Nutrition is the focal point of health and well being. It is directly linked to the human resource development, productivity and prosperity of a country. Food security has been major developmental objective of the India since the beginning of the planning. Linkages between household food security, energy balance and chronic energy deficiency in women belonging to reproductive age group in rural setups have been not explored optimally. In programme planning it is imperative to delineate factors influencing them. With this background this study was contemplated in a rural block of Varanasi district. The aim of the study was to find out Household and Individual Food Security, Energy Balance and Chronic Energy Deficiency in women of reproductive age in rural Varanasi.

The specific objectives of this study were:

1. To investigate the extent of household as well as individual food security of the study subjects.

2. To compute the Energy Balance of study subjects.

3. To find out the nutritional status of study subjects with special reference to CED.

4. To find out the association among Food Security, Energy Balance and CED.

5. To identify the correlates of Food Security, Energy Balance and CED.

This study was conducted in rural area of Varanasi. A community based cross sectional design was adopted for this study. Women of reproductive age group (15-49 years) were considered for this study. Pregnant and seriously ill women were excluded from the study. Computation of required sample size of 610 was based on the assumption that prevalence of CED in the rural reproductive age group women is around 40%. The required sample size was selected by adopting multi stage random sampling procedure. The study had prior approval of the academic bodies of Banaras Hindu University, Varanasi, and prior consent was taken from the study subjects for participation in this study.

Tools used in the study were pre-designed and pre-tested interview schedule, Libra weighing machine, steel anthropometric rod with parallel bars and measuring tape. Information pertaining to socio-demographic profile was obtained by interviewing the study subjects with the help of pre-designed and pre-tested schedule. Household food security was assessed by interviewing subjects using pre-designed and pre-tested schedule. Energy intake of the study subjects was assessed by 24 hour recall method. Activity pattern of each study subject was recorded by 24 hour recall method. This served as the basis for estimation of their energy expenditure. Energy balance of the study subject was computed by taking the difference of EI and EE. Nutritional Status of study subjects was assessed by weight and height recording and measuring waist and hip circumference by following by guidelines as suggested by **Jellife (1966)** following standard techniques.

In order to find out the relationship among Food Security and Energy Balance and CED cross tables were generated and logistic regression was done. Associates of food security, Energy balance, and CED were examined by generating cross tables; χ^2, ANOVA and logistic analysis were applied for statistical inferences. Salient findings of the study were:

6.G: SOCIO-DEMOGRAPHIC CHARACTERISTICS OF STUDY SUBJECT:

6.G.1 As much as 35.9%, 32.1% and 24.8% subjects belonged to the age groups 15-24, 25-34 and 35-44 years, respectively.

6.G.2 Majority (92.8%) of them were from Hindu.

6.G.3 As much as 31.3% and 46.7% subjects were from SC/ST and OBC castes, respectively.

6.G.4 As much as 52.5% and 4.9% subjects were from nuclear and 3 generation families, respectively.

6.G.5 Two third of the study subjects were literate; 15.41% were engaged in gainful employment whereas 63.3% subjects were housewives and 21.3% subjects were primarily engaged as students.

6.G.6 On the basis of modified BG Prasad's classification 36.4% and 32.6% were from lower and lower middle class, respectively.

6.G.7 In case of 3.1% subjects maximum education in the family was illiterate whereas in 10.3% this was above graduation.

6.G.8 Main occupation of head of the family was farmer in 12.8% and labor in 37.4% subjects, respectively.

6.G.9 In case of 38.7% and 32.0% subjects type of house was pucca and kacha, respectively; 39.3% subjects had mixed pattern. Locality of house was congested in 36.9% subjects.

6.G.10 In 60.2% households, kitchen was separate.

6.G.11 Hand pump was the main source of drinking water in 63.1% households.

6.G.12 Maximum (66.7%) households were not having proper water drainage facility whereas 59.7% did not have latrines in their houses.

6.G.13 In case of majority (70.7%) subjects menarche occurred before 13 years.

6.G.14 Menstrual Cycle was regular in 76.1% subjects.

6.G.15 Average duration of menstrual flow was observed in 57.7% subjects.

6.G.16 Nature of bleeding at the time of menstruation was scanty in 23.9%, normal in 65.2% and excessive in 10.8% subjects.

6.1 HOUSEHOLD FOOD SECURITY *VIS-À-VIS* INDIVIDUAL FOOD SECURITY:

6.1.1 Three hundred sixty six (60.0%) subjects worried about not having enough food in household and out of them 48.63% were often worried about not having enough (quantity) food in household whereas 39.89% and 11.48% were worried for sometimes and rarely, respectively.

6.1.2 Two hundred thirty seven (38.9%) subjects had not enough of the kind of food they wanted to eat; 31.0% had enough but not always kinds of foods they wanted to eat. Reasons for this was insufficient money possession in maximum (64.02%) subjects; in 4.76% subjects it was too hard to get to the stores for the food products they wanted to eat.

6.1.3 Among all 22.0% subjects had sometimes not enough to eat and in 8.2% households, subjects had not even enough food to eat. The reason for these was insufficient money possession in 88.59% subjects.

6.1.4 In 64.4% households, family members ate a limited variety (food groups) of foods due to lack of resources. Among these 56.49% faced this very often, 36.13% faced it sometimes and 7.38% family members faced this situation rarely.

6.1.5 Maximum number (355) of household members eaten food that is not preferred to eat because of lack of resources to obtain other types of food. Maximum (47.89%) subjects practiced this very often, 29.01% rarely and 23,1% practiced it sometimes.

6.1.6 In case of 25.7% household members slept at night hungry because there was not enough food to eat. In 10.83% households all family members suffered from sleeping hungry at night.

6.1.7 In answer of need of any government subsidy to satisfy the hunger of family 69.3% subjects replied that they need government subsidy.

6.1.8 In case of 29.8% and 15.9% level of food security was high/marginal and low, respectively. More than half (54.3%) households had very low food security.

6.1.9 In case of 31.2% households, energy intake PCU was adequate and 69.8% subjects had inadequate consumption at household level.

6.1.10 With respect to RDA 37.4% subjects had adequate calorie consumption.

6.1.11 Of those having adequate household consumption, 51.6% subjects had adequate calorie consumption at individual level whereas those having inadequate consumption at family level 133 (31.2%) had calorie adequacy at individual level (p<0.001).

6.1.12 Primary occupation of subjects exerted significant influence (p<0.001) on caloric adequacy; 43.0% housewives and 46.2% students had adequate consumption of calorie whereas none of the subjects having primary occupation as domestic worker, agriculture labor, service or skilled worker belonged to this category.

6.1.13 As much as 55.0% middle and 32.0% lower class subjects had calorie adequacy. None of the subjects from upper and upper middle class belonged to this category.

6.1.14 Although maximum education in the family of study subjects was significantly associated with calorie adequacy, there was no discernable trend. Higher level of caloric adequacy prevailed for subjects having maximum education in the family above middle and up to intermediate level.

6.1.15 Adequate calorie consumption by study subjects did not differ significantly (p>0.05) with respect to their age religion, caste, type of family, marital status and educational status of subjects.

6.1.16 There existed significant (p<0.001) association between SES and calorie adequacy of subjects. As much as 55.0% middle and 32.0% lower class subjects had calorie adequacy. None of the subjects from upper and upper middle class belonged to this category.

6.1.17 The odds of inadequate calorie consumption was high for housewives (AOR 1.69; CI: 1.02-2.81) and other occupations (AOR 85.59; CI: 18.87-379.27).

6.1.18 In comparison to lower class odds of calorie inadequacy was low for lower middle class (AOR 0.30; CI: 0.19-0.47).

6.1.19 In all 54.1% subjects without ration cards had very low FS at household level; corresponding values for subjects having Antyodaya and BPL cards were 56% and 77.3% respectively. As much as 37.7% APL subjects also belonged to this category (p<0.001).

6.1.20 Out of 512 subjects having any type of cards, 51.76% received commodities regularly from FPS.

6.1.21 Of 265 subjects receiving commodities regularly from FPSs 31.32% were satisfied with the quality/quantity of that commodity.

6.1.22 The reasons stated for un satisfaction with commodities supplied from FPSs were poor quality (49.45%), inadequate quantity (32.42%), irregular supply (16.48%) and adulteration (5.49%).

6.1.23 Average energy, protein and fat intakes were 84.4%, 81.82% and 55.54% of respective estimated RDA.

6.1.24 In case of 14.6% subjects daily calorie consumption was <50% of RDA whereas 37.4% subjects had calorie consumption more than RDA.

6.1.25 In all 42.13% subjects had protein intake ≥ 80% of RDA. Protein consumption was <50% of RDA in 12.5% subjects**.**

6.1.26 The study population was heterogeneous in consumption of fat. 23.93% had percentage intake of fat with respect to RDA <50% whereas 58.7% subjects had fat consumption more than RDA.

6.1.27 Average iron intake of study subjects was 14.8, ±7.32 mg/day, which was 70.48% of RDA.

6.1.28 In case of 32.8% subjects adequacy ratio of Iron intake was<50% of RDA, 15.26% subjects was in the range of >80% to 100%; 17.9% subjects had Iron consumption more than RDA.

6.1.29 Average iron intake was maximum (16.63 ±7.9 mg/day) in students and least (12.16 ±5.78 mg/day) in subjects engaged in domestic work.

6.1.30 There was no definite trend in average iron consumption of study subjects and their SES. This was maximum (18.66 ±7.71mg/day) in subjects belonging to upper middle and least (11.72 ±3.59 mg/day) in upper class.

6.1.31 There was no significant association between age, religion, caste, type of family, marital status, education of study subjects, maximum education in the family and main occupation of head of the family and average iron intake of study subjects.

6.1.32 Average Vitamin A and C intake were 1605.09, ±1684.74µg/day, and 68.54, ±30.1 mg/day respectively.

6.1.33 Intake of vitamin A and C were 35.39% and 171.13% with respect to RDA values.

6.1.34 Majority (84.4%) subjects had Vitamin A consumption <80% of RDA, contrary to this 82.0% subjects had Vitamin C intake more than RDA; only 11% subjects had Vitamin C Consumption <80% of RDA.

6.1.35 Average Vitamin A intake was significantly influenced by caste, type of family, subjects' educational status, SES, maximum education in the family and occupation of head of the family.

6.1.36 Vitamin A intake was maximum in other caste category (2123.99 ±1817.0 µg/day), in subjects from 3 generation family (2714.28 ±1846.24 µg/day), in graduates (2624.89 ±1967.53 µg/day), belonging to upper middle class (4253.05 ±1256.02 µg/day), having maximum family education up to graduation (1855.56 ±1895.12 µg/day) and with occupation of the head of the family as service (1855.65 ±1805.58 µg/day).

6.1.37 There was no significant association between average vitamin A intake and religion, marital status, occupation of study subjects

6.1.38 None of the socio-demographic variables except SES was significantly associated with Vitamin C intake of the study subjects

6.1.39 Majority (70.3%) subjects were non vegetarian.

6.1.40 Iodized salt was used by 93.6% subjects.

6.1.41 67% subjects, exclusively used mustard oil as cooking oil.

6.1.42 In the family of majority (95.9%) subjects, sieved flour was used.

6.1.43 Three hundred eighteen (52.1%) subjects had frequency of meal thrice a day.

6.1.44 In case of 62.5% subjects timing of meal was irregular.

6.1.45 *Dal* and Rice were washed 1-3 times before cooking in the family of 81.5% and 95.1% subjects, respectively.

6.1.46 Use of water after final washing of *dal* and Rice were discarded in family of 65.7% and 61% subjects, respectively.

6.1.47 Green leafy vegetables were washed before and after cutting in the family of 17.4% and 53.1% subjects, respectively; in 29.5% cases mixed pattern were followed.

6.1.48 In all 53.1% subjects practiced fast; of these majority (79.5%) did so on yearly basis**.**

6.1.49 Rice, wheat, tubers, fats and oils and sugars were consumed by 98.2%, 99.5%, 98.5%, 99.5% and 79.7% subjects, respectively on regular basis.

6.1.50 In case of 80.7% subjects, consumption of green leafy vegetables (GLVs) was on irregular basis; only 19.1% subjects consumed GLVs regularly.

6.1.51 Nearly Half (52.6%) subjects consumed milk on regular basis.

6.1.52 Majority (96.4%) subjects consumed fruits on irregular basis.

6.1.53 Meat and egg were consumed by 74.1% subjects on irregular basis.

6.2 ENERGY BALANCE OF THE STUDY SUBJECTS:

6.2.1 Energy balance (EE-EI) was negative in 67.4% and PEB in 32.6% study subjects.

6.2.2 Average calorie intake of study subjects was 1657.81 (±461.91) Kcal/day.

6.2.3 None of the variables except socio-economic status were significantly associated with energy intake.

6.2.4 Post hoc test revealed that calorie intake of the upper SES (1567.21 ±479.08 Kcal/day) was not significantly different from those belonging to Upper middle class (1613.26 ±406.88 Kcal/day) and lower class (1557.10 ±488.63 Kcal/day). In comparison to these groups calorie intake was significantly more in subjects belonging to middle class (1765.57 ±442.72 Kcal/day).

6.2.5 Calorie intake of lower middle class (1742.58 ±427.16 Kcal/day) was significantly more than upper and lower class. Post Hoc test also revealed that calorie intake of middle class was significantly more than upper middle class.

6.2.6 The overall EE for study subjects was 1943.05 (±553.24) Kcal/day.

6.2.7 Energy expenditure of study subjects according to socio-demographic variables. Age, religion, caste, marital status of subjects, primary occupation of the subjects, maximum education in the family and main occupation of the head of the family were not significantly ($p>0.05$) associated with energy expenditure of study subjects.

6.2.8 Post hoc test revealed that average energy expenditure of subjects from nuclear family (2018.04 ±589.60 Kcal/day) was significantly ($p<0.001$) more than subjects from joint family (1854.64 Kcal/day ±505.55 Kcal/day).

6.2.9 EE of subjects from middle (1978.62 ±533.15 kcal/day), lower middle (2020.72 ±553.39 Kcal/day), and lower class were significantly ($p<0.001$) more than subjects

from upper (1603.82 ±87.37 Kcal/day) and upper middle (1739.28 ±469.30 Kcal/day), socio-economic status.

6.2.10 Post hoc test revealed that energy expenditure of illiterate subjects (1997.22 ±573.97 Kcal) was significantly more than those of subjects having educational status as middle (1833.38, ±479.47 Kcal/day) and graduate.

6.3. NUTRITIONAL STATUS OF STUDY SUBJECTS WITH SPECIAL REFERENCE TO CED:

6.3.1 The average weight, height, WC and HC of study subject was calculated 46.94 (±8.58) Kg, 148.35 (±6.47) cm, 66.11 (±8.91) cm, and 84.29 (±8.58) cm respectively.

6.3.2 The range for weight, height, WC and HC were 28-85 Kg, 123-167 cm, 46-106 cm and 28-124 cm respectively

6.3.3 Extent of CED was 19.67%. Over weight/ obese subjects were 26.56% (Asian criteria) and 16.07% (Global criteria).

6.3.4 There was significant association between WHR (cut off value 0.85) and BMI (cut off value 23). Out of 610, 63 (10.33%) subjects had WHR ≥0.85 and were characterized as obese/high risk for non communicable diseases (NCDs). Of these 30 (47.62%) and 33 (52.38%) were categorized as high (BMI ≥23kg/m^2) and non obese/low risk (BMI <23 kg/m^2) respectively.

6.3.5 Out of 547 subjects with WHR <0.85 (non obese/low risk), 415 (75.87%) and 135 (24.13%) were labeled as non obese/low and obese/high risk on the basis of BMI. Out of 162 subjects with BMI ≥23kg/m^2, 30 (18.52%) and 132 (81.48%) subjects were characterized as obese/high and non obese/low risk on the basis of WHR. Of 448 subjects having BMI <23 kg/m^2, 33 (7.37%) and 415 (92.63%) were characterized as obese/high and non obese/low risk on the basis of WHR.

6.3.6 Taking WHR as gold standard, maximum sensitivity and specificity was obtained at the cut off 22.3 kg/m^2 of BMI. The AUC was 0.73 (0.67-0.79) at 95% Confidence Interval (CI).

6.3.7 Problem of under nutrition and over nutrition exists simultaneously in the rural women of reproductive age group. Based on the ROC value, the WHO's cut off value of BMI (23kg/m^2) for detecting over weight/obesity be lowered to 22kg/m^2.

6.4 ASSOCIATION AMONG HOUSEHOLD FOOD SECURITY, EB & CED OF STUDY SUBJECTS:

6.4.1 Out of 182 subjects having household food security at high and marginal level 42.9% and 34.6% subjects had nutritional status as normal (BMI 18.5-22.9 kg/m^2) and overweight and obese (BMI ≥23 kg/m^2). Corresponding values for subject with very low food security were 60.4% and 21.1%. There existed significant association between nutritional status of study subjects and FS at household level (p<0.05).

6.4.2 Of 448 subjects having BMI <23kg/m^2, 261 (58.26%) subjects had very low food security at household level; corresponding value for subjects having BMI >23 was 43.2%.

6.4.3 There existed no significant association between energy balance and nutritional status of the study subjects (p>0.05). Of 199 subjects with PEB 30.7% were over weight and obese; corresponding value for 411 subjects with NEB was 24.6%. However, extent of CED was almost similar in both the groups

6.4.4 Of 411 subjects in NEB, 21.4%, 17.0% and 61.6% subjects had high/marginal, low and very low food security (VLFS) at household level respectively. Contrary to this out of 199 subjects with PEB 47.2%, 13.6% and 39.2% had high/marginal, low, very low food security, respectively. There existed significant association between EB of study subjects and food security at household level.

6.4.5 When this aspect was analyzed in different category of food security, it was observed that out of 182 subjects with high/marginal FS 48.4% subjects were in NEB; corresponding values in low and VLFS categories were72.2% and 76.4% respectively.

6.5 CORRELATES OF HOUSEHOLD FOOD SECURITY, EB AND CED:

6.5.1 As much as 70.2% SC and ST, 54.0% OBC and 31.1% subjects from other caste category had food security at household level as very low whereas 13.1%, 28.1%, and 57.5% subjects from respective caste categories had highly marginal food security (p<0.001).

6.5.2 In case of 46.5% from joint, 62.5% from nuclear and 33.3% subjects from 3 generation families had household food security as very low (p<0.001).

6.5.3 Socio-economic gradient prevailed for extent of food insecurity at household level (p<0.001). Very low food security prevailed for 93.7% lower, 54.3% lower middle and 4.53% subjects from middle socio-economic status respectively, whereas none from upper middle and upper SES belonged to this category.

6.5.4 Food security was highest in subjects having maximum (73.7%) education of the family as illiterate, whereas this was least in subjects with maximum education of the family above graduation.

6.5.5 Taking other caste as reference odds of food insecurity was significantly more in SC/ ST (AOR 2.80; CI: 1.05-7.49). Although AOR for OBC category (2.06), was not significant (CI: 0.95-4.45).

6.5.6 When the three generation family was taken as reference it was observed that odds of food insecurity was significantly more in subjects belonging to nuclear family (AOR 9.59; CI: 2.11-43.53). Even AOR was more for subjects from joint family (AOR 3.99), however this was not significantly different (CI 0.88-18.08).

6.5.7 In comparison to subjects having educational status as graduate and above, odds of food insecurity was significantly (p <0.01) more in illiterate subjects (AOR 3.97; CI: 1.51-10.44).

6.5.8 Odds of food insecurity were significantly (p<0.05) more in subjects having maximum education in the family as illiterate (AOR 4.39; CI: 1.04-18.52).

6.5.9 In comparison to main occupation of the family as farmer the risk of food insecurity was significantly (p<0.05) in subjects working as labourers (AOR 2.14; CI: 0.92-4.98).

6.5.10 Risk of food insecurity was maximum in subjects belonging to lower and lower middle (AOR 50; CI: 5.13-500) and this was least in upper class. The overall correct prediction of the model was 87.9% which is quite acceptable.

6.5.11 There was significant association between energy balance of study subjects and their age, educational status, SES, maximum education in the family and occupation of head of family.

6.5.12 Negative Energy Balance (NEB) was to the extent of 65.3%, 64.7% 76.8% and 56.8% in the age group of 15-24, 25-34, 35-44 and ≥45 years of age respectively.

6.5.13 This was maximum (73.8%) in illiterate and 58.5% subjects with educational status as graduate and above. As much as 69.4% lower, 81.9% lower middle and 72% middle SES subjects had NEB.

6.5.14 This NEB was less in contrary to the subjects belonging upper middle (23.2%) and Upper (27.3%) SES.

6.5.15 NEB was maximum (85.5%) in subjects having maximum education in family as illiterate; this was least in subjects with maximum education of family more than educated at graduate level.

6.5.16 Occupation of Head of family can exert significant influence on the energy balance of subjects considered in this study. This is also supported by the findings of present study as well. The extent of NEB was maximum (78.2%) in subjects with occupation of head of the family as farmer and least (57.3%) in subjects whose head of family were engaged in business.

6.5.17 Religion, caste, type of family, marital status and occupation of subjects were not significantly associated (p>0.05) with their energy balance.

6.5.18 Significant effect of age and educational status obtained in univariate analysis got eliminated in logistic model. Logistic analysis has revealed that taking maximum education in the family graduation as reference, AOR of NEB was 2.48 (CI 1.08-5.70) for subjects having maximum education in the family as illiterate.

6.5.19 When the occupation of the head of the family as skilled worker was taken as the reference, it was observed that AOR for NEB was 2.71 (CI 1.11- 6.62) for subjects whose head of the family were farmer. The overall percentage of correct classification by the logistic model was 75.2%.

6.5.20 Extent of CED and overweight and obesity was 26% and 15.1% in the age group of 15-24 years. Corresponding values in the age group of 35-44 Years were 15.9% and 33.8%. Extent of CED was 17.3% in the 25 to 34 years and 11.4% in ≥45 years of age group respectively. In the corresponding age group extent of overweight and obesity were 29.1% and 47.7%.

6.5.21 There existed significant association between nutritional status and age group of study subjects

6.5.22 Extent of CED was significantly more in Muslim subjects (31.8%) than in Hindu subjects (18.7%) whereas proportion of overweight and obese subjects were more than 20% in both age groups.

6.5.23 As much as 22.3% and 30.4% subjects belonged to joint family had CED and overweight/Obesity, respectively. Corresponding values were lower in subjects belonging to nuclear and three generation families.

6.5.24 As much as 30.2% unmarried and 16.5% married subjects were victim of CED, whereas none of the widow/separated subjects belonged to this category. Extent of overweight and obesity was 11.3% in unmarried, 31.7% in married and 40% in widow and separated subjects. Marital status of study subjects was significantly (p<0.001) associated with their nutritional status.

6.5.25 Educational status of study subjects was significantly associated with nutritional status there was no discernable trend. Overweight and obesity were highest in subjects having educational status graduate and above and this was least 18.6% in subjects having the same as high school.

6.5.26 Nutritional status of the study subjects was not significantly (p>0.05) associated with their caste and occupation.

6.5.27 Socio economic class gradient prevailed in the occurrence of overweight and obesity in the study subjects (<0.001). Maximum over weight and obesity was in upper SES (54.5%) and least in lower SES (19.4%).

6.5.28 There was no significant association between maximum education in the family and nutritional status of the subjects.

6.5.29 Main occupation of the family exerted significant (p<0.05) influence on the nutritional status of study subjects; extent of overweight & obesity was maximum (35.0%) in subjects having occupation of head of the family as service.

6.5.30 In order to pin point correlates of CED logistic analysis was applied; the comparison groups were CED vs. other groups. Taking three generation family as

reference, it was observed that the risk of CED was significantly more in subjects from joint families. (AOR 6.02; CI 1.27-33.3).

6.5.31 It further revealed that in comparison to subjects with educational status as up to graduation and above, subjects having educational status up to high school and up to intermediate had significantly higher risks for CED; AORs and CIs for corresponding categories were 2.33 (CI 1.01-5.38) and 4.03 (CI 1.47-11.05). The overall prediction was 80.8% which is quite acceptable.

Based on the findings of the study several conclusions have been drawn which served as the basis for several and research recommendations.

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