stunting rates in children in relation to maternal height tertiles suggesting that the height of mother does have some impact on children's linear growth. Underweight and wasting rates in pre-school children showed a clear gradient in relation to maternal height.

Maternal undernutrition is associated with low maternal weight gain during pregnancy and low birth weight. Birthweight and length are determinants of growth during childhood and adolescence. This accounts for the gradient in undernutrition in children in relation to maternal height tertiles and maternal BMI. However the fact that children of majority of the overweight mothers and undernourished mothers are normally nourished has to be kept in mind. In view of these it is important that all children are screened by weight and height measurements and BMI computation to identify those who are undernourished and those who are overnourished so that appropriate interventions can be provided.

NFHS 3 did not undertake a nutrition survey of the father and hence could not provide any information on the relationship between the nutritional status of the father and his child. So far there has been no publication on the relationship between paternal nutritional status and the nutritional status of the pre-school child. The present community-based study attempted to bridge this gap in information. Almost all fathers left for work between 8-9 AM and returned home after 6 PM; even on holidays fathers were seldom at home during morning hours. Because of these problems, we were able to get anthropometric measurements in only 636 fathers.

Unlike the situation in mother-child pairs, there was a lack of a consistent trend in the relationship between paternal nutritional status and child nutritional status. Stunting rates in children were highest when the father was normally nourished and lowest when he was under-nourished. Wasting rates in children were similar when the father was under-nourished or normally nourished. The inconsistencies in the relationship between paternal nutrition and child nutrition status might at least in part be due to

inadequate sample size; the anthropometric assessment was done only in 636 fathers of them and only 4% were under-nourished.

To overcome the problems due to inadequate numbers, child under-nutrition rates in 636 families in relation to paternal and maternal height and BMI tertiles were analysed. The results showed that the discordance between the paternal nutritional status and child under-nutrition rates disappeared if BMI tertiles were considered. These data suggest that there was greater concordance between maternal undernutrition and child under-nutrition as compared to paternal under-nutrition and child under-nutrition. If the father or mother was in the lowest height tertile the prevalence of stunting in pre-school children was over 40% suggesting that parental short stature is an important determinant of stunting in pre-school children. However, even when the parents were in the highest height tertiles one-fourth of the children were stunted. These data indicate that parental height is an important but not the only determinant of height in pre-school children.

There were the large differences in nutritional status between the under-five child and the other woman and men in the family, there were no significant trends in the nutritional status of the child in relation to the nutritional status of the other woman in the family.

In adults undernutrition was not a major problem but nearly half the adults were over-nourished. In contrast 35.2% of the under five children were stunted, 22% underweight and about 3.9% were wasted. In view of the substantial differences in nutritional status between adults and children in the family there were large intrafamily differences between adults and children. Screening all members of the family to identify under and overnourished persons and providing appropriate management is essential in the dual nutrition burden era.

Intrafamily differences in nutritional status between children

Comparison of the prevalence of under-nutrition between children from the same family showed that some interesting findings. When the elder under five sibling was stunted prevalence of stunting in the younger sibling was 38.3% and if the elder sibling was normal in prevalence of stunting in younger sibling was only 25.1%. When the elder under five sibling was underweight 36.3 % of the younger siblings were underweight but if the elder sibling was normal weight, 83.6 % of the younger

siblings were normal in wight. When the elder under five sibling was wasted 24.3 % of the younger siblings were wasted but if the elder sibling was normal wasting rates in younger siblings was only 12.7%. (Figure 4.16) .A similar situation was seen when nutritional status of 5-9 year old children were compared with the under five children (Fig 4.17) and nutritional status of 10-18 years old children were compared with under five child (Fig 4.18) . These data suggest that irrespective of the parameter (stunting, underweight or wasting) or the age group (0-4, 5-9 or 10-18 years), if the elder sibling was stunted, underweight or wasted, the prevalence of stunting, underweight and wasting in the younger sibling was higher (Figures 4.16 to 4.18). This is because the siblings share some of the major factors responsible for under-nutrition in children such as small parental stature, low parental weight, low dietary intake and poor environmental sanitation.

When the elder under-five sibling was stunted 54.7% of the younger sibling is normal in height ; Even when elder under five child was underweight 63.7% of the younger siblings were normal in weight. Even when the elder under five child was wasted 73% of the younger sibling was normal (Figure 4.16). Similar situation is seen while comparing the nutritional status of underfive children with 5-9 year children (Figure 4.17) and underfive children with 10-18 year children (Fig 4.18). These data suggest that the majority of the younger siblings of under-nourished elder siblings were normally nourished (Figures 4.16 to 4.18). These data suggest that, the majority of the younger siblings of under-nourished elder siblings were normally nourished (Figures 4.16 to 4.18).

Over-nutrition rates in 0-4, 5-9 and 10-18-year-old children were low. It was therefore not possible to compute over-nutrition rates in the younger siblings of over-nourished older children.

The majority of the younger siblings of under-nourished elder siblings and the majority of the elder siblings of under-nourished younger siblings were normally nourished. In view of this, it is imperative that all children in the family and community are screened to ensure that under-nourished children across the age spectrum are identified and appropriate intervention provided.

Intrafamily differences in the nutritional status of adults in the family

Irrespective of the age and sex prevalence of undernutrition is low and overnutrition rates are high in adults. However in all age and in both the sexes about half the persons were normally nourished. It is uncommon for all adults in the family to be either under or overnourished Therefore it is important to screen all adults to identify under and overnourished persons and initiate appropriate interventions.

Nutritional status of all members of the family

In the study families about half of adults (men and women) are normally nourished; undernutrition rates are low (10%) and over-nutrition is a major problem (affecting nearly half the persons). In these food secure families, low physical activity appears to be the major factor associated with overnutrition.

A third of the children were stunted and one fifth were under weight. Stunting and underweight appears to be mainly related to low birthweight and length and small parental stature. One tenth of children were wasted prevalence of over nutrition in children is low.

Nearly two third of the families had one or more normally nourished , undernourished or over nourished persons; In less than 1 % of the families all persons of the family were undernourished or over-nourished.

Based on the data on nutritional status as assessed by BMI in adults and BMI for age in children, families were classified into different categories. All members of the family were normally nourished (NN) in over a third of the families. All members of the family were under-nourished (UN) or over-nourished (ON) in 1% or less of the families. In over 60% of families, there were differences in the nutritional status of persons in the family: both under- and over-nutrition coexist in the family. In view the large intrafamily differences in nutritional status between the members of the family (both children and adults), it is essential to screen all members of the family, identify the person with under and overnutrition and initiate appropriate interventions.