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Impact of Nutrition Intervention on Health Indices of Undernourished Punjabi Women: A Cross Sectional Study

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Abstract:- The objective of this study was to determine changes in the health indices of undernourished (BMI<18.5 kg/m^2), anemic, adult women (18-50 years) after receiving a nutrition intervention for 120 days. For this purpose a highly nutritious, cost effective, easy to prepare, ready-to-cook food product i.e. Nutrient Dense Ingredient Mix (NDIM) was formulated. The developed mix was found to be energy dense as 100g of cooked NDIM provided 437.4 Kcal of energy, 13.58g protein and 3.62mg of iron.The experimental group was supplemented with NDIM daily for 120 days along with effective nutrition education on a fortnightly basis whereas the subjects form the control group received no supplementation or nutrition education. Data regarding the dietary intake, anthropometric measurements and hemoglobin levels of subjects was collected before and after the intervention. To assess the effectiveness of the nutrition education imparted to the experimental group and its difference from that of the control group, pre and post assessment of Knowledge, Attitude and Practice i.e. KAP score was used as an evaluation tool. A comparative analysis of nutritional profile and knowledge of subjects from both the groups revealed that the nutrition intervention caused a significant improvement in the nutritional profile of the experimental group.

Word count: 8361

Keywords:- *Nutrient dense ingredient mix, Ready-to-cook, Malnutrition, Undernourished women, Anemia.*

I. INTRODUCTION

India is witnessing an amusing yet sad scenario of dual burden, where the upper economic strata is falling prey to obesity and the low income group is still undernourished due to many disparities. India's jaw dropping rank of 101 out of 116 countries in the Global Hunger Index (GHI 2021), indicates the severity of undernourishment in the country. The undernourished segment of the population, if not ministered aptly, may cause a disturbed mortality scenario mainly in context with the women (women of child bearing age and pregnant women) and children. National Family Health Survey (NFHS-5 2020-21), states that, 18.7 per cent of women, 32.1 per cent of children and 16.2 per cent of men (age 15-49 years) in India are undernourished having Body Mass Index (BMI) <18.5 kg/m^2. Evidences indicate that in developing countries, malnourished women show a consistent increase in mortality rates as well as increased risk of illness (Ramesh 2004). Undernutrition can be defined as the inability to absorb appropriate amount of protein, micronutrients and energy to meet the elementary needs of body for proper growth, development and maintenance. Malnutrition, currently, is a big issue on global front, and is inevitably linked with poverty (Rouse 2003). The consequences of poor nutrition lead to chronic, intergenerational and permanent deficiencies. The consequences of deficient fetal growth and/or stunting and the consequent cognitive-social disability in the initial years of childhood, persist in the adulthood also. Facts confirm that 'Poverty Nutrition Trap' does prevail in India (Jha et al 2011). It has been substantiated by data that the progress of a country can be hindered due to undernourishment of mother and child and adult short stature, decrease in rate of school attendees and reduced economic prospects. Congregation of malnutrition has been documented in the geographical regions where rate of women education is low, meager income, female BMI status was found to be less than average (Khan and Mohanty 2018).Strong and healthy children develop into healthy grown-ups, who have strength and contribute towards the productivity, thus, considered as a resource for the country (Narang 2016). The principal objective of nutritional intervention policies, basically, is to enhance and maintain the health of every single person, thus hampering the intergenerational poverty circle. In an attempt to achieve this target, the two fundamental types of direct interventions incorporate enhanced nutritional status of women (especially before and during pregnancy) along with improvement in the nourishment levels of new born children. Deteriorating nutritional status of Indian women is directly reflected by the insufficient diets, poor hygienic conditions, deficient health care services and social and gender based discrimination. These factors in turn affect the anthropometrics of children.

Punjab is amongst the most prosperous states of the country, producing abundant food, therefore, no issues regarding lack of 'availability' of food security should be expected. Unfortunately, Punjab holds a share of total 12.7 per cent of undernourished women, out of which 11.9 per cent belong to the urban areas whereas 13.1 per cent belong to the

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rural locality (NFHS-5 2020-21). Prevalence of high rates of undernourishment can be attributed to the lack of macro as well as micro nutrients out of which energy and iron deficiency fall under the main light.

Although Punjab is ahead of Kerala with regards to per capita net state domestic product, but falls behind as far as, the issues of maternal mortality ratio, infant mortality rate, under 5 mortality rate and neonatal mortality rate are concerned. Among Punjabi women (15-49 years of age) prevalence of anemia has gone up from 53.5 per cent (NFHS-4 2015-16) to 58.7 per cent and this percentage included 58.5 per cent rural and 59.0 per cent urban women (NFHS-5 2020-21). Iron and folic deficiency can cause impaired cognitive performance and behavioral and motor development, decreased immunity and increase in morbidity. Incidentally, anaemia is not caused only due to deficient intake or absorption, but unhygienic environmental conditions (infestation of hookworms) also, especially in the villages. Gender inequality in providing nutritional food and over emphasis on consumption of dairy products, specially, milk, which leads to deficiency of nutrients like iron and even Vitamin C (Bhatia 2013).

It is universal that mothers with good educational background are indeed better informed of the available health services along with their effective utilization. Various studies prove that decrease in malnutrition is directly proportional to the literacy level of the mother (Murarkar et al 2020). Illiteracy and ignorance in women, insufficient decision making power, inferior status in society can be considered as a few of the important underlying attributes which lead to bad maternal health and malnutritional conditions.

Nutrition awareness and education program are very much required to combat the prevalent issues of under as well as overnutrition in the women who are in the reproductive age group because according to a study despite the fact that average macronutrient consumption are less than the approximated RDAs, a large number of subjects are in the extreme status of extreme levels on the macro nutrients scales. Great disparity in the consumption of macronutrients in this age group of women has been observed. Henceforth, it is imperative that awareness and educational initiatives are being taken, especially, aimed and focused at bringing down the issues of malnutrition of this age group (Khanam et al 2016). Therefore, apart from the physical health factors related to food and nutrition, the nutritional health of a woman and her education is a formidable pointer of the nutritional guarantee of her progenies as well as food security of her household (Weerasekara et al 2020). Education is important to create awareness among the public so as to modify the practice and behaviour (Edith and Priya 2016). To attain desired alternates in behaviour regarding the nutrition and health, actually are dependent on acquiring appropriate understanding, self- efficacy, best approach and attitude (Shariff et al 2008). Education of nutrition is actually, an intervention that addresses undernourishment by initiation of behavioral change (Øvrebø, 2014). This behavioural change attained via nutrition education includes changes with regards to consumption of healthy food along with effective nutrition-related practices (Nguyen et al 2013). Knowledge related to nutrition and attitude puts an individual in a diet pattern which is healthier, thus, nutrition and diet-related Knowledge, Attitude and Practice (KAP) is an important factor for attaining food and nutritional security for every household (Weerasekara et al 2020). In 1950's KAP (Knowledge, Attitudes and Practices) studies surfaced effectively due to the requirement to measure opposition to family planning services (Cleland 1973). Observing the outcomes from the past studies, KAP scores are thus being used effectively in family planning and population studies so as to assess as well as direct the prevailing programmes with their use being extended to the fields of health, nutrition as well as food (Chen et al 2012). KAP studies related to nutrition evaluate and examine people's KAP score with regards to food, diet, nutrition along with closely related issues of health and hygiene (Goh *et al* 2016).

KAP score has been proven to be a powerful tool to access current knowledge about a particular group, attitude, practice in context with certain topics to know their requirements, issues and possible problems, before developing and applying the intervention study (Hiew et al 2015). Interestingly, KAP surveys showed improvement in mother's knowledge of nutrition (Murty et al 2016). Weerasekara et al (2020) reported that the BMI status of women along with their household food security is greatly affected by their awareness, prespective and practices towards nutrition. Therefore, it is of utmost importance that women must be made aware about topics related to health promotions, thus, promoting healthy eating practices and acquire a reasonable nutritional status , where, the focus is on quality of diet along with body mass index (BMI) (Moos et al 2008). Recent evidences indicate that while designing health intervention programs, our focus should be on examining the extensive spectrum of socio-cultural and economic aspects along with importance of engaging the members of the family to improve the health of the women of reproductive age (Mwangome et al 2010).

Although the government is actively providing adolescent girls, pregnant and lactating women with iron, folic acid and other required micronutrient supplements, but there is a dire need to provide these nutrients through their natural sources i.e. through the diet. If the daily requirement of nutrients is not being fulfilled by the meals then a wise way for the provision of the basic nutrients should be fabricated. Taking into account the various conditions like economic status, physiological status, food availability and accessibility, a judicious way would be supplementation through pre-cooked mixtures which are cost effective, nutritious, locally available and shelf stable. According to the need of the hour such ready-to-use precooked mixtures provide a very practical and congenial solution to the problem of malnutrition. Women with varying physiological needs, occupation and especially those belonging to the low socio economic background, who have a meager access to energy and nutrient dense foods, should be provided with such novel foods, if not the provision then at least they must be educated about the ways these foods can be consumed on a household level.

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These days the food market is flooded with nutritious, cost effective variants of convenience foods. They can either be consumed directly or may require minimal cooking efforts and thus have been proven to be a boon to the working class saving their time whilst providing health and nutrition. These variants may be termed as Ready-to-use/ Ready-to-eat/ Ready-to-cook/ Ready-to-serve etc. depending upon their nature and time required for consumption. These products are processed or prepared with very little efforts as compared to the tedious conventional cooking methods. The demand for ready to cook foods are increasing due to a number of factors involved such as its easy availability, cultural acceptability, nutrition and minimal processing requirement, urbanization of domestic labor, dearth of time, increased buying capacity etc. RTC foods have emerged as an excellent alternative to a complete home-cooked meal or may be an addition to the daily diet. Its consumption trends are hiking due to an increase in working women population (Sathiyabamavathy and Sekhar 2020). Development of ready to cook/eat food products for supplementary feeding programmes along with nutritional education can be imparted to the vulnerable section of society so as to improve the well- being of under-nourished individuals. Nutrition education programmes including techniques such as the KAP score method, should be introduced to the working class of rural women as they are more vulnerable and susceptible to deficiencies ultimately leading them into the clutches of undernourishment.

II. MATERIAL AND METHODS

A. *Standardization of mixture*

After intense research and cogitation various permutation and combinations of ingredients with different treatments were carried at a preliminary scale for variants of Nutrient Dense Ingredient Mix (NDIM) to be selected for organoleptic evaluation by panelists. The ingredients of NDIM i.e. cereal (semolina (*suji*)), pulse (whole green gram (*moong dal*)), millet (pearl millet (*bajra*)), green leafy vegetable (fenugreek leaves (dried)), oilseed (peanuts), spices and condiments were carefully balanced for the final composition of the mix (Table 1).

B. *Nutrition intervention*

- ***Selection of subjects*:** A total of 295 adult women (aged 18-50 years) were screened from two villages namely Khwaja Vaju and Rarhe da agwar from tehsil Jagraon of Ludhiana district, out of which 60 anaemic (Hb <12mg/dl) women having Body Mass Index (BMI) less than 18.5 kg/m^2 were selected and were divided into two groups (control and experimental) of 30 subjects each. The experimental group was supplemented with NDIM daily for 120 days along with effective nutrition education on a fortnightly basis whereas the subjects form the control group received no supplementation or nutrition education. The research was permitted by Ethical Committee of Punjab Agricultural University, Ludhiana (No. DR-8323-32-19-4-19) and a well informed written consent of the subjects was taken for the same.
- ***Standardization of dose*:** The dose of NDIM to be supplemented was standardized after determining the energy and iron gap in adult women with the help of analysis of prevailing literature (of last 20 years).
- ***Development of questionnaire and interview schedule:*** A questionnaire cum interview schedule was developed for the selected subjects to educe data regarding their general information, economic status, food habits, food consumption patterns, daily dietary intake, anthropometric measurements, physical activity level and KAP test etc.

C. *Data collection*

- ***General information:*** General information of the subjects such as age, marital status, type of family, education, land holding, total monthly income, occupation, no. of meals, food habits, family income etc. was collected by interview method.

D. *Supplementation of NDIM*

Quantity of the mixture (NDIM) to be supplemented was standardized in accordance with the gap prevalent between the daily intake and requirements (ICMR 2020) of energy and iron amongst adult women. The gap was determined after a thorough analysis of the prevailing literature (almost for the last 20 years) for the difference between daily intake and requirements of nutrients of women (with special reference to Punjab) in terms of energy, protein and iron. Precooked dry mixture (100g) was provided in polyethylene zip lock pouches along with *ghee* and dried fenugreek leaves packed in separate small polyethylene zip lock pouches which was ready-to-cook and consume. Subjects were instructed to cook the mixture (with addition of salt according to taste) and consume the whole serving as a snack at any time of the day without substituting it for a meal. To ensure the daily intake of supplement, an incessant contact was established with the subjects like through persistent phone calls, social media (whatsapp group), home visits, collective group eating etc. After the consumption of NDIM for 120 days along with regular nutrition education, nutritional status of experimental group before and after the feeding trial was compared with that of the control group to evaluate any significant difference in the nutritional parameters by the subjects in the experimental group. The efficacy of the supplemented mixture was further evaluated by applying statistical analysis to the data.

E. *Pre and Post supplementation assessment*

Measurements included height, weight, mid-upper arm circumference (MUAC), waist and hip circumference according to the methods of Jelliffe (1966). Waist/Hip ratio and Body Mass Index (BMI) were derived from the same. Blood was drawn with all aseptic precautions and haemoglobin level was estimated by cyanomeath haemoglobin method Dacie and Lewis methos (1975). Dietary intake of subjects was recorded by '24 Hour Recall Method' for three consecutive days to assess the nutrient intake of the subjects. Data was collected for the amount of cooked food consumed by each subject for each meal along with their respective time of consumption. The software 'Diet Cal' (Kaur 2014) was used to assess and calculate the daily intake if macro and micro nutrients. The daily nutrient intake was compared with the Recommended Dietary Allowances (RDA) given by ICMR (2020) to evaluate the adequacy of nutrients in diet.

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F. Nutrition education

Nutrition education was imparted to subjects under the experimental group on a fortnightly basis for a period of 120 days. The subjects were familiarized with the concept of malnutrition, undernutrition, sustainable physical and mental wellbeing etc. Education was imparted regarding multiple topics including importance of exclusive breast feeding, colostrum, weaning foods, green vegetables, local and seasonal food items, maintenance of personal hygiene, symptoms and cure for anemia, protein energy malnutrition (PEM) etc. Information was imparted regarding relevant content using posters, power point slides, interactive sessions and fun games.

G. Knowledge, Attitude and Practice (KAP) Score

To assess the effectiveness of the nutrition education imparted to the experimental group and its difference from that of the control group, pre and post assessment of Knowledge, Attitude and Practice i.e. KAP score was used as an evaluation tool. KAP based questionnaire (Marías and Glasauer, 2014) on attitude and practice related to malnutrition, anemia and food hygiene were used to identify the level of right attitude, knowledge and practice towards health.

KAP proficiency was tested with 30 multiple-choice questions divided into three parts comprising of knowledge (10 questions), attitude (10 questions), and practice (10 questions). Questions in the knowledge section were regarding general dietary health and anemia. Answers to the knowledge part were either "yes" or "no" and each right answer ensured 1 mark to the subject. Similarly, in order to check their attitudes and awareness towards good dietary practices and if they were concerned about what they were eating, multiple choice questions were included which again bagged 1 mark for each correct answer. This section consisted of questions more inclined towards their awareness regarding the nutrient composition of the daily diets they consumed. Part three in the KAP questionnaire was a practice part containing "yes" or "no" questions with 1 mark for each correct practice followed with regard to certain dietary and food hygiene practices. Mean scores for each section including the responses from both groups, before and after the intervention were then analysed.

H. Statistical analysis

The collected data were analyzed using appropriate statistical tools including SPSS software. Mean and standard deviation values for different parameters were computed in triplicates for calculations. Paired t-test was employed to assess the efficacy of supplementation on the nutritional status of selected subjects in the experimental as well as the control groups ($p<0.05$, $p<0.01$).

III. RESULTS AND DISCUSSION

Table 2 depicts a conclusive collection of the prevailing literature (from the year 2000 till 2020) with regard to the prevalence of nutrient deficiencies among women (in terms of energy, protein and iron intake).The dose of NDIM to be supplemented was standardized after determining the gap from this data. The age group of women studied in the enlisted researches included a wide range from 13 to 80 years, the approximate average being 20-48 years as was that of our subjects too. As per the comparison between the mean energy, protein and iron intakes with their respective Recommended Dietary Intakes (RDI) of that year, mean gap prevailing over the years was obtained. Results deduced from the analysis indicated that the mean energy intake of the subjects over a period of 20 years was 1722.79±292.46 Kcal (Mean ± SD) whereas the mean of the RDA was 2065.34±166.48 Kcal. Information after a comprehensive analysis revealed that an approximate gap of 342.55 Kcal of energy existed over the years. The difference between recommended protein and its intake was 7.23g per day with a per cent adequacy of 84.9 per cent. The statistics also revealed a whooping gap of 12.95mg of iron intake, with the per cent adequacy of 47 per cent which was a clear reason for the high prevalence of anemia among Indian women. Based on this data 100 g of NDIM was supplemented as an attempt to fulfil the prevailing gap for energy and iron among the undernourished subjects.

A. General information

General information about the 60 subjects has been presented in the Table 3. For the collection of data regarding the age of the subjects, range for the age was divided into three groups i.e. 18-30, 31-40 and 41-50 years. Majority of the subjects i.e. 56.7 per cent belonged to the 18-30 years category. Twenty one subjects were 31-40 years old accounting to 35 per cent of the total subjects whereas only 5 of them were over 41 years of age. This data depicted that maximum number of the subjects were young adults with the mean age being 30.38 years. Marital status of the subjects depicted that majority of them were married i.e. 81.7 per cent whereas 18.3 per cent were unmarried. Maximum number of subjects (40) belonged to nuclear families whereas 33.3 per cent were residing in joint families. Classification of education showed that majority of the subjects i.e. 32 per cent attained middle school education whereas 35 per cent of the women were found illiterate, very few of them (6.7%) pursued higher education, clearly indicating the low level of formal education received which in turn drops a hint of their poor knowledge of health and nutrition, thus rendering them undernourished. Monthly income data revealed that majority of the subjects belonged to the low socio-economic group as 46.7 per cent of them had an income ranging from Rs.10,000-20,000. The total monthly income below Rs. 10,000 was among 6.7 per cent of the subjects, whereas only 8.3 per cent of them had a family income above Rs, 50,000. The average monthly family income of the subjects was Rs. 22016.67. Furthermore, in the present study, fifty five per cent of the subjects had a marginal land holding (less than 1 hectare) whereas 45 per cent of the women were totally landless. Most of the subjects were formally working i.e. 65 per cent of them had jobs like that of a school attendant, sweeper, household maid, cook, tailor etc. whereas 35 per cent were non-working but were performing most of the household chores by themselves. Majority of them were vegetarians (61.7%) whereas 38.3 per cent of them followed a non-vegetarian diet regime. Results of the number of meals consumed per day revealed that 76.7 per cent of them preferred 3 meals per day and 23.3 per cent were having only 2 meals per day.

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B. Anthropometric measurements

Anthropometric measurements including height (cm), weight (kg), waist circumference (cm), hip circumference (cm) and mid-upper arm circumference (cm) of the subjects were taken before and after the intervention. Table 4 shows a comparison of the anthropometric measurements of subjects from both the groups i.e. control and experimental groups.

Average height of the subjects remained unchanged in both control and experimental group i.e. 160.1 and 160.7 cm, respectively before and after the intervention. The corresponding values for the before and after, body weight of the control group were 45.60 and 45.67 kg respectively. On the other hand, a significant ($p<0.05$) weight increase was observed in the experimental group after the intervention of 120 days i.e. from 45.88 to 48.16kg. There was a non-significant difference in the waist circumference of control group whereas the experimental group exhibited a significant gain over the period of the time. On the contrary no significant gain in the hip circumference was observed in both the groups which resulted in a non-significant waist-to-hip ratio (W/H ratio) of all the subjects. The mean mid-upper arm circumference (MUAC) of the control participants was 22.4 cm whereas that of the experimental subjects turned out to be 22.5 cm after the intervention.

C. Biochemical assessment

Biochemical assessment was conducted by estimating the hemoglobin levels of the subjects in both groups before and after the intervention. Results (Table 4) revealed that a mild increase in the hemoglobin (HB) levels of the control subjects was observed i.e. from 8.28 to 8.39 g/dl which was statistically non-significant but significant ($p<0.01$) rise in the Hb levels of the experimental group was observed.

D. Nutrient intake of the subjects

a) Macronutrients

The results (Table 5) on the macronutrient intake revealed that the average daily intake of energy by the control group before and after the intervention was 1234 Kcal and 1312 Kcal respectively which showed a non-significant rise. On the other hand a significant increase in the energy intake was observed among the subjects of the experimental group i.e. from 1350 Kcal to 1711 Kcal per day and the per cent adequacy (Fig 1) after intervention turned out to be 80.2 per cent. The protein intake of experimental subjects significantly increased from 36.87 to 47.87g**.** A non-significant increase in the fat intake was observed in the control group whereas on the contrary the per cent adequacy of the experimental group reached 198.64 per cent after the intervention.

b) Micronutrients

In case of the control group no significant increase was observed after the intervention with regard to vitamin A. While on the other hand, vitamin A content of the diet increased to a considerable amount (1587.76 µg) for the experimental group being more than the RDA (840µg) for the same. The average calcium and iron intake of the control group post intervention was found to be 467.12mg and13.22mg. In comparison to the control group, experimental group exhibited a significant increase in the calcium and iron intake in their daily diets. However, a non- significant increase was observed in case of folic acid intake of both the groups.

c) Nutrition education

Owing to the importance of nutrition education, it was imparted to subjects in the experimental group on a fortnightly basis for a period of four months.

d) Knowledge, Attitude and Practice (KAP) Score

The results (Table 6) of KAP assessment revealed that though there was an increase in the mean knowledge, attitude and practices of the subjects in the control group but it was non-significant. Whereas in case of the experimental group a positive impact was observed as the score for all the three parameters improved significantly ($p<0.01$).

The maximum score was attained in the category of practices i.e. 7.93, the effect of which was clearly visible in the day-to-day behavior and lifestyle of the subjects with regard to improved dietary and hygiene practices.

IV. DISCUSSION

A. General information

In a study conducted by Mastiholi et al (2018) on rural women in Karnataka, it was reported that a majority of the participants (64.8%) belonged to the low socio-economic group and significant associations were found between socio-economic status and anaemia as severity of anaemia was greater among the women from lower low socio-economic status. Moreover, evidences from the past studies prove that subjects living in poorer households are more likely to be underweight than those living in the higher socio-economic strata of the society (Griffiths and Bentley 2001).

B. Anthropometric measurements

Table 4 depicts a comparison of the anthropometric measurements (height, weight, waist circumference, hip circumference and mid-upper arm circumference) of subjects from both the groups i.e. control and experimental groups, before and after intervention.

A significant ($p<0.05$) weight gain was observed in the experimental group after the intervention of 120 days but still the mean body weight of subjects i.e. 48.16 kg, was far less than the reference value of 55 kg given by ICMR (2020). The BMI thus reflected the expected outcome i.e. a non-significant difference in the control group but a statistically significant ($p<0.05$) weight gain (from 17.54 to 18.45kg/m^2) in the experimental group. This improvement can be credited to the regular consumption of the NDIM which provided 437.4Kcal and 17.56g fat per 100g along with the effective nutritional education. Though there was a gradual increase in the BMI of the experimental subjects but it was still under the category of undernourished segment only. The gain in weight observed in both can be attributed to the reported increased intake of energy dense traditional foods consumed during winters. These foods are considered to be rich in calories, fat,

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protein and iron. Significance of the same is discussed later under the 'nutrient intake' segment. However, Monika et al (2017) reported 55.4 kg as the mean weight of girls under study from Rajasthan whereas Ranjit et al (2015) reported the average weight of 56 kg among 18-22 years old college girls from Punjab. A non-significant difference in the waist circumference of control group was observed whereas the experimental group exhibited a significant gain. But no significant increase in the hip circumference was observed in either of the groups which resulted in a non-significant waist-to-hip ratio (W/H ratio) of all the subjects. As a matter of fact the ideal waist-to-hip ratio for women should be <0.8 (Ghafoorunissa and Krishnamurthy 2000)**,** though the subjects were undernourished, interestingly their waist-to-hip ratio was found to be close to the recommended values. On the similar line, a study conducted by Mastiholi et al (2018) on rural women in Karnataka reported that 36.6 per cent women were underweight and nearly 25 per cent of the subjects were found to have a MUAC less than 22.0 cm. A total of 76.6 per cent participants had W/H ratio less than 0.8.

C. Biochemical assessment

Results (Table 4) from the biochemical assessment depicted a significant ($p<0.01$) rise in the hemoglobin (Hb) levels of the experimental group which can be considerably attributed to the daily consumption of NDIM, as it provided 3.62md/dl of iron along with the dietary and hygiene improvements due to the knowledge attained from the nutrition education which was based on the dietary interventions that may have aided in the enhanced absorption of iron in the body. The possible reason for overall increase of Hb in both the groups can be conferred to the fact that in winters a gradual increase in consumption of seasonal green leafy vegetables, fruits along with traditional, homemade, energy and iron rich foods (like *pinni, panjiri, ladoo, jaggery)* was observed among the local population including the selected subjects. These factors might have attributed to the increased iron intake in the body thus resulting in an overall increase in the hemoglobin levels of the subjects.

Most of the subjects were following a vegetarian diet pattern. Results from studies suggest that up to 70% of all anemia cases, a significant cause may be the high prevalence of vegetarianism, as was observed in the present study also, and limited access to iron supplements (Rammohan et al 2012). Little et al (2018) found that meat consumption and egg consumption were associated with less occurrence of moderate and mild anemia among women and men respectively. It was also reported that meat and fish, being a rich source of highly bioavailable heme iron, can prove to be beneficial in improving blood Hb concentrations (Hurrell and Egli 2010). Not only does vegetarianism affect the iron bioavailability but can also be associated with the deficiency of vitamin B12 which plays an important role in the occurrence of anemia. Mastiholi et al (2018) reported that intake of dietary of Vitamin B12 (Cobalamin) of 35.4 per cent of women was less than 50 per cent of RDA. However it is a very personal choice of being non- vegetarian, cases of which were found less in the present study. Lastly, trending consumption of refined grains (e.g., polished white rice and flour) and sugar, products that are poor in iron content and have replaced animal products and vegetables in the diet, were associated with increased risk of mild anemia among women and men respectively (Little et al 2018). The widespread replacement of popular, conventional jaggery and jaggery products with refined, white sugar and it's products may also be a underrated reason for the epidemic of anemia among the Indian women.

D. Dietary survey

a) Macronutrients

Nutritional status of selected subjects from both the groups was assessed through anthropometric status and dietary intake. In case of dietary intake the information regarding nutrient intake of the selected subjects was obtained through 24 hr recall method.

An increase in the energy intake was observed among the subjects of the experimental group after intervention. The intake of subjects was low as compared to the average energy intake of participants reported by Agrawal and Varma (2016) which was 1697.44 ± 443.48 kcal/day, for women belonging to 35–70 years of age group. The findings for adolescent girls revealed that their dietary intake met only two-third to three-fourth of the recommended energy and protein requirements (Malhotra and Passi 2007). The findings were consistent with the results of a former study conducted among poor adolescent girls in rural Rajasthan (Chaturvedi et al 1996) where the energy and protein intake were 64- 74 per cent and 65-77 per cent of the recommended allowances respectively. However, a lower caloric intake (55-64% of the RDA) was reported in another study carried out on young girls belonging to a low socio-economic group in Delhi (Sharma et al 2005). In the present study, a non-significant increase in the fat intake was observed in the control group whereas on the contrary the per cent adequacy of the experimental group reached 198.64 per cent after the intervention which can be attributed to the high fat content (17.56g/100g) of the NDIM rendering the diet energy dense.

b) Micronutrients

The daily micronutrient intake of subjects from the control as well experimental group was analyzed before and after the intervention. The β-carotene content of NDIM was fairly high which could be a possible reason for the significant ($p<0.01$) increase in the vitamin A intake in experimental subjects. In comparison to the control group, experimental group exhibited a significant increase in the calcium and iron intake in their daily diet owing to their improved overall dietary intake along with the continuous supplementation of nutrient rich mixture (NDIM) for 120 days. Poor intakes of dietary iron and folic acid can pave the way for nutritional anemia in women (Agrawal and Varma 2016). The low intake of iron and folic acid in the present study could be attributed to the poor consumption of Green leafy vegetables in their diet. Total energy intake among the selected subjects was also inadequate. Similarly, an energy intake of 1,607.53 ± 318.95 kcal/day was observed by Rastogi (2007) during a study conducted in Jaipur

among women aged 35–75 years. During a study conducted in Uttar Pradesh, an energy intake of 1,492 ± 456 kcal/day among women aged 18–60 years was reported, meeting nearly 75 per cent of daily energy requirements (Mittal et al 2010).

E. Knowledge, Attitude and Practice (KAP) Score

Education was imparted regarding multiple topics including importance of green leafy vegetables, local and seasonal food items, maintenance of personal hygiene, symptoms and dietary management of anemia, protein energy malnutrition (PEM) etc.

The maximum score attained in the category of practices was a clear indication of improved dietary and hygiene practices. For instance, the consumption of tea in daily diets of the subjects in the present study was very high, that too along with the main meals which could also be seen as major factor for reduced iron absorption, education regarding the same was imparted to the experimental group which in turn had a positive impact on the dietary practices of the subjects improving their Hb levels as most of them attempted to change this habit. In a study conducted by Weerasekara *et al* (2020) reported that most women had a positive attitude towards receiving nutritional knowledge but had a low-level practice of a healthy diet. Furthermore, knowledge, practices, and attitudes of women largely affected their BMI status, as well as household food security. However, Shahzad et al (2017) reported a low level of impact of knowledge related to a nutritional problem such as iron and iodine deficiencies. Furthermore, women's health and knowledge should be given significant consideration which will in turn aid in attaining Millennium Development Goals (MDGs). Many studies have supported encouraging healthy behavioural practices among women (Weerasekara *et al* 2020).

A well- devised nutrition intervention can positively affect nutrition knowledge, attitude and behavior of the target population (Pérez-Escamilla *et al* 2008). This observation was in conformity with the study conducted by Cannoosamy et al (2016) where in the results displayed a positive impact on the knowledge, attitude and fruit and vegetable intake in the subjects after nutrition education intervention (NEI).

V. CONCLUSION

The prevalence of dual burden in India where the upper economic strata is falling prey to obesity and the low income group is still undernourished due to many disparities calls for an alarming consideration. The dropping of India's rank in the Global Hunger Index 2021, indicates the severity of undernourishment in the country. The undernourished segment of the population, if not ministered aptly, may cause a disturbed mortality scenario mainly in context with the women (women of child bearing age and pregnant women) and children. Evidences indicate that in developing countries, malnourished women show a consistent increase in mortality rates as well as increased risk of illness. This calls for an immediate attention to the same. Taking into account the various conditions like economic status, physiological status, food availability and accessibility, a judicious way would be the supplementation of healthy pre-cooked mixtures which are cost effective, nutritious, locally available and shelf stable.

Therefore, keeping this in view, a highly nutritious, ready-to-cook Nutrient Dense Ingredient Mix (NDIM) formulated with roasted semolina, whole green gram, pearl millet, peanuts, dried fenugreek leaves was supplemented. The developed mix (100g cooked NDIM) provided with 437.4 Kcal of energy, 13.58g protein and 3.62mg of iron.

Supplementation of NDIM (for 120 days) along with effective nutrition education of undernourished, anemic women significantly improved their nutritional profile.

The formulated NDIM can be consumed on a daily basis as a nutritious meal or snack at any time of the day with minimal efforts and time for cooking so as to improve the nutritional profile especially with regard to energy, protein and iron. The developed Ready-to-cook Nutrient Dense Ingredient Mix can further be investigated for incorporation into the government food schemes for children like mid-day meal, due to its nutritious composition, cost effectiveness, convenient availability of ingredients and high palatability.

The product can be popularized among self help groups for enhancing their livelihood and nutritional security.

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TABLES

Ingredients	Amount (g)
Semolina	45g
Pearl millet	5g
Whole green gram	10g
Fenugreek leaves	10g
Peanuts	10g
Cumin seeds	2g
Turmeric powder	1g
Red chilli powder	0.5g
Black pepper	0.5g
Salt	1g
Ghee	15g
Water	100ml

Table 1: Composition of the Nutrient Dense Ingredient Mix

Nutrient	**Intake (Mean±SD)**	**RDA (Mean±SD)**	**Gap (Mean±SD)**	**% Adequacy**
Energy (Kcal)	1722.79±292.46	2065.34±166.48	342.55	83.4
Protein (g)	40.54±18.64	47.77±18.16	7.23	84.9
Iron (mg)	11.48±8.79	24.43±4.84	12.95	47.0

Table 2: Mean nutrient intake of adult women in terms of energy, protein and iron (year 2000-2020)

Values are expressed as Mean ± SD

Characteristics		n (%)
Age (in years)	18-30	34(56.7)
	31-40	21(35.0)
	41-50	5(8.3)
Marital status	Married	49(81.7)
	Unmarried	11(18.3)
Type of family	Joint	20(33.3)
	Nuclear	40(66.7)
Education	Illiterate	21(35.0)
	Primary	3(5.0)
	Middle	32(53.3)
	Higher education	4(6.7)
	Graduation or above	0
Land holding	Landless	27(45.0)
	Marginal (less than 1 hectare)	33(55.0)
	Small (1-2 hectare)	0
	Large (more than 2 hectare)	0
Total monthly income	Upto 10,000	4(6.7)
	10-20,000	28(46.7)
	20-30,000	14(23.3)
	30-40,000	9(15.0)
	40-50,000	5(8.3)
Occupation	Working	39(65.0)
	Non-working	21(35.0)
No. of meals/day	1	0
	2	14(23.3)
	3	46(76.7)
	4	0
Food habits	Vegetarian	37(61.7)
	Non-vegetarian	23(38.3)

Table 3: General information of selected subjects (N=60)

Values in parenthesis indicate percentage

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Parameters	Control (n=30)				Experimental (n=30)			
	Pre intervention	**Post intervention**	**% change**	**t-value**	**Pre intervention**	**Post intervention**	**% change**	**t-value**
Anthropometric measurements								
Height (cm)	160.1±6.25	160.1±6.25	-	-	161.7±4.50	161.7±4.50	-	-
Weight (kg)	45.6±3.67	46.3±3.73	1.64	0.73^{NS}	45.88±2.27	48.16±2.49	4.98	3.86**
Waist circumference (cm)	69.33±1.22	70.08±1.36	1.09	0.54^{NS}	69.84±1.25	71.10±2.69	1.81	2.91***
Hip circumference (cm)	82.99±2.50	83.15±2.70	0.18	0.24^{NS}	83.63±3.20	85.01±2.35	1.65	2.31**
Mid-upper arm circumference (cm)	22.32±1.66	22.73±1.57	1.82	1.00^{NS}	22.28±1.24	23.09±1.17	3.61	5.93***
Body Mass Index (Kg/m^2)	17.76±0.73	17.98±0.81	1.21	0.72^{NS}	17.55±0.59	18.46±0.70	5.19	5.73**
Waist-Hip Ratio	0.84±0.03	0.84±0.02	0.89	0.00^{NS}	0.84±0.03	0.84±0.03	0.07	0.00^{NS}
Biochemical								
Hemoglobin (g/dl)	8.28±1.12	8.39±0.96	1.25	0.38^{NS}	8.33±0.96	9.01±1.57	14.17	5.06***

Table 4: Nutritional status of the selected subjects pre and post intervention (N=60)

Values are expressed as Mean ± SD
**Significant at 5 per cent level of significance (p<0.05)
***Significant at 1 per cent level of significance (p<0.01)
NS - Non significant

Nutrients	**RDA**	**Control Group (n=30)**			**Experimental Group (n=30)**		
		Pre intervention	**Post intervention**	**t-value**	**Pre intervention**	**Post intervention**	**t-value**
		Intake	**Intake**		**Intake**	**Intake**	
Energy (Kcal)	2130	1234.21±350.98	1312.33±230.63	1.02^{NS}	1350±430.56	1710.87±340.32	3.59**
Protein (g)	46.0	38.07±14.60	42.22±12.65	1.18^{NS}	36.87±10.09	47.87±11.43	3.95**
Carbohydrate (g)	-	165.87±49.89	171.23±56.32	0.44^{NS}	171.76±51.43	211.98±64.45	2.62**
Total fat (g)	25 (visible)	37.38±15.51	40.33±12.54	0.42^{NS}	34.98±12.65	49.66±14.32	2.06**
Vitamin A (µg)	840	305.5±77.29	301.23±65.32	0.21^{NS}	337.78±80.87	1587.76±98.76	19.4***
Calcium (mg)	1000	430.97±204.81	467.12±165.23	0.77^{NS}	454.23±198.76	543.77±211.32	6.93**
Iron (mg)	29	11.57±4.21	13.22±5.23	1.71^{NS}	13.45±5.65	18.31±7.65	2.81**
Folic acid (µg)	220	189.22±53.99	193.26±78.92	0.23^{NS}	186.98±60.27	195.27±88.92	1.08^{NS}

Table 5: Mean daily nutrient intake of selected subjects (pre and post intervention, N=60)

Values are expressed as Mean ± SD
***Significant difference at 1% level of significance (p<0.01)
** Significant difference at 5% level of significance (p<0.05)
NS- non significant

Test parameters	**Control (n=30)**			**Experimental (n=30)**		
	Pre intervention	**Post intervention**	**t-value**	**Pre intervention**	**Post intervention**	**t-value**
Knowledge (10)	5.96±1.13	6.33±1.27	1.28^{NS}	6.03±1.33	7.70±1.21	6.02***
Awareness (10)	5.70±1.42	6.10±1.77	1.64^{NS}	5.53±0.97	7.13±1.17	8.73***
Practices (10)	5.66±1.45	6.00± 1.60	1.62^{NS}	6.20±1.73	7.93±1.28	7.54***

Table 6: Average KAP score of the subjects (pre and post intervention, N=60)

Values are expressed as Mean ± SD
***Significant at 1 per cent level of significance (p<0.01)
NS - Non significant

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FIGURES

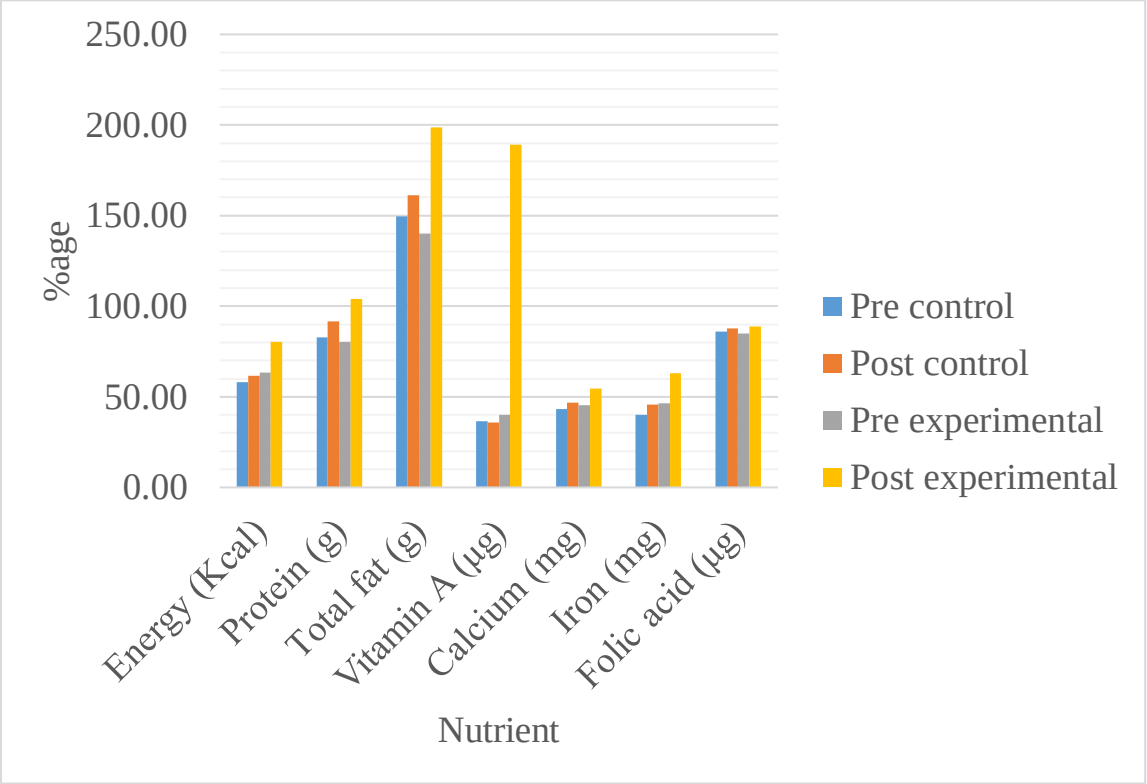

Fig. 1: Percent adequacy of nutrient intake of selected subjects (pre and post intervention, N=60)