ABSTRACT

Introduction

In 1947, when India became independent, the country was not self-sufficient in food production. By 1970s, green revolution ensured that the country produced enough food to meet the cereal requirement for the population. But over 70 % of the families were poor and food insecure and over 70% of all members of the family were undernourished. As poverty and household food insecurity were major factors responsible for the high prevalence of undernutrition, intervention programmes identified families below the poverty line and provided them with jobs to improve purchasing power and subsidised food grains through Public Distribution System (PDS) to improve household food security. To address the gap between requirement and actual dietary intake in vulnerable groups such as children, pregnant and lactating women food supplementation programmes such as the Midday Meal Programme (MDM) and Integrated Child Development Services (ICDS) were initiated.

Data from National Family Health Surveys 1-5, District Level Household Survey 2and 4 and CAB component of Annual Health Survey showed that

- prevalence of under-nutrition in preschool children continue to be high, but overnutrition in children is low and
- prevalence of both under and over-nutrition are high in adults- both women and men.

Given this scenario it is inevitable that there were substantial intrafamily differences in the nutritional status between preschool children, their mothers and to other members of the family. NFHS3 was the first survey to report that there are substantial differences in the nutritional status between the mothers and their under- five children. It is important to assess the intrafamily differences between under five children and other members of the family and also ascertain the factors responsible for these differences. There are however very few publications documenting the extent of intrafamily differences in nutritional status.

When poverty and food insecurity were the major factors responsible for undernutrition, most of the interventions aimed to identify families below the poverty

line and provide them employment to improve purchasing power, subsidized food grains to improve household food security and food supplementation to women and children to improve their energy intake and nutritional status. Over time there has been improvement in household food security. In the 1990s data from the National Nutrition Monitoring Bureau showed that even in households where dietary intake of energy was adequate in adults (men and women) energy intake was inadequate in about 40% of the preschool children. This was attributed to the poor infant and young child feeding and caring practices. Recent NNMB reports suggest that the trend is worsening and currently in nearly 60% of households where energy intake is adequate in adults, intake of preschool children was inadequate.

With the emergence of a intrafamily differences in dietary intake and nutritional status, there may be a need to shift in the strategy from identifying families living below poverty line and providing the family with goods and services to screening individuals, to identifying the individual with undernutrition and providing personalized counselling and nutrition support for the management of under-nutrition.

The primary objective of the study was to assess the intrafamily differences between under five children and other members of the family and also ascertain the factors responsible for these differences.

The secondary objectives were to assess

- dietary diversity , household food security, and physical activity in a sub sample of families
- the intra-family differences in nutritional status between mother and other members of the family

Methodology

Yearly census of the low middle income families in the three ICDS blocks (Neb Sarai, Lado Sarai and Andheria Mod) in South Delhi was conducted and families with under-five children were identified. Families from the low- middle income group, with at least one under-five child, who were likely to continue to reside in the area for at least 1 year and were willing to participate in the study were enrolled for the mixed longitudinal study . Consent to participate in the study was obtained from parents and other adult family members. For children in the 0-6 year age groups

parental consent was obtained. For children in 7-18 years consent for their child's participation was obtained from the parent and assent to participate in the study was obtained from the child.

Socio-demographic details of the enrolled families were obtained in a uniform precoded proforma. In a subsample of the families

dietary diversity was assessed by food frequency questionnaire

energy consumption/ consumption unit/day was computed by NSSO method (based on food purchased for consumption by the family over a defined time) and NNMB method (based on the food cooked for consumption of the family on the previous day)

food security status of the family was assessed by comparing the energy consumption/ consumption unit/day with the estimated average requirements (EAR) for energy for Indians (ICMR-NIN report on Nutrient requirements for Indians 2020), and

physical activity of school age children and adults was assessed using a 24 hour recall questionnaire; based on the intensity and duration of the physical activity persons were classified as sedentary, moderate or vigorous.

Anthropometric measurements were carried out in under-five children, their mothers and other family members who were available at the time of data collection and consented to participate in the study. Length/height measurements were carried out using infanto-meter /stature-meter with 0.1 cm accuracy. Weight was measured using a digital balance (with an accuracy of 100g). Accuracy of the stature meter and the digital balance were tested every day . From the height and weight measurements BMI was calculated for all persons.

Nutritional status of children was assessed using WHO Anthro and WHO Anthro plus software. Based on height for age children were classified as stunted (HAZ <-2SD), normal (HAZ-2SD to +2SD) and tall (>+2SD), based on weight for age as underweight -(WAZ <-2SD,), normal (WAZ-2SD to +2SD) and overweight (WAZ >+2SD), and based on BMI for age wasted (BAZ<-2SD), normal (BAZ-2SDto +2SD) and overnourished BAZ >+2SD). Adults were classified on the basis of BMI - underweight (BMI <18.5), normal BMI between 18.5 and 24.9 and overweight BMI ≥ 25. Intrafamily differences in nutritional status between preschool children, their

mothers, their fathers, siblings, other women and other men in the family were computed In addition, the differences in nutritional status mother and , father, other women and men in the family were computed.

An earlier study on morbidity nutrition interactions in the same community showed that intra-family difference in wasting between two under-five children was 10%. The sample size required for the present study was calculated assuming 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.

The study was approved by the Institutional Ethics committee of the Nutrition Foundation of India. Permission to conduct the study in families living in the ICDS blocks was obtained from the Deptt of Women and Child Development of NCT Delhi.

Data entry and cleaning was done using MS excel. Initial data entry and cleaning was done on the day of data collection. If any data collection errors were detected they were corrected by going back to the household the very next day. Prior to data analysis the data pertaining to all variables were checked for errors in data entry & data entry errors were corrected by checking with the hard copy.

Data analysis were done using MS Excel, WHO Anthro, Anthro plus and SPSS version 26 software. Means & standard deviations were computed for continuous variables; statistical significance of differences between groups were assessed by student "t" test. Prevalence was computed for categorical variables; statistical significance of differences between groups were assessed using chi square test.

Results

A total of 5148 families were enrolled for the study. Analysis of data on the socio-demographic profile of households showed that the majority of families were from low middle income group, men worked in petty white-collar jobs or were employed as semiskilled skilled workers. Over 90% of the women were home makers. The family income was sufficient to meet essential requirements of shelter, household possessions, education of children and health care. These families stated that they had adequate money to purchase food needed for the family and so considered that they were food secure. They lived in one or two room overcrowded tenements in unhygienic localities, because of urban housing constraints.

Dietary diversity was assessed by food frequency questionnaire. Cereals were consumed every day(wheat in over 90% of days and rice in 50% of the days. Pulses and legumes were consumed daily in about 50% of the households .Oil , milk and sugar were consumed daily almost by all the families. Roots and tuber (mainly potatoes and onions) were consumed almost daily throughout the year by most of the families. Roots and tubers, milk, oil consumption was higher than the balanced diet for reference sedentary man. Consumption of other vegetables and green leafy vegetables was low both in terms of frequency and in quantity. Fruits except banana were not regularly consumed. Animal foods were consumed once or twice a month but on the day they were consumed adequate quantity was prepared and consumed. These data suggest that though cereal, oil, consumption of the families was adequate, the consumption of pulse, legume, vegetables and fruits was low. Low consumption of the micronutrient rich vegetables and fruits might be reason for the widespread anaemia in this population.

Food security status of the family was assessed by computing energy consumption/consumption unit/ day based on the food stuffs purchased (NSSO method) or food cooked and consumed on the previous day (NNMB method). 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. From the data on food stuffs /purchased or cooked and consumed per consumption unit the total energy consumption/consumption unit/day was calculated using the Nutrient composition tables (ICMR - NIN 2017).

The mean energy consumption was 1974kcal/ CU /day by NSSO method and 1900kcal /CU/day indicating that there was good concordance between NSSO and NNMB methods in terms of computed nutrient consumption. 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 weighing 65 kg (2100 Kcal /day ICMR NIN, 2020)) but higher by 140 Kcal when the EAR for average weight (55 kg) sedentary man (1760 kcal) was considered. The perception of the families that they are food secure was confirmed by the data energy consumption/CU /day. About one-fourth of the families consumed ≥ 2110 Kcal/CU/day; over 75% of the families consumed ≥ 1760 Kcal/CU/day.The persistent higher energy consumption by adults (100-200/kcal higher than requirement for sedentary adults) is the major factor

responsible for the progressive increase in overnutrition with increasing age seen in men and women.

Information on physical activity was collected using a 24 hour physical activity recall in a sub sample of the households. Average time spent by adults and children in sleeping was 500 minutes. During waking hours, over 75% of time was spent in sedentary activities. Both adults and children spent less than 60 minutes a day in moderate physical activity. Majority of young mothers with under five or 5-10 year children had moderate physical activity around 60 minutes/day mainly in household chores and child care. Majority of women in their forties and fifties did not spend any time in 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... In children overnutrition rates are low because of the nutrient requirements the growth. In adults sedentary life style without commensurate reduction in energy intake appears to be the major factor responsible for increase in prevalence of over nutrition with increase in age.

Anthropometric measurements were done in 6539 under-five children (some families had more than one under-five child), 5303 mothers (some mothers had more than one preschool child); 636 fathers, 1288 other women (mostly grandmothers and aunts of the child), 465 other men (mostly grandfather and uncle of the child), 734 siblings in 5-9 years and 376 siblings in 10-18 years.

In 0-18 children there was a progressive increase in the

mean height (78.8 ± 15.49, 117.6±10.62, 146.4 ± 12.14 cm respectively for 0-4 and 5-9 year & 10-18 year children); mean weight (9.9 ± 3.61, 21.0 ±5.51 ,39.1 ± 10.54 kg respectively for 0-4 and 5-9 year & 10-18 year children; mean BMI was similar in 0-4 (15.4 ± 1.99) and in 5-9 yr (15.0± 2.23) groups but higher in 10-18 year age group (17.9 ± 3.17). This increase in BMI-with-age is due to the increase in muscle and fat mass as children become older. Similar trends in Height, weight and BMI with age have been reported in AHS CAB (RGI AHS-CAB 2014) and DLHS 4 (IIPS DLHS 4 2012-13).

Mean age was 26.6±4.21yrs in mothers, 31.2±5.52 fathers of under five children were 5 years older than the mothers. Fathers were 13.2 cm taller and 14.4 kg heavier than the mothers. The mean BMI of fathers was higher than BMI of mothers. The

mean age was similar for other men and other women. Other men were taller by 13.5 cm and heavier by 8 kg as compared to the other women. The mean BMI of other men and women was 26.1 kg/m2 and 25 kg/m2 respectively. Mothers had 60 min of moderate activity (child care and household chores).Men and other women were sedentary and this accounts for their higher mean BMI .

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.

Stunting rate was lowest in 5 to 9 years of age, lower in 10 to 18 year children, and highest in under five children. Underweight rates were available only for under five and 5-10 year age groups. The difference in the underweight rates between 0–4 year children and 5–9 year children were not statistically significant. Wasting rates ranged between 9-13% in children. In wasting rates were lowest in preschool children, and showed a small rise thereafter.

If the criterion of BAZ>+2SD for under five children and BAZ>+1SD for 5-18 year children prevalence of overnutrition was higher in the school age children. When uniform criterion was used across age groups either BAZ of >+1SD or BAZ of >+2SD, this trend of substantially higher overnutrition in school age children is not seen.

Prevalence of undernutrition (BMI<18.5) in parents, other men and women in the family were low (<10%), over half of the adults in the family were normally nourished (BMI between 18.5 to 24.9) . Prevalence of overnutrition (BMI $\geq$ 25) adults was high (30-50%).

Intrafamily differences between under five child and other members of the family was computed in 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);Under five child and mother (6539 pairs) ;Under five child and father (636 pairs) Under five child and other woman (2054 pairs) and Under five child and other man (670 pairs).

Intra-family differences in the nutritional status between adults in the family was studied in Mother and father of under five child (636 pairs);Mother of under-five child and other woman (1689 pairs);Mother of under five child and other man (670pairs).

There were 1590 pairs of two under five children. 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. 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 under nourished and majority of the older siblings of the undernourished younger siblings were normally nourished.

In 931 pairs there were under five children and 5-9 year elder 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. 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.

In 472 pairs there were under five children and 10-18 year elder siblings. If the elder sibling was stunted, underweight or wasted, the prevalence of stunting, underweight and wasting in the younger sibling was higher. But majority of the under five siblings whose elder siblings were stunted ,or wasted were normally nourished and vice versa .

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.

Clearly there are substantial differences in nutritional status between siblings in the same family. Though prevalence of under-nutrition is higher in younger siblings whose elder siblings are under-nourished , majority of the younger siblings whose elder siblings are under-nourished are normally nourished. In view of these findings, it is imperative that all children in the family should be screened to ensure that under-nourished children are identified and appropriate intervention provided.The protocol of community based management of under-nutrition in under-five children envisages that all children will be screened for under-nutrition, under-nourished children will be provided with appropriate ICDS supplements and monitored. Implementation of this protocol may help in accelerating reduction in undernutrition

Intrafamily differences in mother and under five children were studied in 6539 pairs. 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. Under-nutrition rates in children (stunting, underweight and wasting) were higher when mother or father was under-nourished but majority of children were normally nourished even when parents were under-nourished. Conversely substantial proportion of children were under-nourished even when parents were normally nourished or over-nourished

Under-nutrition rates in children were computed in relation to maternal height tertiles to explore the impact of mother height on the nutritional status of the pre-school child. If their mother's height was in the lowest tertile, 42.9% of the children were stunted. Children's stunting rates varied according to the maternal height tertiles, showing that the mother's height does affect the child's linear growth to some extent. Pre-school children of mothers with BMIs in the lowest tertiles showed higher prevalence rates of stunting, underweight, and wasting than children of mothers with BMIs in the other two tertiles. There was a significant gradient in underweight and wasting in pre-school children with mother’s height & BMI tertiles.

Intrafamily differences in father and under five children were studied in 636 pairs. There was a small gradient between paternal BMI tertiles and height tertiles and

increasing under-nutrition rates in children. However, even when father were in the top tertile of either BMI or height, some of their children were stunted, underweight and wasted.

Intra family differences between under-five children and other women were studied in 2054 pairs- There were no significant trends in the nutritional status of the under five children in relation to the nutritional status of the other woman in the family. Irrespective of the fact the other woman was over-nourished or under-nourished majority of the preschool children were normally nourished if BMI for age was used as a method for assessing nutritional status of the child.

Comparison between under-five children and other men were studies in 670 pairs. There were no significant trends in the nutritional status of the under five children in relation to the nutritional status of the other men in the family. This might partly be due to the fact that the other members of the family:

- do not share the close biological links between parents and their children
- other men and women in the family are older and have higher over-nutrition rates as compared to the parents

In 636 pairs nutritional status of the father and mother of the under five child could be compared 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

In 1689 pairs nutritional status of the other women and mother of the under five child could be compared. Under-nutrition rates in the other women were higher when the mother was undernourished. However overnutrition rates were high in other women even when the mother was undernourished or normally nourished. If the mother was over-nourished, nearly two thirds of the other women were overnourished.

In 670 pairs nutritional status of other men and mother of the under five child could be compared. Undernutrition rates were higher in other men when mother was under nourished. If the mother was over nourished majority of other men were also overnourished.

Comparison of the nutritional status of mothers and fathers (636 pairs) showed that the 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. 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.

Similar trend was seen when nutritional status of mother and other women (1689 pairs), mother and other men (670 pairs)women were compared. The higher overnutrition rates in other men and women as compared to mother and father appears to be due to increase in prevalence of over nutrition with increase in age mainly due highly sedentary life style of these older persons .

On the basis of nutritional status as assessed by BMI in adults and BMI for age in children, families were classified into different categories. In about a third of families all members were normally nourished. All family members were under or over-nourished in < 5% of the families. In 60% of families some members were under-nourished, others normally nourished or over-nourished. Therefore it is not appropriate to treat family as a unit while providing nutrition services.

Summary & conclusion

Intra-family differences between nutritional status of preschool children and other members of the family was investigated in urban low income families .These families were food secure and had access to health and nutrition services but lived in unhygienic environment in small ill ventilated tenements because of economic constraints .Physical activity levels in all members of families was low; all members including children were sedentary.

Prevalence of stunting and underweight in preschool and school age children were high; prevalence of wasting was lower than national average ; overnutrition in preschool and school age children were low. Small statured neonates grow along a low trajectory of growth. Small parental stature and low birthweight are major factors responsible for high undernutrition rates in children. Prevalence of undernutrition in mothers, fathers and other women and men , in the family was low because the families were food secure. Prevalence of overnutrition in mothers,

fathers and other women and men , in the family was high because energy intake was higher by 100-200Kcal as compared to energy requirements of these adults with sedentary life style.

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. In view of 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

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 overnourished persons within the family.