



## Food and nutritional security analysis of farm women in Siwalik region of North Western Himalayan Region

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### ABSTRACT

The multifaceted challenges concerning women's health in hills of Uttarakhand is associated with increasing malnutrition in the State, which ultimately affect the nutritional dividend of the nation. Sub-Himalayan range of the northern Indian subcontinent include regions where an overwhelming number of rural women have always been a part of the active work force in agriculture and allied sector. Present study is an attempt to document the nutritional status of farm women emphasizing their food consumption pattern, dietary intakes and diversification, energy and nutrient balance in Uttarakhand State in the year 2019–20. Collected field level data were analyzed with the help of suitable statistical techniques. It was found that 48 % women in foot hills and 40% women in mid hills had low dietary diversity. The findings also suggest that the prevalence of Chronic Energy Deficiency was high among farm women and energy balances in the respondents (from 171.97 kcal to 415.32 kcal) are corresponding to different grades of BMI. Multivariate regression analysis were employed to drive relationships between high dietary diversity ( $\geq 5$  food groups) and other independent variables as age, BMI, MUAC, CC, skinfold measurements, body density (D), % body fat, fat mass, fat free mass (kg). It was found that MDD-W is positively correlated with independent variables ( $R^2=0.702$ , Adjusted  $R^2=0.721$ , Standard Error of Estimate=0.0312).

**Keywords:** Chronic energy deficiency, Energy consumption pattern, Nutritional profiling, RDA, RDI

Siwalik Range or outer Himalayas are the sub-Himalayan range of the northern Indian subcontinent. It extends west-northwestward for more than 1000 miles (1600 km) wide in places, and has an average elevation of 3000 to 4000 feet (900 to 1200 m). Inter-mountain valleys of the region in Uttarakhand are also important elements of mountainous landscapes in the Himalaya that have developed in response to climatic fluctuations and neotectonics activities during the Quaternary period (Singh *et al.* 2001, Dutta *et al.* 2012). The region has a unique feature in respect to topography, climate and production system. The undulated topography, rugged terrain, unfavorable cold climate, lack of production and marketing infrastructure have made the area poorest in terms of production and productivity of the crops. Agriculture and rural economic activities are essential for growth, poverty reduction and food security among rural hill community. Women are regarded as the builder and moulder of the nutritional cycle of the

family (Duggal 2002). They are instrumental in ensuring nutritional security of the family. However, very often they suffer from malnutrition and are highly vulnerable to morbidity and mortality due to under-nutrition (Agnihotri 2003 and Shetty 2004).

Health status of rural women in hills of Uttarakhand is of serious concern. It is also reflected in infant mortality rate (40/1000 live births), maternal mortality rate (110/100000 live births) as per data of National Family Health Survey 4 although it is lower than NFHS-3 data. Women in Uttarakhand hills are more actively involved in hill agriculture and household activities. Due to more workload, they require high quality nutrients in more quantity, whereas women typically eats last and least in the family which results in under nutrition. More than half of all Indian women develop anaemia due to lack of essential nutrients. Forty-two percent of women in Uttarakhand have anaemia, including 31% with mild anaemia, 10% with moderate anaemia, and 1% with severe anaemia. Anaemia exceeds 40% for almost every group of women. It has been estimated that prevalence of clinical and sub clinical vitamin A deficiency in India is among the highest in the world.

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### MATERIALS AND METHODS

The present study was conducted on 100 farm women from foothills and mid hills of Siwalik range of Uttarakhand.

The subjects selected were in the age group of 18 to 45 years (excluding pregnant and lactating women) and actively engaged in farming activities. Those women who willingly cooperated to provide information required for the study were only included in the study. An attempt was made to assess the diet and nutrition profiling of women in foothills and mid hills of Siwalik range of Uttarakhand. Food intake during three non-consecutive days was investigated with nutritional assessment methods like 24-hr recall method, Minimum Dietary Diversity for Women (MDD-W) etc. The women were asked about the kind of meals, foods and beverages they had in the previous 24 hours, expressed in cooking units, which were then converted to grams (g). The nutrient composition was estimated with the software NutWin® 1.5, version 2002. Following nutritional profiling along with physical fitness index has been calculated as;

$$\text{VO}_2 \text{ Max (l/min)} = 0.023 \times \text{Body weight (kg)} - 0.034 \times \text{Age (yrs)} + 1.65;$$

$$\text{VO}_2 \text{ Max (ml/kg/min)} = \text{VO}_2 \text{ max (l/min)} / \text{Body weight (kg)} \times 1000;$$

TEE = REE  $\times$  AF (Activity Factor by PAL) Mifflin equation for TEE;

$$\text{REE} = 10 \times \text{Weight (kg)} + 6.25 \times \text{ht (cm)} - 5 \times \text{age} - 161;$$

$$\text{BMR} = 655.1 + 4.35 \times (\text{weight in lbs}) + (4.7 \times \text{height inches}) - 4.7 \times \text{age}$$

where, TEE, Total Energy Expenditure; BMR, Basal Metabolic Rate; REE, Resting Energy Expenditure

Dietary intake data for all subjects was collected for every subject on a week day to avoid bias and average food and nutrient intake was computed using food composition tables for Indian foods (Gopalan *et al.* 1996) and Indian Food Composition Table 2017 by National Institute of Nutrition. The percent nutrient intake was determined using the latest recommended dietary allowance as per Indian Council of Medical Research (ICMR 2020).

Skin-fold Thicknesses were measured with the following criteria and equation, viz.

$$\text{age (years) 17-19 equation } D = 1.1549 - (0.0678 \times L);$$

$$\text{age (years) 20-29 equation } D = 1.1599 - (0.0717 \times L);$$

$$\text{age (years) 30-39 equation } D = 1.1423 - (0.0632 \times L);$$

$$\text{age (years) 40-49 equation } D = 1.1333 - (0.0612 \times L).$$

where, D = Body Density, Skinfold sum = biceps + triceps + subscapular + Suprailiac. L =  $\log_{10}$  Skinfold sum [mm]; Percent Body Fat =  $(495/\text{Body Density}) - 450$ ; Fat Mass (kg) =  $\text{Body weight (kg)} \times (4.95/D - 4.5)$ ; Fat Free Mass (kg) =  $\text{Body weight (kg)} - \text{Fat mass (kg)}$ .

Collected data was analyzed with the help of suitable statistical techniques, viz percentage, arithmetic mean, standard deviation and two samples 't' test. Coefficient of correlation was computed by Karl Pearson's formula to determine the nature of relationship between independent variables and nutritional status of farm women.

## RESULTS AND DISCUSSION

*Physiological characteristics:* Physiological characteristics of subject from foothills region were analyzed by using different parameters. Subjects were with mean age

of  $30.31 \pm 7.89$  years, having mean height of  $153.67 \pm 9.25$  cm, mean weight  $49.67 \pm 12.63$  kg, bicep  $5.79 \pm 1.39$  mm, tricep  $7.83 \pm 1.35$  mm, subscapular SFT  $11.51 \pm 1.82$  mm, suprailiac SFT  $10.74 \pm 2.21$  mm, Body Density (D)  $1.039 \pm 0.012$ , percent Body Fat  $24.81 \pm 1.49$ , Fat mass  $10.29 \pm 2.14$  Fat free mass  $32.05 \pm 3.21$  kg and BMI,  $\text{kg/m}^2$  reported  $18.2 \pm 3.51$ . As per NHFS-4 (2016) survey of Uttarakhand 20.0 per cent of rural women had Body Mass Index (BMI) below normal ( $\text{BMI} < 18.5 \text{ kg/m}^2$ ). In mid hills of Siwalik region (Uttarakhand) also women were found to have low BMI  $17.92 \pm 5.21$  which is in line with NHFS-4, 2016 data.

*Minimum Dietary Diversity-Women:* Data on dietary diversity among subjects was computed as intake of different food stuffs per day by number of respondents. The Dietary Diversity Score (DDS) was calculated as the number of different food groups consumed by the women the day before survey out of the list of 10 Food Groups recommended for the calculation of the MDD-W (Leroy *et al.* 2015). The total number of food groups consumed is summed and all foods are equally weighted. The population-level indicator is calculated.

It was evident from data (Table 1) that 48% and 40% women had low dietary diversity in foothills and in Mid-hills respectively. Mallikharjuna *et al.* (2010) also stated that low intake of all food groups except other vegetables, roots and tubers; micronutrient deficiency prevalent were Fe, Vitamin A and free folate in their subjects. Overall food dietary diversity indicates that the varieties of foods consumed were very limited and subjects depended mostly on locally grown produce.

*Food and nutrient intake:* Women of reproductive age living in hills are at high risk of inadequate micronutrient intakes as their diets lack diversity and are dominated by staple foods. A well balanced diet is required for adequate amounts of protein, fat, carbohydrates, vitamins, and minerals. Meat, fish, eggs, and milk, as well as pulses and nuts, are rich in protein (Sharma *et al.* 2016). The information pertaining to the food consumption pattern of the farm women has been given in Table 1. Food consumption by the women farmers, in both the zones of Siwalik range was quite low as compared to recommended dietary intake. Intake of cereals, pulses, green leafy vegetables, milk and milk products and fruits were less than Recommended Dietary Intake (RDI) in both the regions.

The energy balance of the respondents on the basis of presumptive diagnosis of different grades of Chronic Energy Deficiency and BMI status with respect to RDA by ICMR (2010) in terms of energy intake by average consumption of foods and energy expenditure by Mifflin equation and BMR were reported. Body Mass Index (BMI) of the respondents was computed using height and weight values and subjects were classified into various categories of Chronic Energy Deficiency (James *et al.* 1988). The findings reveal that the prevalence of Chronic Energy Deficiency was high among farm women. However, no woman was found overweight. It was observed from data that energy balances in the respondents (from 171.97 kcal to 415.32 kcal) are

Table 1 Physiological characteristics, nutritional anthropometry and average consumption of various food items (g/day) of the Subject (n<sub>1</sub>=50, n<sub>2</sub>=50)

Physiological characteristics and nutritional anthropometry													
	Age (Years)	Weight (kg)	Height (cm)	Bicep (mm)	Tricep (mm)	Subscapular SFT (mm)	Suprailiac SFT (mm)	Body Density (D)	% Body Fat	Fat mass	Fat free mass (kg)	BMI, (kg/m <sup>2</sup> )	
Foothills Mean± SD	30.31 ± 7.89	49.67 ± 12.63	153.67 ± 9.25	5.79 ± 1.39	7.83 ± 1.35	11.51 ± 1.82	10.74 ± 2.21	1.039 ± 0.012	24.81 ± 1.49	10.29 ± 2.14	32.05 ± 3.21	18.2 ± 3.51	
Mid-hills Mean± SD	32.52 ± 8.27	47.52 ± 3.89	156.21 ± 7.54	5.03 ± 1.12	7.01 ± 1.08	10.91 ± 1.01	10.02 ± 1.23	1.031 ± 0.001	23.43 ± 1.52	9.51 ± 1.74	29.41 ± 1.68	17.92 ± 5.21	
<i>Average consumption of various food items (g/day) with RDI</i>													
	Cereals and millets (g)	Pulses (g)	Green leafy vegetables (g)	Other vegetables (g)	Roots and tubers (g)	Milk and milk products (g)	Fruits (g)	Fats and oils (g)	Sugar and jaggery (g)	Low dietary diversity <5 group (%)	High dietary diversity ≥5 group (%)		
RDI	350	60	125	75	75	200	30	35	30				
Average consumption Mean± SD (Foothills)	368 ±2.54*	40.26 ±3.24**	98.56 ± 2.32**	68.62 ± 7.23*	95.50 ± 0.12 NS	150 ± 6.81*	27.56 ± 5.89**	30 ± 0.35NS	35.26 ± 3.21NS	48.0	52.0		
't' value (P-value)	3.26* (.001)	3.45** (.003)	1.32** (.09)	1.35** (.008)	2.56** (.003)	1.29** (.008)	3.62* (.012)	3.51* (.008)	4.56* (.008)				
Average consumption Mean± SD (Midhills)	367 ±3.65*	38.20 ±2.45**	100.05 ± 5.23**	65.82 ±5.62**	98.56 ± 5.26NS	165 ± 5.35NS	25.5 ± 4.56*	29.5 ± 2.15NS	32.5 ± 2.15NS	40.0	60		
't' value (P-value)	3.65** (.0003)	4.21* (.0001)	1.58NS (.044)	4.12NS (.051)	2.36* (.003)	1.32** (.0001)	4.52* (.004)	3.67* (.0081)	2.22NS (.061)				

Source: RDI (Recommended Dietary Intake), NIN , Hyderabad

Table 2 Determinants of nutritional profiling and anthropometric measurements in MDD-W among rural women

Variable	Low dietary diversity <5 group	High dietary diversity $\geq 5$ group	Correlation and regression analysis of physiological characteristics and high dietary diversity			
			Correlation coefficient (r)	Estimate (B)	Standard error	Significance (P)
Intercept	-	-	-	0.087	1.351	0.0231
Age, Years	31.26 $\pm$ 5.35	30.54 $\pm$ 7.52	0.21236	1.235	0.043	0.0026*
BMI	19.56 $\pm$ 4.14	20.5 $\pm$ 5.66	0.31256	1.124	1.311	0.0026**
MUAC	18.24 $\pm$ 7.52	21.71 $\pm$ 3.87	0.002354	0.354	0.847	0.3214**
CC	21.23 $\pm$ 3.12	24.89 $\pm$ 4.15	0.03152	1.121	0.325	0.1546 **
Bicep (mm)	4.59 $\pm$ 3.55	5.68 $\pm$ 2.65	0.004247	0.324	0.235	0.2335
Tricep (mm)	6.98 $\pm$ 2.56	7.52 $\pm$ 3.94	0.10063	0.751	0.524	0.0463*
Subscapular SFT (mm)	10.52 $\pm$ 3.62	11.02 $\pm$ 4.53	0.03458	0.641	0.124	0.0121*
Suprailiac SFT (mm)	9.89 $\pm$ 2.52	10.09 $\pm$ 3.64	0.12138	0.184	1.002	0.005 NS
Body density (D)	1.003 $\pm$ 0.074	1.033 $\pm$ 0.013	0.32145	0.145	0.457	0.0263**
% body fat	21.42 $\pm$ 2.34	22.12 $\pm$ 3.87	0.26345	1.021	0.312	0.0078**
Fat mass	9.95 $\pm$ 3.28	10.13 $\pm$ 6.11	0.23141	1.005	0.214	0.3145**
Fat free mass (kg)	31.92 $\pm$ 3.56	32.22 $\pm$ 3.12	0.00258	0.945	0.221	0.1236**
TEE	1712.21 $\pm$ 4.25	1703.23 $\pm$ 1.2	0.00547	0.127	0.984	0.2457**
BMR	1702.35	1625.15	0.0524	0.287	0.623	0.0857**

\* Significant at 5% level, \*\* Significant at 1% level. R, 0.714; R<sup>2</sup>, 0.702; Adjusted R<sup>2</sup>, 0.721; Standard Error of Estimate, 0.0312.

corresponding to different grades of BMI. As the BMI of the subjects is towards normal the energy retention is more which is having an important role in many bio-chemical, biophysical and physiological processes in the body.

According to NNMB (2002) intake of protein, energy, vitamin A and riboflavin was less than the Recommended Dietary Allowances (RDA) in almost all States. Protein plays an important role in many bio-chemical, biophysical and physiological processes in the body. Several studies have also reported deficient intake of calories and protein among populations relative to the Indian RDA, which may be an explanation for the high rates of stunting among this group (Agte *et al.* 2005, Mittal and Srivastava 2006).

Data (Table 2) presents the determinants of nutritional profiling and anthropometric measurements in MDD-W among rural women and correlation and regression of selected physiological characteristics of subjects and dietary diversity. Further relationship between High dietary diversity  $\geq 5$  group and other independent variables as Age, BMI, MUAC, CC, Bicep (mm), Tricep (mm), Subscapular SFT (mm), Suprailiac SFT (mm), Body Density (D), % Body Fat, Fat mass, Fat free mass (kg) were also analyzed and it was found that MDD-W is positively correlated with variables.

The results of the present study confirmed the importance of dietary diversity specific to women in both the foothills and Mid-hills of the Siwalik region of NWHR. Fight against maternal malnutrition and assurance of nutritional security needs interventions specific to nutrient rich varieties, awareness for nutritional security, access and availability of good quality food of all food groups. Rural hill women were particularly vulnerable to under nutrition due to lack

of measures and energy deficiency due to hardship pertained by them. It is important to ensure balanced nutritional diet encompassing maximum available food groups adequate in micro and macro nutrients.

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