Formulation and Impact Evaluation of Selected Nutrition Intervention Methods on Reproductive Age Women.

Baisali Bharadwaj Dash

(20PFN004)

Thesis Submitted To

Avinashilingam Institute for Home Science and Higher Education for Women

Coimbatore – 641043.

In Partial Fulfilment of the Requirements for The Degree of Master of Science in Food Science and Nutrition

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M. Sylvia 26/5/22

Signature of Supervisor

M. Sylvia 26/5/22

Signature of the Head of the Department

Declaration

DECLARATION

I hereby declare that the dissertation titled "**Formulation and Impact Evaluation of Selected Nutrition Intervention Methods on Reproductive Age Women**", submitted to the Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, in partial fulfilment of the requirements for the award of the **Degree of Master of Science in Food Science and Nutrition** is a record of original research work done by me under the supervision and guidance of **Dr. M. Sylvia Subapriya**, Professor and Head, Department of Food Science and Nutrition, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore and that it has not formed the basis for the award of any Degree/ Diploma/ Associateship /Fellowship or similar title to any candidate of any other University and it represents entirely an independent work on the part of the candidate.

M. Sylvia
26/5/22

Signature of the Supervisor

Baisali Bharadwaj Dash

Signature of Candidate

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Contents

CONTENTS

LIST OF TABLES

LIST OF PLATES

LIST OF FIGURES

LIST OF APPENDICES

Introduction

I. INTRODUCTION

The term reproductive age group refers to a woman's active reproductive years, which begin around the age of 12-14 years and conclude around the age of 45-49 years. The reproductive age group is commonly classified as 15-49 years or 12-49 years for demographic purposes. Reproductive health is defined by the World Health Organization (WHO, 1998) as "a state of physical, mental, and social well-being in all matters concerning the reproductive system at all phases of life."

According to Census 2011, women in the age group of 15-24 years constitute about 19 percent of the total female population of India. Women in the reproductive age group (15-49) are the most vulnerable demographic in a developing country like India. Women of childbearing age are not only a large group, but also a particularly vulnerable demographic population. Women are often both caregivers and recipients of health care, therefore they play an important role in defining the community's health. As a result, recognising a woman's health care needs must take precedence in women's health.

According to the National Institute of Environmental Health Sciences (2019), “Reproductive health refers to the diseases, disorders and conditions that affect the functioning of the male and female reproductive systems during all stages of life”.

Nutrition during the reproductive age group have a significant impact on future function and health. It has an impact on not only the child's growth, but also the child's brain growth and development, as well as long-term cognitive function and achievements, behaviour and educational achievements, immune function, including the risk of allergies and autoimmune diseases, bone health, and many other outcomes. The substantial link between early nutrition and later risk of obesity and associated illnesses like diabetes, as well as cardiovascular disease risks like heart attacks and stroke, is particularly intriguing.

In India, a quarter of women of reproductive age are undernourished, having a BMI of less than 18.5 kg/m (Source: NFHS 4 2015-16). It is well knowledge that an undernourished mother will inevitably give birth to an undernourished child, repeating the undernutrition cycle. Undernourished girls are more likely to become undernourished mothers, who are more likely to give birth to babies with low birth weight, sustaining an intergenerational cycle. This cycle can be exacerbated in young moms, particularly adolescent girls who start having children before they are fully developed. When mothers have numerous children and have very short intervals between pregnancies, this might increase nutrition deficiencies, which are

subsequently passed on to their offspring. Thus, adequate nutrition in the reproductive years aids in achieving correct teenage growth, a sufficient nutrient storage throughout the reproductive years for a safe pregnancy, and an optimal nutritional status during the postmenopausal era, particularly to maintain bone health. As a result, maintaining healthy eating habits throughout a woman's life is critical for both her and her children's health. Women in the reproductive age group should be educated about health issues and encouraged to participate in health promotion programs to support healthy eating habits and achieve optimal nutritional status. As a result, UNICEF India's nutrition programming now includes a special focal area on women's nutrition — before, during, and after pregnancy. The organisation now wants to put more emphasis on ensuring universal coverage of the five critical nutrition treatments for women that have been agreed upon at a global and national level. The 5 Essential Nutrition Interventions for Mothers include improving the quantity and nutrient level of food consumed in the household, preventing micronutrient deficiencies and anaemia, increasing women's access to basic nutrition and health services, improving access to water and sanitation education and facilities. By providing sanitation and hygiene education, including menstrual hygiene, and empowering women to prevent pregnancies too early, too often and too close together (www.unicef.org).

When a new-born is placed in a mother's arms, she feels an extraordinary sense of delight or excitement that every mother should feel. For many pregnant women in India, however, this memory will never be realised because giving birth is a terrible event. Because the direct causes of maternal death are well-known and, for the most part, avoidable and reversible, maternal mortality is a crucial health indicator. Approximately two-thirds of all maternal deaths are caused by severe bleeding (usually after childbirth), infections (usually after childbirth), high blood pressure throughout pregnancy (pre-eclampsia and eclampsia), difficulties after delivery, and botched abortions. India's Maternal Mortality Ratio (MMR) for the period 2016-18 was 113/100,000 live births, down 17 points from 130/ 100,000 live births in 2014-16, according to the latest report from the national Sample Registration system (SRS). The primary cause of death among young women aged 15 to 19 is pregnancy-related complications (www.unicef.org).

Low birth weight new-borns are caused by poor nutritional status in the reproductive age group, insufficient food consumption, and low weight gain throughout pregnancy. The NFHS-4 reports that 23% of women are undernourished and have a BMI of 18.5. Throughout their adult lives and childbearing years, women are at risk of having a low BMI. According to the

National Nutrition Monitoring Bureau, cereal consumption is acceptable. The findings show that cereals provide most of the calories and protein consumed by moms, although the quality of protein consumed remains poor. Micronutrient intake is inadequate.

The present nutritional status of reproductive age women is alarming not only for them but also their offspring which means the future of the country in wider sense. Hence, the present study aims to find out the gap in food and nutrient intake among the reproductive age women by collecting 24-hour diet recall, calculating their average food and nutrient intake, and comparing with the recommended dietary allowances (RDA) given by ICMR in 2020. This information will the women in understanding their increasing nutritional demands, where they are lacking in fulling these demands and motivate them to add the deficit foods and nutrients in their diets for adequate nutrition which will not only benefit them but also the entire society at large.

The mean iron, calcium, carotene, and folic acid levels were substantially below than the RDA amounts in a study of pregnant women in some villages in Balasore District, Odisha. The percentage of pregnant women with common nutritional deficits was substantially greater in the third trimester than in the first and second trimesters. Nutrition intake was lower than RDA in several of the sample women, despite higher education and income. Based on the findings, the study concludes that low-cost nutrition greens and vegetables should be grown in every family, and village women should get nutrition instruction (Panda. *et.al.,* 2006).

A diet survey gives information on dietary intake patterns and predicted nutritional intakes for individual foods consumed. It shows relative dietary deficiencies, which is useful for planning health education initiatives. Diet surveys are an important aspect of any comprehensive research of an individual's or group's nutritional status, as they provide crucial information on nutrient intake levels, nutrient sources, eating habits, and attitudes.

At the International Conference on Population and Development (ICPD) in 1994, sexual and reproductive health was granted an international consensus definition. The promotion of reproductive health, including free and safe sexual and reproductive choices for individuals and couples, as well as decisions about family size and marital timing, is at the heart of it.

Product development, often known as new product management, is the process of conceptualising, designing, developing, and selling newly developed or rebranded goods and services. The goal of product creation is to meet a consumer need to grow, maintain, and expand a company's market share. Because not every product will appeal to every customer or

client base, determining a product's target market is an important step early in the product development process. Quantitative market research should be undertaken at all stages of the design process, including before the product or service is imagined, during its development, and after it is introduced.

The five elements of new product development are:

• **Identification of Design Criteria:** Entails coming up with innovative product ideas. Once a potential product has been discovered, a more formal product development approach can be implemented.

• **Idea Analysis:** Entails a more thorough examination of the product concept, market research and concept studies are conducted to see if the idea is realistic and fits within the company's or consumer's business context.

• **Concept Genesis:** Entails developing a practical concept from a product opportunity.

• **Prototyping:** Entails making a quick prototype for a product concept that has been proven to be relevant and valuable to the organisation. In this case, prototyping involves creating a "quick-and-dirty" model rather than a polished product model that will be evaluated and marketed later.

• **Product Development:** Entails verifying that the proposal has passed muster and has been judged to be commercially viable.

The nutritional supplement, Utkal health mix is unique mixture of ragi, corn, green gram, bengal gram, almonds, fenugreek seeds, wheat flour and jaggery. The Utkal health mix formulated has a lot of nutritional benefits for women of reproductive age. It contains nutrients that are highly essential in the reproductive years. The Utkal health mix in an affordable price range, will help bridge the gap in the intake of essential nutrients among the reproductive age women and help maintain their nutritional status using locally available ingredients.

Sensory evaluation is a multidisciplinary science that uses human panellists and their senses of sight, smell, taste, touch, and hearing to measure the sensory characteristics and acceptability of the food products. Thus, the quality of food is judged in terms of taste, colour, consistency and flavour (Chandrasekhar, 2002). Sensory evaluation of the Utkal health mix with a semi-trained panel will help in estimating the acceptability of the health mix among women belonging to the reproductive age group.

Any combination of learning experiences aimed to support the voluntary adoption of eating and other nutrition-related behaviours beneficial to health and well-being is referred to as nutrition education. It is an important aspect of delivering dietary assistance to the elderly.

Education and reproductive health have a two-way relationship. Women's education benefits the entire society. It is also the most important aspect in increasing children's health and lowering new-born death rates. The International Conference on Population and Development (ICPD) in Cairo in 1994 and the Fourth World Conference on Women (FWCW) in Beijing in 1995 both affirmed everyone's right to education, with a focus on women and girls, recognising that education is a cornerstone of women's empowerment because it allows them to respond to opportunities, challenge traditional roles, and change their lives.

In addition to pregnancy outcomes, nutrition education (NE) is an important factor for women of reproductive age. Nutrition education programs are significant because they aim to improve people' dietary intakes by encouraging behavioural changes such as food selection and cooking ability, goal setting, motivation, and support for change attempts. Dean *et al*., 2014, for example, found that preconception nutrition-specific interventions, such as increased folic acid and multivitamin supplementation, resulted in positive pregnancy outcomes. Rao, 2014 also showed an increase in haemoglobin levels after participating in a nutrition awareness programme that included casual meeting sessions, cookery activities to disseminate knowledge about the usage of iron-rich foods, and a kitchen garden activity. Evidence also highlights the importance of considering a wide range of social, cultural, and economic issues when designing health interventions for women of reproductive age, as well as the importance of involving family members (Jeewon. *et.al.,* 2015).

Nutrition counselling is an important part of reproductive age women. The dietary status of a woman affects not only her health but also the health of her foetus and neonate. Nutritional demands during pregnancy differ greatly from those of non-pregnant people, thus physicians and other healthcare practitioners must be aware of this. Furthermore, a personalised approach to nutritional counselling is advocated, considering a woman's availability to food, financial situation, race-ethnicity and cultural food preferences, and BMI. Furthermore, because many of the recommendations are targeted toward easy pregnancies, adaptations must be made when difficulties occur, such as gestational diabetes (Kominiarek. *et.al.,* 2016).

In terms of improving maternal nutrition knowledge, the educational intervention provides a good return on investment. The inexpensive cost of each handout, as well as the 5-10 minutes spent with each woman examining the information, is a step toward lowering the financial burden and poor health outcomes associated with inadequate nutrition and maternal obesity. Improved maternal nutrition education will lead to healthier food choices, which will improve maternal and foetal health and prevent long-term difficulties (LoGiudice. *et.al.,* 2018).

The knowledge of reproductive age women regarding nutrition is not sufficient. Hence, the study aims at imparting nutrition education to the reproductive age women about the nutrition and lifestyle in pregnancy, which will cover nutritional and lifestyle changes before, during and after pregnancy. Nutrition education before pregnancy will focus on food and nutrient requirements and allowances, pre-conceptional care, maternal underweight risks, importance of healthy eating, nutrient dense foods, physical activity, body weight and importance of folic acid. Nutrition education during pregnancy will focus on metabolic adaptations, importance, requirement and deficiency diseases of macro and micronutrients, avoidance of food borne illness, obesity management, gestational diabetes mellitus, eating fish, and complications in pregnancy. Nutrition education after pregnancy will focus on eclampsia, breast feeding, colostrum, infant feeding, weaning foods, amylase rich food, and immunization.

As it is very difficult to get in personal contact with reproductive age women during this pandemic situation, the study aims to impart nutrition education online using digital platforms like website and YouTube. The nutrition education materials prepared like power point presentations, digital posters and videos uploaded on the website and YouTube, can be accessed by women of reproductive age group throughout the globe. It will help impact a greater number of lives in a short time.

In India, the nutritional status of reproductive age women is poor, leading to poor maternal and child nutrition. So, it is a high time to identify and assess the food and nutrient gap in reproductive age women. As for the health supplement, commercial health mixes are costly and not everyone cannot afford it. Therefore, formulation of low-cost nutritious health mix based on locally available sources and bridging the dietary gap of reproductive age women is important. Beside these, the reproductive age women lack knowledge regarding nutrition and lifestyle changes in pregnancy. Therefore, intervention was planned as a part of the study.

Nutritional problems are rampant among reproductive age women in Odisha, as elsewhere in the country. Since there is an urgent need to bridge the nutrient gap and improve the knowledge, attitude, and practice of reproductive age women in Odisha, this study was conducted. It aims at identifying some of these concerns among reproductive age women and assess the efficacy of selected interventions to alleviate them.

Hence, the present study titled, **'Formulation and Impact Evaluation of Selected Nutrition Intervention Methods on Reproductive Age Women'** was conducted with the following objectives:

1) Assess the Socio-Economic Status of Reproductive Age Women.
2) Determine the Food and Nutrient Gap using 24-Hour Diet Recall.
3) Develop a Food formulation to bridge the Nutrient Gap.
4) Impart Nutrition Education on "Nutrition and Lifestyle in Pregnancy."
5) Assess the Impact of Nutrition Education on KAP of the women.

Review of Literature

REVIEW OF LITERATURE

The literature pertaining to the study on the **'Formulation and Impact Evaluation of Selected Nutrition Intervention Methods on Reproductive Age Women'** is presented in the following headings:

A. Reproductive Age Women – An Indispensable Age Group

B. Nutritional Status of Reproductive Age Women

C. Nutritional Requirements of Women in Reproductive Age Group

D. Tenets of Product Development

E. Digital Health Interventions for Reproductive Age Women

F. Nutrition Education for Reproductive Age Women – Need of the Hour

A. REPRODUCTIVE AGE WOMEN – AN INDISPENSABLE AGE GROUP

Life-course research identifies the reproductive age group as critical for health across generations in the reproductive age group. Many reproductive-age women in low-, middle-, and high-income nations will be nutritionally unprepared for pregnancy. Micronutrient supplementation initiated during pregnancy can rectify significant maternal nutrient deficiencies, but it is insufficient to enhance child health fundamentally; dietary modifications during pregnancy can limit weight growth, but they are also insufficient to improve pregnancy outcomes (Barker. *et.al.,* 2018).

In all aspects connected to the reproductive system and its functions and processes, a condition of total physical, mental, and social well-being, rather than simply the absence of disease or disability is called reproductive health. Women with good reproductive health can have a fulfilling and safe sex life, as well as the ability to procreate and the choice to choose if, when, and how frequently to do so. The right of women to be informed about and have access to safe, effective, affordable, and acceptable methods of family planning, as well as other methods of fertility regulation that are not illegal, is implicit, as is the right of access to appropriate health-care services that will enable women to safely navigate pregnancy and childbirth and provide women with the best chance of having a child (UNFPA, 2016).

The Indian government is currently implementing various programmes aimed solely at women's health during their reproductive years. None of these programmes, however, address

the management of chronic health issues during pregnancy. The findings imply that multimorbidity is important in the setting of reproductive-age women. The programme and policymakers should consider incorporating chronic illness management techniques into mother and child health care. The use of social marketing strategies into primary care would aid policymakers in teaching women about the benefits of living a healthy lifestyle. Dietary diversity can aid in the maintenance of normal oestrogen levels, which in turn can aid in the reduction of multimorbidity rates among Indian women (Pati. *et.al.,* 2021).

In Berhampur, Odisha, research was done to determine the prevalence of adolescent pregnancy as well as the mother and neonatal outcomes of these pregnancies. The rate of teenage pregnancy was 4 percent. 214 of the 564 teenage pregnancies were anaemic, 74 developed pregnancy-induced hypertensions, and 129 were preterm. Foetal discomfort and cephalopelvic disproportion were the most common reasons for caesarean section, which was done in 51.9 percent of cases. 1.04 percent of the 553 live births weighted less than 1.5 kg, 29.16 percent weighed 1.5 to 2.5 kg, 65.5 percent weighed 2.5 to 3.5 kg, and 5.2 percent weighed more than 3.5 kg. The new-borns who needed to be admitted to the NICU were 26.9% and the most prevalent issue was neonatal jaundice, which was seen in 14.3% of the time (Soren. *et.al.,* 2021).

B. NUTRITIONAL STATUS OF REPRODUCTIVE AGE WOMEN

A population-based biomarker survey of anaemia and vitamin B12 and folate status in women of reproductive age group as part of a periconceptional surveillance program in southern India was conducted whose results observed anaemia affected 41.5 percent of reproductive-age women, with 3.0 percent having severe anaemia. Vitamin B12 deficiency was found in 48.3% of reproductive-age women, whereas vitamin B12 insufficiency was found in 74.3 percent. The prevalence of RBC folate insufficiency was 7.6%, and 79.3% of reproductive-age women had RBC folate levels below 748 nmol/L, which is the threshold for optimal Neural Tube Defect prevention. Based on RBC folate contents, the predicted neural tube defect prevalence per 10,000 babies was 20.6 (Williams. *et.al.,* 2021).

A cross-sectional study of 2000 non-pregnant married reproductive age women (18 to 30 years) with one or no child who wanted to have more children in low to middle-income urban neighbourhoods in Delhi, India, found that 58.7% were anaemic, 16.5 percent were undernourished, 26 percent were overweight or obese, 13.2% were hypothyroid, and 10.5 percent had both symptoms and signs of STIs/RTIs. Undernourished women had a higher

chance of RTI/STI symptoms and indications, while overweight or obese women had a higher risk of diabetes or prediabetes. Women from lower wealth quintiles had a higher risk of malnutrition. Obese women and those with at least a secondary education had a lower risk of moderate to severe anaemia (Mazumdar. *et.al.,* 2020).

Anaemia and micronutrient deficits are common in women of reproductive age (WRA). The importance of periconceptional diet in the development of unfavourable pregnancy problems is supported by evidence. However, there is a scarcity of population-based data in India to inform evidence-based recommendations and priority-setting. The results of this biomarker survey confirm the prevalence of anaemia and micronutrient deficiencies in women of reproductive age, and they directly guide a randomised trial in Southern India to prevent anaemia and birth abnormalities (Finkelstein. *et.al.,* 2020).

A validated food frequency questionnaire was used to examine diet in 3041 nonpregnant women of reproductive age (15-49 years) from two trials in India (FFQ). The average GDQS (Global Diet Quality Score) was 23 points. Positive correlations between the overall GDQS and GDQS+ and calcium, fibre, folate, iron, monounsaturated fatty acid (MUFA), protein, polyunsaturated fatty acid (PUFA), saturated fatty acid (SFA), total fat, and zinc were reported in energy-adjusted models. Quintile studies revealed that the GDQS was linked to higher nutrient sufficiency. Simultaneously, the GDQS was linked to greater TC, lower HDL, and a higher BMI. There was no link between the GDQS and hypertension (Matsuzaki. *et.al.,* 2021).

In Ethiopia, Kenya, Nigeria, and South Africa, a systematic review of the status and intake of iron, vitamin A, iodine, folate, and zinc in women of reproductive age (15-49 years) and pregnant women found that the prevalence of anaemia ranged from 18-51 percent, iron deficiency 9-18 percent, and iron deficiency anaemia at 10% in women of reproductive age. The prevalence was higher in pregnant women, ranging from 32-62 percent, 19-61 percent, and 9-47 percent, respectively. Vitamin A, iodine, zinc, and folate deficits were found in 4-22 percent, 22-55 percent, 34 percent, and 46 percent of reproductive-age women, respectively, while they were found in 21-48 percent, 87 percent, 46-76 percent, and 3-12 percent of pregnant women (Harika. *et.al.,* 2017).

C. NUTRITIONAL REQUIREMENTS OF WOMEN IN REPRODUCTIVE AGE GROUP

According to a systematic study of dietary guidelines adherence during preconception and pregnancy, reproductive-age women do not consume enough vegetables, cereal grains, or folate. In 91 percent and 55 percent of the included studies, pregnant women did not fulfil iron or calcium consumption requirements, while in 55 percent of included research, pregnant women surpassed fat intake limits. Among pregnant women, higher education was linked to better adherence to guidelines, but in reproductive age women, older age and non-smoking status were linked to better adherence to guidelines. The findings show that women of reproductive age may not be reaching the basic dietary and nutritional requirements set forth in dietary guidelines and/or nutritional recommendations. This could have negative repercussions for pregnancy and birth outcomes, as well as offspring's health (Caut. *et.al.,* 2020).

Maternal micronutrient deficiencies are a common nutritional concern for women in resource-poor settings, with repercussions that influence not just the health and survival of women but also the health and survival of their infants, particularly through intrauterine growth retardation. The low quality of women's diets, particularly their lack of diversity, is one of the main causes of this type of malnutrition. There is plenty of evidence from wealthy countries showing dietary diversity is substantially linked to nutrient sufficiency, and evidence from underdeveloped countries is rising as well. Low-quality, monotonous diets are the norm in resource-poor regions all throughout the world. The danger of micronutrient deficiencies is greater when grain or tuber-based staple foods predominate, and diets lack vegetables, fruits, and animal-source meals. Because of their greater micronutrient needs, women of reproductive age (15-49 years old) are particularly vulnerable (Custodio. *et.al.,* 2020).

Micronutrients are essential for women's health during their reproductive years, during pregnancy, adolescence, and beyond menopause. The negative consequences of micronutrient deficiencies on women's health and pregnancy outcomes are extensively documented. Although inadequate food consumption is a prominent source of micronutrient deficiencies, other factors such as heredity, vitamin and drug interactions, poor absorption, and specific disorders can also contribute to such shortages. Calcium, iron, folate, zinc, thiamine, riboflavin, and vitamins A, D, B-6, and B-12 deficiencies are particularly common and cause worry in women of reproductive age. Low economic levels and a lack of understanding about healthy habits such as good eating patterns are two possible causes of micronutrient deficiencies.

Deficiencies in these essential nutrients increase the risk of complications during pregnancy, including neural tube abnormalities, early foetal death, preeclampsia, and maternal mortality. The most well-known recommendation for reproductive age women is to take 400 mg of folic acid per day to avoid neural tube abnormalities, while pregnant women should take 600 mg (Dunneram. *et.al.,* 2015).

According to a study titled Low Intake of Vegetable Protein Is Associated With Altered Ovulatory Function Among Healthy Women of Reproductive Age, 84 percent of participants satisfied the recommended total protein dietary requirement for reproductive-aged women. There was no link between total or animal protein intake and reproductive hormones or anovulation. In comparison to the middle tertile, vegetable protein intake in the lowest tertile was linked to lower luteal phase progesterone, higher follicle-stimulating hormone, and a higher chance of anovulation. The only protein-rich foods linked to an increased risk of anovulation were nuts and seeds (Kim. *et.al.,* 2021).

D. TENETS OF PRODUCT DEVELOPMENT

New product development is a difficult task. When compared to similar products, the product should meet the marketing criteria and have a higher client preference. New products are classified as either new to the world, new to the company, or an extension of an existing product line. There are numerous innovations in the food industry nowadays. Many new food products are introduced every day. New food product development is motivated by innovation, a customer's demand (Change of lifestyle, healthy living), current market loss, and market forces.

There are numerous processes involved in developing and launching a new product in any area. Product Development process has seven stages, which are as follow:

1. **Idea generation & screening:** An idea that has the power to transform someone's life can originate from anywhere. A market survey can generate new product ideas. Staff from any area, such as sales, marketing, production, and administration, can record their thoughts after the brainstorming session. Regardless of their utility now, all ideas should be listed. Because there may be numerous obstacles in putting these ideas into action, screening is required. Finance, marketing, processing, laws, packaging, and distribution are all possible constraints.

2. **Market Research:** Market research provides insight into consumer preferences and product adoption. For data collection, it entails both primary and secondary market research. Focus groups and test panels may be used in market research. When conducting surveys, the following characteristics are considered: age, gender, economic status, geographic location, and so on. Following a market survey, data is collected using a marketing information system. It has four main components: internal firm data gathering, market data for competitors' products, acquired primary and secondary data, and promotion tactics.
3. **Product Specifications:** Product definition can be a difficult and time-consuming procedure. Raw ingredients, various processing methods, quality control, quality assurance, packing and storage conditions, and so on are all covered. It informs producers about the description of the product they desire, as well as assisting manufacturers in obtaining precise information about what consumers desire. Market research will assist in obtaining this specific information because of the above two processes Idea development and screening.
4. **Feasibility study (Financial & Technical):** A feasibility study is required to determine whether a new product is viable. Technically and financially, new product concepts should be realistic. Checks for the practicality of the new processing method, appropriateness of equipment, availability of sufficient staff, time, and money requirements, and so on.
5. **Process Development:** A product can be completely new and distinct from the existing line, or it can simply be a line extension or a packet update. According to it, the process is developing. It entails the addition of a new product line, a redesign of the existing layout, new processing procedures, and personnel training.
6. **Prototype Development & Testing:** Prototype development is required to gain an understanding of large-scale processes and aids in market entry. Large-scale production entails managing ingredients, processes, and production, as well as storage and packaging on a larger scale. Market testing will aid in the detection of any flaws in the product, design, or other aspects. It will also assist in determining the appearance and worth of a product in a specific market.
7. **Launch:** After testing all the concepts through several stages, the final step is to launch the new product on the market. It should include information about product launch dates and target clients. When it comes to launching, the right attitude against competitors is crucial. Customer feedback will also provide you an insight of what clients want. It is not necessary to work on product modifications right away. The launch of a product is not the final phase in the creation of a new product. It is a never-ending process, and continued development is critical to the success of a product (WWW.discoverfoodtech.com).

Food product development is heavily dependent on consumer perception and approval. Hence involving the consumer in the development process is critical to reducing failure risks. Sensory analysis and market research are two approaches that can help you achieve this goal. Product and process development is an important aspect of any wise business strategy in the food sector, as it is in any other industry. Failure to generate new and superior products forces businesses to compete purely on price, favoring those with the lowest cost inputs. Processing technologies and packaging systems are two areas of the food industry where substantial advancements and innovation have been recorded, with very significant results (Ramalhosa. *et.al.,* 2016).

When consumed during pregnancy, fortified beverages and supplementary foods have been found to help reduce maternal anemia and iron deficiency. Micronutrient fortified supplementary foods, particularly those containing milk and/or essential fatty acids, have been shown in studies to enhance mean birthweight by 60–73 g during pregnancy. A few studies have also found that enriched supplementary foods can help to lengthen births and reduce premature births. Fortification levels have typically varied from 50 percent to 100 percent of the required nutritional consumption (RNI). Important minerals such as iron, zinc, copper, iodine, selenium, vitamins A, D, E, C, B_1, B_2, B_6, and B_{12}, folic acid, niacin, and pantothenic acid have been added to fortified beverages and supplemental foods for pregnant and breastfeeding women. While calcium has been shown to reduce the risk of preeclampsia and maternal mortality, calcium, phosphorus, potassium, magnesium, and manganese can have negative effects on organoleptic properties. As a result, many of the products tested either did not include these nutrients or did so in a limited way. Milk and essential fatty acids in fortified dietary supplements can help improve maternal health and pregnancy outcomes. Micronutrient deficits such as anemia and iron insufficiency have been proven to be reduced by fortified beverages containing only multiple micronutrients (Yang. *et.al.,* 2011).

E. DIGITAL HEALTH INTERVENTIONS FOR REPRODUCTIVE AGE WOMEN

The COVID-19 epidemic has interrupted Sexual and Reproductive Health (SRH) services around the world, resulting in many undesired pregnancies, stillbirths, maternal and neonatal deaths, as well as significant effects on women's mental health. Despite the obstacles, some countries have used health technologies to secure healthcare access and delivery, paving the path for a future of digital health. mHealth and telemedicine have gained global attention during lockdowns, showcasing their potential beyond assisting underserved and vulnerable groups. There are also chances to improve healthcare access and promote gender equality in the post-

COVID age. Poverty, a lack of access to Digital Health Interventions (DHIs), a lack of digital health participation in some groups, and hurdles to digital health literacy are all variables that can lead to poor health outcomes. As a result, Digital Health Equity (DHE) should be incorporated into health policy to address equality, access, and affordability challenges, particularly in rural areas. As a result, there is a pressing need for health systems to be deliberate in addressing greater gender imbalances and integrating digital health technology to increase resilience to future health crises (Javed. *et.al.,* 2021).

A study was done to test the efficacy of digital Cognitive Behavioural Therapy for insomnia (CBT-I) compared with standard treatment among pregnant women with insomnia symptoms. Digital CBT-I consisted of 6 weekly sessions of approximately 20 minutes each. When compared to women who received standard treatment, women who received digital CBT-I saw statistically significant improvements in insomnia symptom severity from baseline to post intervention. Except for sleep duration, all secondary outcomes showed statistically significant improvements from baseline to post intervention. The shift from baseline to follow-up showed a similar pattern of outcomes (Krystal. *et.al.,* 2020).

A Systematic Review of Qualitative Studies on Health Professionals and Postpartum Women's Perspectives on Digital Health Interventions for Lifestyle Management revealed that in the Postpartum Period DHIs are seen as a beneficial, user-friendly, and approved delivery medium for lifestyle interventions by postpartum mothers. It became clear that the challenges women have in participating in postpartum lifestyle treatments are identical to those they face in non-digital therapies. Future study is needed to identify hurdles that can be particularly overcome utilizing DHIs and to design appropriate solutions. In addition, the behavior modification tactics used in DHIs appear to be like those used in non-digital interventions, such as monitoring and feedback, goal setting, involving a credible source (e.g., a health professional), and social support (Madden. *et.al.,* 2019).

As mobile phone networks spread across low- and middle-income nations, digital technologies provide enormous promise for assisting women in achieving positive SRHR results. Information and services can be made available when and where they are needed, facilitating a broader transition toward user-controlled products and services, such as family planning. Providing SRHR services and providing information and support to empower women to take control of their health and fertility, on the other hand, may in some cases pit individuals' sexual health rights and reproductive autonomy against conservative or patriarchal social

norms, putting some women at risk. Nonetheless, if correctly planned and implemented, digital technologies have the potential to do good because they are highly accessible and can allow for scale (Naved. *et.al.,* 2019).

A systematic review on the effectiveness and characteristics of mHealth interventions to increase adolescent's use of SRH services in Sub-Saharan Africa (SSA) revealed that mobile health interventions were effective in increasing teenage adoption of SRH services across the board. Contraceptive usage received the most evidence. Adolescent adoption of SRH services was improved to a larger extent in interventions with two-way interactive features and more behavior change approaches included in the interventions. The findings imply that mHealth interventions encouraging HIV prevention or treatment adherence for those at risk of or living with HIV are acceptable to teenagers and that they are viable to implement in SSA. Two studies with limited data found that interventions were inexpensive, but none of the research looked at cost-effectiveness (Wafula. *et.al.,* 2022).

F. NUTRITION EDUCATION FOR REPRODUCTIVE AGE WOMEN – NEED OF THE HOUR

A total of 11,170 caregiver-infant pairs were randomly assigned to receive an educational intervention delivered to the caregiver or normal care in 23 studies (from 35 reports). Nineteen of the studies were conducted in the community, while four were conducted in an institution. Furthermore, 13 of the included studies were cluster-randomized, whereas the rest were randomly assigned to individuals. The interventions were primarily focused on the timing of the introduction of complementary feeding, the types and amounts of complementary foods to be offered to infants, and hygiene. Using the GRADE criteria, it was reported that the evidence quality was moderate, owing to insufficient allocation concealment and blinding. Educational interventions improved complementary feeding practices and cleanliness practices at the age at which complementary foods were introduced. The pooled results for duration of exclusive breastfeeding were consistent with both a decrease and an increase in the outcome. For all growth outcomes, there was little (low to very low-quality) evidence of an influence. Educational interventions can enhance supplemental feeding practices, but there is insufficient data to establish that they affect growth results (Arikpo. *et.al.,* 2018).

A study on pregnant women's knowledge and awareness of nutrition concluded that the findings support the use of MyPlate and current evidence-based guidelines to inform and improve nutrition education among pregnant women. Education was similarly beneficial

regardless of age, race, parity, or pre-pregnancy BMI, indicating that this approach can be used on wide range of pregnant women. This study also suggests that dietary education for women in subsequent pregnancies should not be disregarded. This educational intervention delivers a good return on investment in terms of enhancing maternal nutrition knowledge. The low cost of each handout, as well as the 5-10 minutes spent reviewing the information with each woman, is a step toward reducing the financial burden and poor health outcomes associated with inadequate nutrition and maternal obesity. Continued improvements in maternal nutrition education will lead to healthier food choices, which will improve mother and foetal health and reduce long-term issues (Blondin. *et.al.,* 2018).

A randomized clinical trial was done on impact of nutrition education in improving dietary pattern during pregnancy based on Pender's Health Promotion Model. Participants were randomly assigned to the intervention (n = 96) or control group (n = 96) at 6–10 weeks of pregnancy and followed until the conclusion of the pregnancy. At the time of registration, each woman in the experimental group met with the research nutritionist and a personalized nutrition plan was created. In addition, three 45–60 minute training sessions based on Pender's Health Promotion Model (HPM) were designed in the 6–10, 18, and 26 weeks of pregnancy. At 6–10 weeks and 34–36 weeks of pregnancy, the individuals' typical food intake was measured using a three-day dietary diary. When compared to the control group, the interventional group's mean scores for perceived advantages, self-efficacy, activity-related affect, interpersonal factors (husband support), and commitment to action improved while the competing demand scores declined. Pender's HPM for nutrition education worked because the pregnant women follow the dietary guidelines and follow the food pyramid (Moghadam. *et.al.,* 2018).

A study was done to investigate the necessity of prenatal nutrition training by measuring the level of nutritional knowledge in pregnant women. A total of 100 pregnant women answered 20 questions to assess their dietary knowledge throughout pregnancy. Those who answered correctly to 16 or more statements received a "excellent" grade, "average" for those who answered correctly to 11–15 statements, and "inadequate" for those who answered correctly to 10 or fewer statements received a "inadequate" score. In the 95 percent confidence interval, the data were evaluated at a significance level of p 0.05. 26.0 percent of pregnant women had a "excellent" nutritional knowledge score, 46% had "average" , and 28.0 percent had "inadequate" nutritional knowledge. The average nutritional knowledge scores of individuals who got nutrition education and those who did not, did not differ statistically. All pregnant

women should receive nutrition instruction, and this education should be more competent (Yardimci. *et.al.,* 2018).

The effect of nutrition and reproductive health education of pregnant women in Indonesia using quasi experimental study concluded that after receiving education, pregnant women in the intervention group reported a significant increase in knowledge, attitudes, and behaviors related to nutrition and reproductive health. The intervention group's pre- and post-test mean scores for overall knowledge, attitudes, and practices were respectively 55.1 and 83.1 for overall knowledge, 40.2 and 49.0 for attitudes, and 36.2 and 40.2 for practices. There was no significant difference between the pre-test and post-test mean scores for these three variables in the control group. The intervention group and the control group had a significant difference (P 0.001) in the post-test mean, although the difference was not significant (P > 0.05) in the pre-test. Pregnant women's knowledge, attitudes, and habits are improved by providing nutrition and reproductive health education in small groups using interactive approaches. By maximizing collaboration between government, non-governmental organizations, and mother and child health service providers, this intervention has the potential to be reproduced and developed for large-scale deployment (Rizqiya. *et.al.,* 2021).

A quasi-experimental study on the effect of nutrition education by health professionals on pregnancy-specific nutrition knowledge and healthy dietary practice among pregnant women in Asmara, Eritrea concluded that pregnant women who received training saw a significant boost in their knowledge scores, which went from 29.01/47 pre-intervention to 42.73/47 immediately afterward. However, the score dropped by 1.79 points from the time of intervention to the 6-week follow-up. Even though the score had dropped, knowledge at the 6-week follow-up was remained significantly higher than before the intervention. Pregnant women's primary source of information was health professionals (70.2 percent). At 6-week follow-up, the pregnancy-specific dietary practice score was considerably higher than before the intervention. There was no significant relationship between demographic variables and changes in practice or knowledge. The nutrition instructions delivered to pregnant women by educated health professionals utilizing a holistic approach over time played a significant influence in expanding their knowledge and promoting beneficial eating patterns, according to this study. As a result, ANC clinics must take the lead in coordinating the effort to raise awareness about nutrition during pregnancy (Amanuel. *et.al.,* 2020).

Methodology

METHODOLOGY

The methodology adopted for the present study titled **'Formulation and Impact Evaluation of Selected Nutrition Intervention Methods on Reproductive Age Women'** is presented as follows:

Phase I: Selection of Women and Collection of Background Information.

Phase II: Assessment of Nutritional Status through Diet Survey

Phase III: Development of a Health Mix

Phase IV: Imparting Nutrition Education and Impact Evaluation on KAP

PHASE I: SELECTION OF WOMEN AND COLLECTION OF BACKGROUND INFORMATION

Approval was granted from the Institutional Human Ethics Committee of Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for the thesis work. Ref: proposal No. IHEC/21-22/FSN-04 entitled "Formulation and Impact Evaluation of Selected Nutrition Intervention Methods on Reproductive Age Women" was submitted for approval of IHEC on 23.11.2021. The Approval number is AUW/IHEC/ FSN-21-22/XPD-04 (Appendix I).

Sixty women in the reproductive age group (18 – 35 years) were selected from the state of Odisha, using purposive sampling technique (Kothari, 2005), in which the number of samples required are selected deliberately or purposively depending upon the object of enquiry so that only the important items representing the true characteristics of the population were included. Women in the reproductive age group suffering from any kind of physiological disorder or disease were excluded. Totally, 60 (30 Pregnant and 30 Non-pregnant & non-lactating) women belonging to the reproductive age group constituted the total sample size for the study.

The method of scheduled questionnaire was used for data collection from the samples. Questionnaire was designed to assess Socio-Economic Status (SES) of the reproductive age women which included information about the age, sex, area of residence, type of family, education, occupation, and income of the reproductive age women (Appendix II). Figure I depicts the map of Odisha and the regions where the study was conducted.

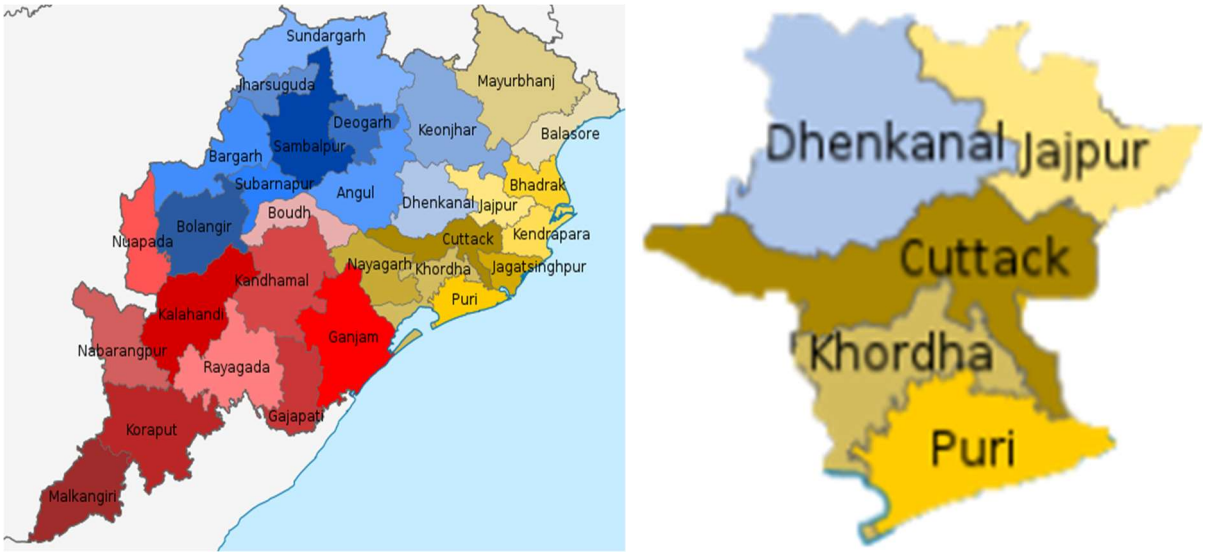


FIGURE 1

MAP OF ODISHA

PHASE II: ASSESSMENT OF NUTRITIONAL STATUS THROUGH DIET SURVEY

Dietary assessment is defined as the set of methods that measure and estimate food intake which can be converted to nutrient intake by means of food consumption tables (Dwyer, 2000).

24-hour Food Recall method was used to assess the food intake of the women. In this recall method of oral questionnaire diet survey, a set of "standardized cups", suited to local conditions were used. The cups were used mainly to aid the respondent recall the quantities prepared and fed to the individual members. Food Recall was performed for the women for three consecutive days wherein,

1) The homemaker or the member who cooked and served the family members was asked about the types of food preparations made at breakfast, lunch, teatime, and dinner.

2) An account of raw ingredients used for each of the preparations was obtained.

3) Information on the total cooked amount of each preparation was noted in terms of standardized cups.

4) The intake of each food item by the specific individual in the family such as the adolescent girl or pregnant women was assessed by using the standardized cups.

Food intake was computed from the food recall and compared with the suggested food allowances (ICMR 2020). The nutritive value was calculated for each reproductive age women.

The intake of macronutrients like energy, carbohydrate, protein and fat and micronutrients like calcium, iron, folate, vitamin B12, vitamin C and β-Carotene was calculated. The estimated intake these nutrients was then compared with their RDA (Recommended Dietary Allowances) as given by ICMR in 2020.

The comparison of the estimated food & nutrient intake with the RDA 2020 gave the food & nutrient gap of the women. After finding out the food and nutrient intake, the dietary intake patterns of pregnant and non-pregnant women were compared using paired samples T-test to find any possible relationship in them. Dietary intake according to socio-economic parameters was presented and Pearson's correlation coefficient (r) value was calculated to find out how the socio-economic factors of the samples affects their dietary patterns.

PHASE III: DEVELOPMENT OF A HEALTH MIX

A health mix was developed using ingredients that were deficit in the diets of the selected women belonging to the reproductive age group. The investigator decided to name the health mix as "Utkal Health Mix" based the former name of Odisha. The health mix was prepared with a view to bridge the nutrient gap in the diets of the women. The nutrients lacking include protein, calcium, iron, folate, vitamin C, and β-carotene. The ingredients used include ragi, corn, bengal gram, green gram, almond, fenugreek seeds, wheat flour and jaggery. The ingredients for the health mix were collected fresh from the local market of Odisha. Sensory evaluation was conducted to evaluate the acceptability of the health mix. The nutritive value of Utkal Health Mix was calculated using the Indian Food Consumption Tables 2017. The cost of the health mix per 200g was estimated. The composition of the Utkal Health Mix is given in Table I.

TABLE I

COMPOSITION OF UTKAL HEALTH MIX

Ingredients	Amount (g)
Ragi	30
Corn	30
Green Gram	30
Bengal Gram	30
Almonds	10
Fenugreek Seeds	10
Wheat Flour	20
Jaggery	40
Total	**200**

The importance of the ingredients used in Utkal health mix is as follows:

Ragi: Also known as finger millet, the major proteins of ragi are prolamins and glutelin and they appear to be adequate in all the essential amino acids. Ragi is rich in calcium, fibre and phytate and tannin which interfere with mineral availability.

Corn: Maize contains around 11 percent of protein. It is a good source of carotene and contains thiamine and folic acid in appreciable amounts. It is rich in calories and is used in Supplementary Nutrition Programmes and Integrated Child Development Services programmes to feed malnourished children.

Green Gram: Green gram is taken as superfood as it is one of the richest sources of plant-based protein in the world and offers 211 calories and 14.2 grams of proteins. This legume abounds iron, folate, carotenoids, and other bioactive compounds that enhance optimal health.

Bengal Gram: Bengal gram is a superfood that is loaded with health benefitting properties. Its satiety value can help avoid snacking cravings and avoid excess calories. It is rich in calcium, iron, folate, and β-Carotene.

Almonds: Almonds contain fibre, which is essential for proper digestion while vitamin E keeps skin and hair healthy. It contains magnesium, riboflavin, and folate which are required for proper brain functioning as well as maintaining the nervous system. Manganese regulates body weight in both mother and child. It helps in maintaining milk supply during lactation. They are also rich in iron, protein, and healthy fats.

Fenugreek Seeds: Fenugreek has several purported health benefits, especially for females such as increasing breast milk production, relieving menstrual cramps, and improving sex drive. They are used as an herbal galactagogue - a substance that promotes lactation in humans. It is one of the most used galactagogues.

Wheat Flour: Wheat flour not only improves quantity and quality of protein but also improves functional characteristics such as moisture retention and less oil absorption in the product.

Jaggery: Jaggery can be an excellent substitute for sugar for the health-conscious people as it is not only sweet but also contains essential nutrients and minerals. This superfood is extremely low in saturated fat, cholesterol, and sodium. Additionally, it is rich in essential minerals such as magnesium, phosphorus, iron, and calcium.

METHOD:

- Ragi, corn, bengal gram, green gram, almonds, and fenugreek seeds were washed properly.
- Then they were dry roasted and ground into fine powder separately without adding salt.
- Then wheat flour and jaggery were added which are already available in powder form.
- The powdered ingredients were added in required amounts into a clean and dry bowl.
- Then all the ingredients were thoroughly mixed to prepare the health mix (Plate 1).

The Utkal Health Mix is easy to make with appreciable yield made with ragi, corn, bengal gram, green gram, almond, fenugreek seeds, wheat flour and jaggery. The health mix could be administered in the form of porridge, nutri balls, pancakes, and cookies.

a) Ragi:


b) Corn:



c) Green Gram:



d) Bengal Gram:



e) Peanuts:


f) Fenugreek Seeds:


g) Wheat Flour & Jaggery:


h) Preparing the Health Mix:



i)Packaging and Storage:


PLATE 1

PREPARATION OF UTKAL HEALTH MIX

COST CALCULATION:

The cost to produce the health mix was calculated based on the existing prices of the raw ingredients prevalent in the market during April 2022 and the amount of each ingredient that was used to make the product. The approximate cost of gas/fuel used for roasting ragi, corn, green gram, bengal gram, almonds and fenugreek seeds and electricity for the usage of light for 30 minutes and blender for 5 minutes for grinding the ingredients was also added.

EVALUATION OF ACCEPTABILITY:

The product was rated by 30 semi-trained panel members (Plate 2), using the standard protocols for sensory evaluation. The investigators name, the ingredients and other details about the product were not disclosed to the panel members to avoid biased rating. The attributes that were rated include appearance, color, flavor, texture/mouth feel, and taste. The above attributes were rated on a nine-point hedonic scale (Matthew. *et.al.,* 2020) indicating the following scores:

9 – Like extremely	8 – Like very much	7 – like moderately
6 – Like slightly	5 – Neither like nor dislike	4 – Dislike slightly
3 – Dislike moderately	2 – Dislike very much	1 – Dislike extremely

The criteria considered for sensory evaluation (Sharif. *et.al.,* 2017) are discussed as follows:

APPEARANCE:

The most important attribute for any food's appearance is its color, especially when it is directly associated with other food-quality attributes. Surface characteristics of food products contribute to the appearance. The quality of food item may simply be judged from its appearance when it is placed in front of a consumer.

COLOUR:

Food may considerably vary from place and season depending upon the numerous factors. Color also provides useful guide to quality control and is used by food processors as a criterion for selecting raw material. Food appearance determined mostly by surface color is the first sensation that the consumer perceives and uses as a tool to either accept or reject food.

FLAVOUR:

The term ‘Flavor’ indicates taste, smell and feeling of the food on the tongue. The sense of taste is limited to three characteristics namely sweet, salt and bitter. Flavor is the sensory impression of a food or other substance and is determined mainly by the chemical senses of taste and smell. The “trigeminal senses”, which detect chemical irritants in the mouth and throat, may also help in determining flavor.

TEXTURE:

Texture includes physical factors such as softness, hardness, juiciness, grittiness, or chewiness felt by the consumer. When an individual handles the food with finger or tongue or teeth, or palate, any deviation from the expected texture is referred to as a quality defect. Texture refers to those qualities of a food that can be felt with the fingers, tongue, palate, or teeth. Texture is also an index of food quality. Texture is one of the major criteria which consumers use to judge the quality and freshness of many foods.

TASTE:

Taste may be defined as the sensation derived from food, as interpreted through the tongue to the brain sensory system. Taste is eating food in small quantity and assessing it for acceptability. The four primary taste sensations are sweet, salt, sour, bitter and the fifth sensation is Unami (delicious). All these tastes trigger the brain’s response to assess the overall acceptability of a food.

PLATE 2

SENSORY EVALUATION IN PROGRESS

PHASE IV: IMPARTING NUTRITION EDUCATION AND IMPACT EVALUATION ON KAP

All the sixty women belonging to the reproductive age group were included in the nutrition education program. The nutrition education questionnaire was formulated (with 21 knowledge, 20 attitude and 8 practice related questions) and administered to the women and evaluated to understand their initial knowledge (Appendix III). Attitude and practice regarding nutrition and lifestyle in pregnancy. Based on their initial knowledge, attitude and practice, nutrition education materials were prepared. Need based nutrition education was imparted to the women.

In addition to pregnancy outcomes, nutrition education (NE) is an important factor for women of reproductive age. NE programs are significant because they aim to improve people' dietary intakes by encouraging behavioral changes such as food selection and cooking ability, goal setting, motivation, and support for change attempts (Jeewon. *et.al.,* 2015).

IMPARTING NUTRITION EDUCATION:

Nutrition education was imparted to the 60 reproductive age women through PowerPoint presentations, digital posters, and videos on various digitals platforms like google meet, website, and YouTube. As the present study was carried out in the COVID period when it was difficult to have face to face contact with vulnerable groups like pregnant women, digital platform was chosen as the medium for nutrition education.

POWERPOINT PRESENTATIONS:

Power Point Presentation prepared by the researcher was projected to the women as it is a way of attracting audience towards expression of their views and arguments. Power point presentation combines audio and visual, making it easier for the audience to understand the concepts. Even the normal teaching or training becomes interactive by just using presentations in lectures (Paul, 2008). Nutrition education was imparted, and the impact of education program was evaluated using the same questionnaire.

Three PowerPoint presentations were made based on information regarding:

Nutrition Education on Pre-Pregnancy:

- Food and Nutrient Requirements and Allowances
- Pre-conceptional Care
- Maternal Underweight Risks

- Importance of healthy eating
- Nutrient Dense foods
- Physical activity routine
- Body weight
- Folic Acid

Nutrition Education on Pregnancy:

- Metabolic adaptations of pregnancy
- Macronutrients (Importance & Deficiency Diseases): Carbohydrate, Protein & Fat
- Micronutrients (Importance & Deficiency Diseases): Folate, Vitamin B12, Vitamin D, Calcium, Iron, and Iodine
- Avoidance of Food Borne Illness: Listeriosis, Salmonella, toxoplasmosis
- Obesity
- Gestational Diabetes Mellitus
- Eating Fish during Pregnancy
- Physical activity for a healthy pregnancy
- Complications in Pregnancy
- Nausea and vomiting in pregnancy
- Nutrition in Pregnancy: Fact or Fiction

Nutrition Education on Post-Pregnancy:

- Eclampsia
- Breast Feeding
- Colostrum
- Infant Feeding
- Weaning Foods
- Amylase Rich Food
- Immunization

DIGITAL POSTERS:

A digital poster is a poster that's displayed on a screen instead of being printed. Eight digital posters were prepared out of which five were in the investigator's regional language [Odia] (Plate 3). The eight digital posters were based on the following information:

- Importance of Folic Acid in Pregnancy
- Role of Micronutrients & Trace Elements in Pregnancy
- Maternal Obesity
- Diet Diversity
- Iron Folic Acid Tablets
- Early Breastfeeding
- Exclusive Breastfeeding
- Complementary Feeding

PLATE 3

DIGITAL POSTERS

GOOGLE MEET:

Two sessions were organized through google meet for the women on 23rd April 2022 (Sunday) and 30th April (Sunday) to impart nutrition education. The session lasted for over one hour. In the meet, three PowerPoint presentations and eight digital posters were explained in detail to the audience. Plate 4 and 5 depicts some of the pregnant and non-pregnant audience for nutrition education in google meet.

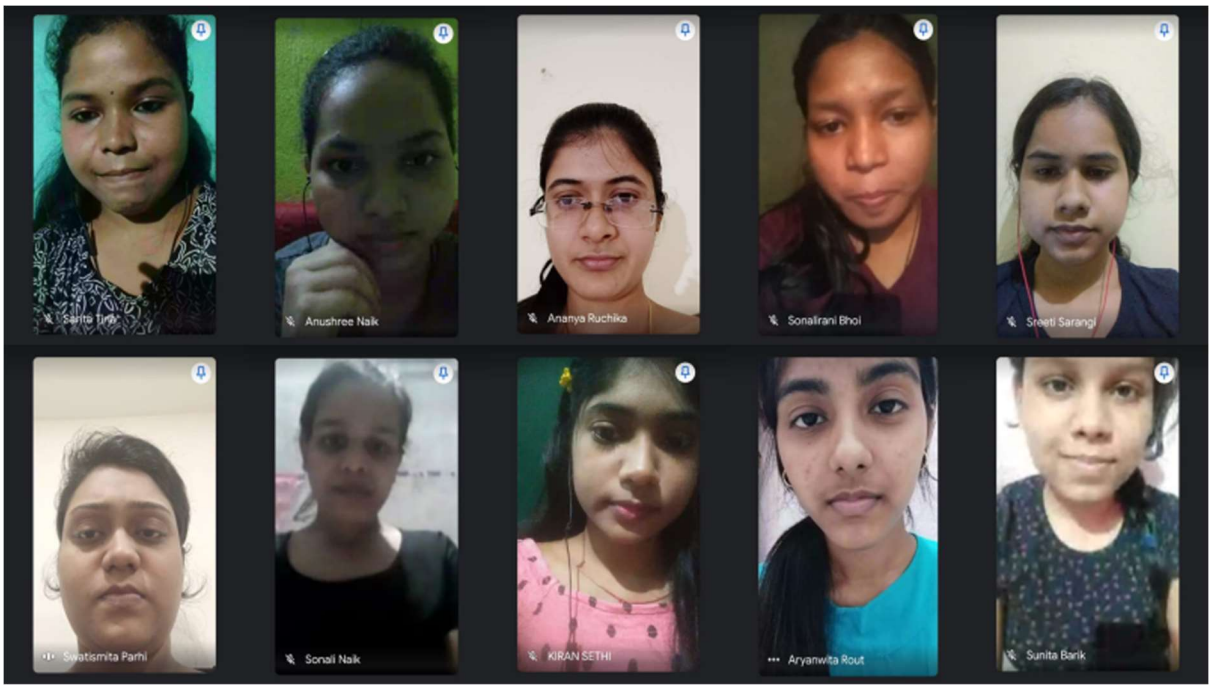


PLATE 4

NUTRITION EDUCATION FOR NON-PREGNANT WOMEN

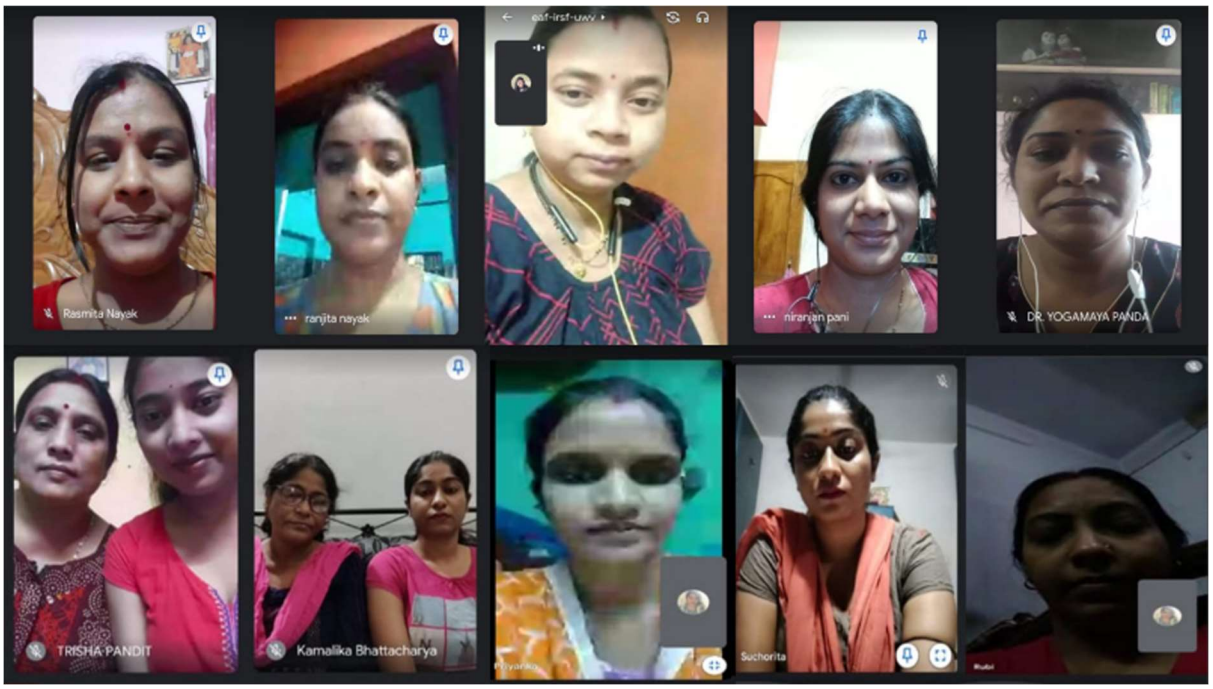


PLATE 5

NUTRITION EDUCATION FOR PREGNANT WOMEN

WEBSITE:

A website titled "Mothers Guide" was created and uploaded on the internet to share information in the form of presentations, posters, and videos as nutrition education material. A feedback form was also attached in the feedback section of the website to get the valuable feedback of the audience which currently has 30 responses.

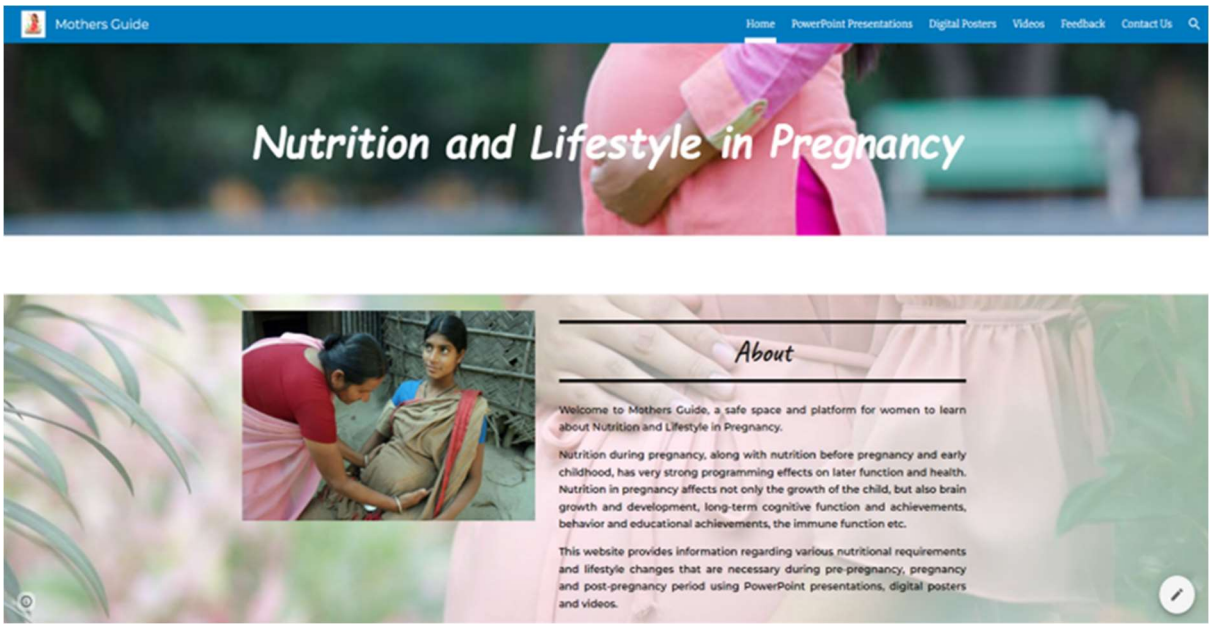


PLATE 6

'MOTHERS GUIDE' WEBSITE FOR NUTRITION EDUCATION

YOUTUBE:

A channel titled "Guide to Maternal Care" was created in YouTube to share the videos made for nutrition education purpose. The channel currently has 58 subscribers. The first video uploaded was Nutrition and Lifestyle Changes in Pre-Pregnancy Phase on 27th April 2022, Wednesday, has 135 views in YouTube. The second video uploaded was Nutrition and Lifestyle Changes During Pregnancy (Part -1) on 29th April 2022, Friday, has 98 views on YouTube. The third video was Nutrition and Lifestyle Changes During Pregnancy (Part -2) on 6th May 2022, Friday, has 85 views on YouTube. The fourth video was Nutrition and Lifestyle Changes in Post-Pregnancy Phase on 9th May 2022, Monday, has 60 views on YouTube.

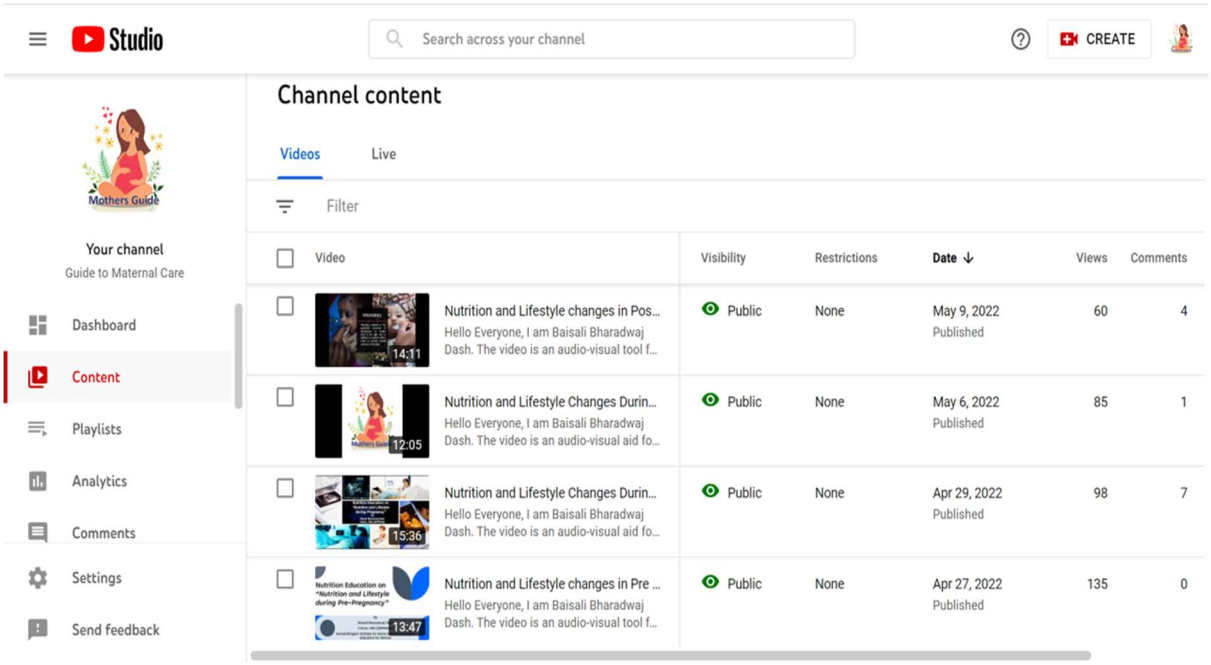


PLATE 7

YOUTUBE CHANNEL FOR NUTRITION EDUCATION

EVALUATION ON KAP:

The impact of nutrition education program was evaluated using the same nutrition education questionnaire which was provided initially to all the women belonging to the reproductive age group, Paired samples T-test was done to find out the improvement in knowledge, attitude and practice after nutrition education was provided. Pearson's correlation coefficient (r) value was calculated to find any possible relationship between socio-economic factors and difference in KAP scores of the samples.

STATISTICAL ANALYSIS:

The statistical analysis was done by using the SPSS software packages Version 26.0. Pearson's Correlation Coefficient was calculated to find out the correlation between different socio-economic factors, between socio-economic factors and food & nutrient intake and between socio-economic factors and KAP. The sensory analysis data was interpreted and analyzed by using mean and standard deviation. Paired sample T-Test was done between dietary intake patterns of pregnant and non-pregnant women. The KAP data was interpreted and analyzed by using paired sample T-Test to find out the effect of nutrition education.

The research design followed in the study is depicted in Figure 2.

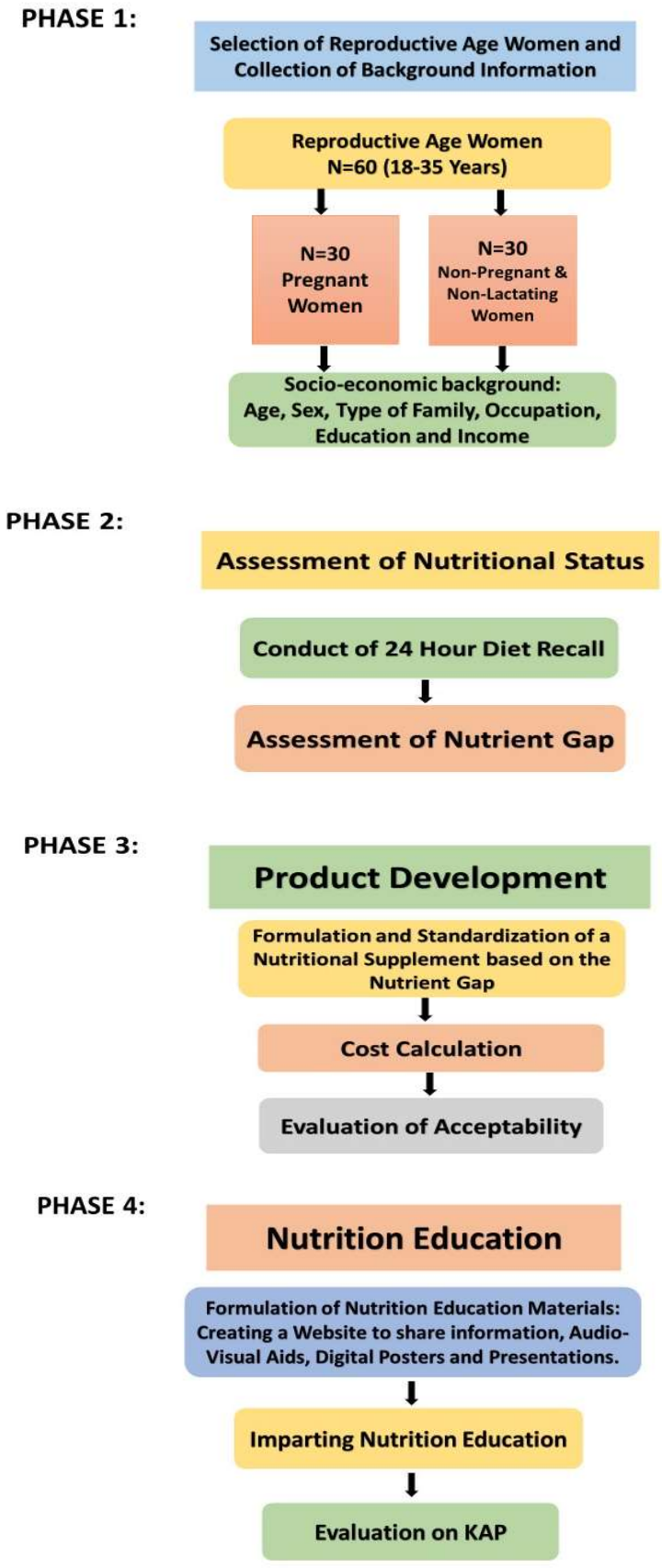


FIGURE 2

RESEARCH DESIGN

Results and Discussion

RESULTS AND DISCUSSION

The results of the present investigation titled **'Formulation and Impact Evaluation of Selected Nutrition Intervention Methods on Reproductive Age Women'** are presented and discussed under the following headings:

A. Socio-Economic Status of Reproductive Age Women
   1. Correlation Between the Socio-Economic Factors

B. Dietary Details of the Reproductive Age Women
   1. Gap in Food Intake among Pregnant Women
   2. Gap in Nutrient Intake among Pregnant Women
   3. Gap in Food Intake among Non – Pregnant Women
   4. Gap in Nutrient Intake among Non – Pregnant Women
   5. Comparison between the Dietary Gaps
   6. Dietary Intake and Socio – Economic Status

C. Details on the Nutritional Supplement
   1. Nutritive Value of Utkal Health Mix
   2. Acceptability of Utkal Health Mix
   3. Bridging the Nutrient Gap
   4. Cost of Health Mix
   5. Comparison between Commercial Health Mix and Utkal Health Mix

D. Effect of Nutrition Intervention
   1. Effect of Nutrition Education on knowledge, Attitude and Practice
   2. Overall Effect of Intervention

A. SOCIO-ECONOMIC STATUS OF REPRODUCTIVE AGE WOMEN

Table II and figures 3 to 10 provide the Socio-Economic and background information namely, age, type of family, type of religion, area of residence, occupation, annual income, educational status, marital status, and pregnancy status of the reproductive age women investigated in the present study.

TABLE II

SOCIO-ECONOMIC STATUS OF REPRODUCTIVE AGE WOMEN

(N = 60)

Socio-Economic Parameters	Criteria	Respondents	Percentage (%)
Age (in years)	18 – 25	39	65
	26 – 35	21	35
Religion	Hindu	49	81.67
	Muslim	7	11.67
	Christian	4	6.66
Area of Residence	Urban	47	78.3
	Rural	13	21.7
Type of Family	Joint	23	38.3
	Nuclear	37	61.7
Education	High Secondary	6	10
	Graduate	34	56.7
	Postgraduate	20	33.3
Occupation	Government Employee	11	18.3
	Private Sector	18	30
	Home Maker	31	51.7
***Annual Income (Rs. In Lakhs)**	Up to 3 (EWS)	33	55
	3 – 6 (LIG)	17	28.3
	6 – 12 (MIG)	10	16.7
Marital Status	Married	39	65
	Un-Married	21	35
Pregnancy Status	Pregnant	30	50
	Non-Pregnant	30	50

***HUDCO 2021;** EWS – Economically Weaker Section; LIG – Low Income Group; MIG – Middle Income Group.

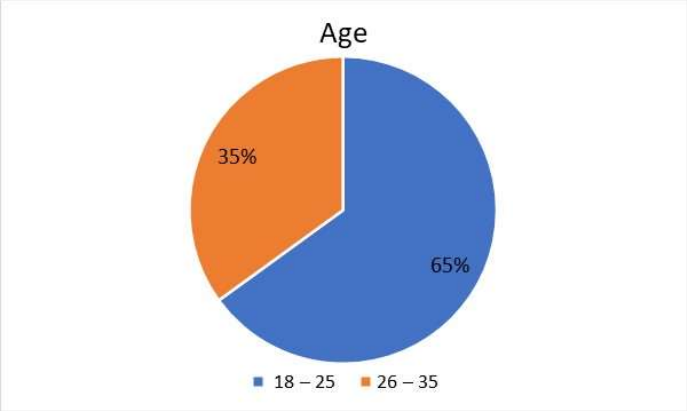


FIGURE 3

DISTRIBUTION ACCORDING TO AGE

Figure 3 shows that 65 percent (39 women) belonged to the age group of 18 – 25 years and the remaining 35 percent (21 women) belonged to the age group of 26 – 35 years. A similar study titled "Food and Nutrition-Related Knowledge, Attitudes, and Practices among Reproductive-age Women in Marginalized Areas in Sri Lanka" conducted by Ploeger. *et al.,* (2020) who reports that 70.6 percent of pregnant women belonged to the age group of 15 – 35 years.

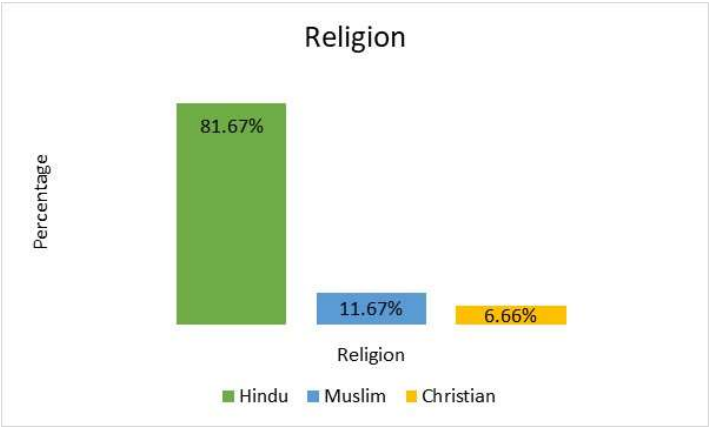


FIGURE 4

DISTRIBUTION ACCORDING TO RELIGION

Figure 4 shows that 81.67 percent (49 women) were Hindus, 11.67 percent (07 women) were Muslims, and the remaining 6.66 percent (04 women) were Christians. According to the Census (2011), Hinduism is the most popular religion in Odisha with 93.63 percent, Christianity is second most popular religion with 2.77 percent and Islam is followed by 2.17 percent. Mishra (2006) from a study on Dietary intake and health status of pregnant women and their association with course and outcome of pregnancy conducted reports that the 97 percent of the women included in the study were Hindus.

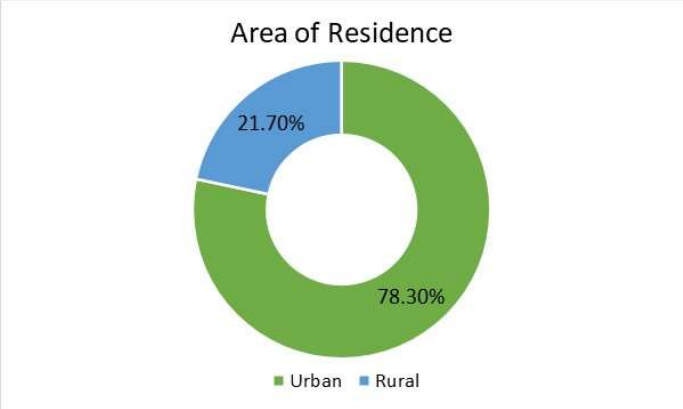


FIGURE 5

DISTRIBUTION ACCORDING TO AREA OF RESIDENCE

Figure 5 shows that 78.3 percent (47 women) reside in urban area and the remaining 21.7 percent (13 women) reside in rural area. However, according to Census (2011) 83.31 percent population of Odisha reside in rural areas and the remaining 16,69 percent reside in urban areas. The finding is supported by a study titled "Prevalence, predictors and reasons for home delivery amongst women of childbearing age in Dodoma Municipality in central Tanzania" conducted by Sanga. *et al.,* (2020) who reported that 68.6 percent women of reproductive age group reside in urban areas and 31.4 percent women reside in rural areas.

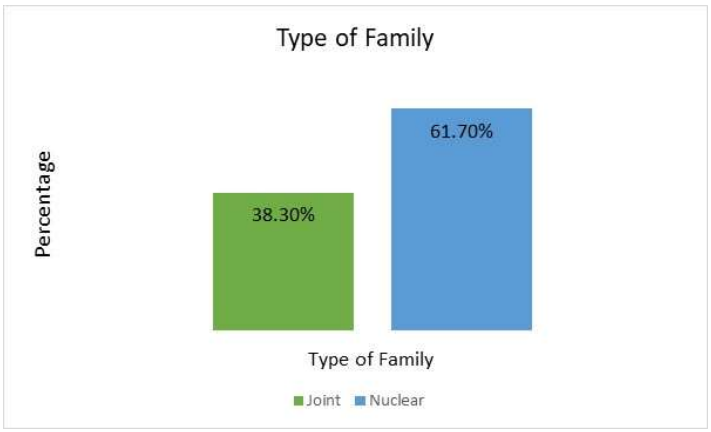


FIGURE 6

DISTRIBUTION ACCORDING TO TYPE OF FAMILY

Figure 6 shows that 61.7 percent (37 women) were living in nuclear type of family and the remaining 38.3 percent (23 women) were living in joint family setting. Mehra. *et al.,* (2020) report from their study on the dietary intake of reproductive age women from four districts of India that 53.6 percent of the women live in nuclear families and the remaining 46.4 percent women live in joint families.

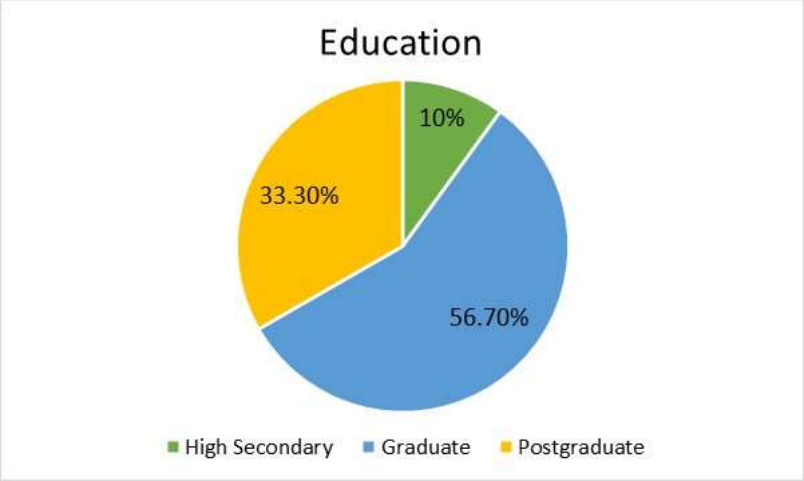


FIGURE 7

DISTRIBUTION ACCORDING TO EDUCATION

Figure 7 shows that 56.7 percent (34 women) were graduates, 33.3 percent (20 women) were postgraduates and the remaining 10 percent (6 women) had completed higher secondary education. However, the literacy rate in Odisha according to Census (2011) stood at 72.87 percent, where male literacy rate was at 81.59 percent while female literacy was at 64.01 percent respectively. The findings of the present study are in near accordance with the study titled "Food and Nutrition-Related Knowledge, Attitudes, and Practices among Reproductive-age Women in Marginalized Areas in Sri Lanka" by Weerasekara. *et al.,* (2020) who report that 91.3 percent of the reproductive age women were educated, of which most had at least primary education.

FIGURE 8

DISTRIBUTION ACCORDING TO OCCUPATION

Figure 8 shows that 51.7 percent (31 women) were homemakers, 30 percent (18 women) work in private sector and the remaining 18.3 percent (11 women) were government employees. This finding is supported by a study titled "Predictors of institutional delivery service utilization among women of reproductive age in Gambia" conducted by Bishwajit. *et al.,* (2020) who report that 53.39 percent women were housewives, and the remaining 46.61 percent were employed.

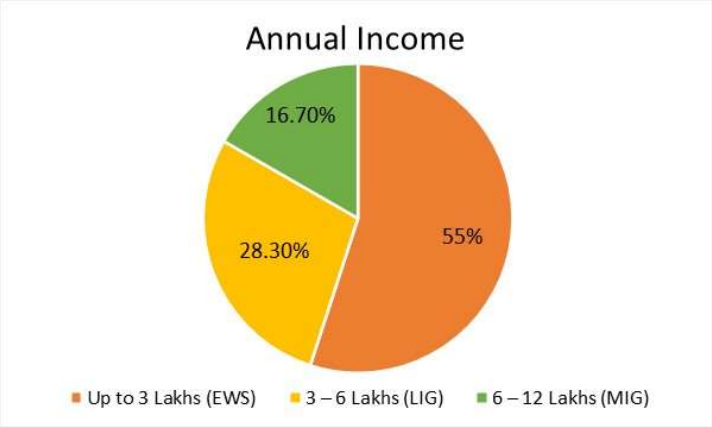


FIGURE 9

DISTRIBUTION ACCORDING TO ANNUAL INCOME

Figure 9 shows the distribution of samples according to HUDCO income classification (April 2021). It shows that majority of the women i.e., 55 percent of the women belonged to Economically Weaker Sections (EWS) with annual income up to Rs. 3 Lakhs, 28.3 percent women belonged to low-income groups with annual income between Rs. 3 – 6 Lakhs and the remaining 16.7 percent women belonged to middle income groups with annual income between Rs. 6 – 12 Lakhs.

FIGURE 10

DISTRIBUTION ACCORDING TO MARITAL STATUS

Figure 10 shows that 65 percent (39 women) were married, and the remaining 35 percent (21 women) were un-married. Similar findings have been reported by "Dietary Intake Patterns among Lactating and Non-Lactating Women of Reproductive Age in Rural Zambia" by Alders. *et al.,* (2019) where 70.4 percent women of child-bearing age were married, and the remaining 29.6 percent women were unmarried.

CORRELATION BETWEEN THE SOCIO-ECONOMIC FACTORS

Table III reveals the correlation between the socio-economic parameters of the study.

TABLE III

CORRELATION BETWEEN THE SOCIO-ECONOMIC FACTORS

Socio-Economic Factors		Pearson's Correlation Coefficient (r)
Area of Residence	**Type of Family**	0.415**
	Education	0.655**
	Occupation	0.457**
	Annual Income	0.803**
Type of Family	**Education**	0.633**
	Occupation	0.834**
	Annual Income	0.644**
Education	**Occupation**	0.753**
	Annual Income	0.766**
Occupation	**Annual Income**	0.710**
**. Correlation is significant at the 0.01 level (2-tailed).		

Area of residence correlated positively with type of family (r=0.415), education (r=0.655), occupation (r=0.457), and annual income (r=0.803). Type of family correlated positively with education (r=0.633), occupation (r=0.834), and annual income (r=0.644). Education correlated positively with occupation (r=0.753), and annual income (r=0.766). Occupation correlated positively with annual income (r=0.710).

The findings of the study suggest that the area of residence namely urban area corresponded to higher incidence of nuclear families, better education and occupation facilities and higher annual income. Similarly, women from nuclear families had better exposure to receiving higher education, better occupation, and higher annual income. Similarly, higher education levels led to better occupation, and higher annual income. Lastly, better occupation status correlated with higher annual income.

B. DIETARY DETAILS OF REPRODUCTIVE AGE WOMEN

The dietary details of reproductive age women included in the present study are presented in the Tables IV– X.

1. GAP IN FOOD INTAKE AMONG PREGNANT WOMEN

The food gap in the intake of cereals & millets, pulses, green leafy vegetables, other vegetables, roots & tubers, fruits, milk, nuts & oil seeds, and spices of pregnant women are presented in Table IV and Figure 11.

TABLE IV
GAP IN FOOD INTAKE AMONG PREGNANT WOMEN

(N=30)

Food Groups	RDA*	Average Intake	Excess/Deficit
Cereals & Millets	325	290	-35
Pulses	90	88.72	-1.78
Green Leafy Vegetables	100	56.56	-43.44
Other Vegetables	200	191.6	-8.4
Roots & Tubers	100	104.21	+ 4.21
Fruits	150	97.39	-52.61
Milk	400	383.8	-16.2
Fats & Oils	25	31.07	+ 6.07
Nuts & Oil Seeds	40	43.13	+ 3.13
Spices	10	18.44	+ 8.44

***ICMR (2020)**

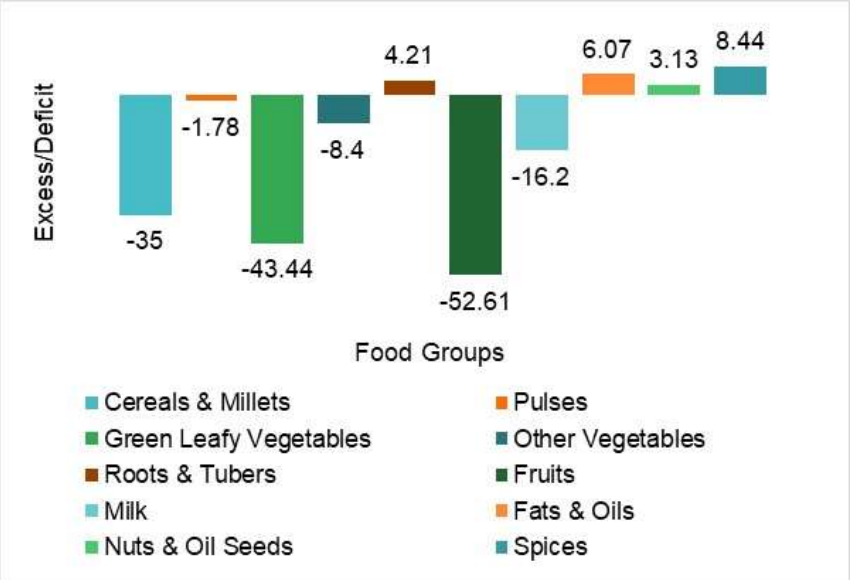


FIGURE 11

GAP IN FOOD INTAKE AMONG PREGNANT WOMEN

The average intake of cereals, pulses, green leafy vegetables, other vegetables, fruits, and milk was less than the RDA given by ICMR whereas the average intake of roots and tubers, fats and oils, nuts and oil seeds and spices were in excess. The average intake of cereals and millets was 290 g/day as against RDA of 325 g/day with a deficit of 35 g. The average intake of pulses was 88.72 g/day as against RDA of 90 g/day with a deficit of 1.78 g. The average intake of green leafy vegetables was 56.56 g/day as against RDA of 100 g/day with a deficit of 43.44 g. The average intake of other vegetables was 191.6 g/day as against RDA of 200 g/day with a deficit of 8.4 g. The average intake of roots & tubers was 104.21 g/day as against RDA of 100 g/day with an excess of 4.21 g. The average intake of fruits was 97.39 g/day as RDA of 150 g/day with a deficit of 52.61 g. The average intake of milk was 383.8 ml/day as against RDA of 400 ml/day with a deficit of 16.2 ml. The average intake of fats & oils was 31.07 g/day as against RDA of 25 g/day with an excess of 6.07 g. The average intake of nuts and oil seeds was 43.13 g/day as against RDA of 40 g/day with an excess of 3.13 g. The average intake of spices was 18.44 g/day as RDA of 10 g/day with an excess of 8.44 g.

2. GAP IN NUTRIENT INTAKE AMONG PREGNANT WOMEN

The nutrient gap in the intake of Energy, Carbohydrate, Protein, Fat, Calcium, Iron, Folate, Vitamin B_{12}, Vitamin C and β-Carotene of pregnant women are presented in the Table V and Figure 12.

TABLE V
GAP IN NUTRIENT INTAKE AMONG PREGNANT WOMEN

(N=30)

Macro-Nutrients	RDA*	Average Intake	Excess / Deficit
Energy (Kcal)	2010	2033.7	+ 23.7
Carbohydrate (g)	175	181.23	+ 6.23
Protein (g)	60	50.12	- 11.33
Fat (g)	30	33.34	+ 3.34
Calcium (mg)	1000	803.3	- 196.7
Iron (mg)	40	34.33	- 5.67
Folate(µg)	570	440.6	- 129.4
Vitamin B_{12} (µg)	2.75	3.17	+ 0.42
Vitamin C (mg)	80	88.54	+ 8.54
β-Carotene (µg)	900	786.1	- 113.9

***ICMR (2020)**

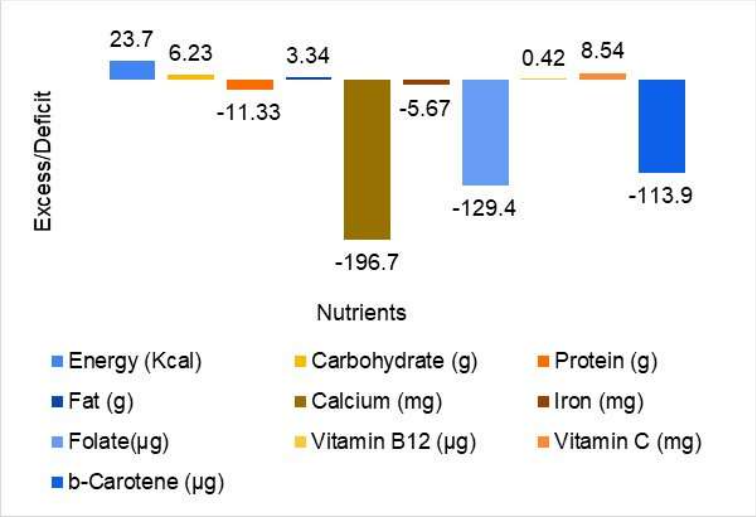


FIGURE 12

GAP IN NUTRIENT INTAKE AMONG PREGNANT WOMEN

The average intake of protein, calcium, iron, folate, and β-carotene was less than the RDA given by ICMR for pregnant women whereas the intake of energy, carbohydrate, fat, vitamin B_{12}, and vitamin C were in excess. The average intake of energy was 2033.7 Kcal/day as against RDA of 2010 Kcal/day with an excess of 23.7 kcal. The average intake of carbohydrate was 181.23 g/day as against RDA of 175 g/day with an excess of 6.23 g. The average intake of protein was 50.12 g/day as against RDA of 60 g/day with a deficit of 11.33 g. The average intake of fat was 33.34 g/day as against RDA of 30 g/day with an excess of 3.34 g. The average intake of calcium was 803.3 mg/day as against RDA of 1000 mg/day with a deficit of 196.7 mg. The average intake of iron was 34.33 mg/day as against RDA of 40 mg/day with a deficit of 5.67 mg. The average intake of folate was 440.6 µg/day as RDA of 570 µg/day with a deficit of 129.4 µg. The average intake of vitamin B12 was 3.17 µg/day as against RDA of 2.75 µg/day with an excess of 0.42 µg. The average intake of vitamin C was 88.54 mg/day as RDA of 80 mg/day with an excess of 8.54 mg. The average intake of β-carotene was 786.1 µg/day as against RDA of 900 µg/day with a deficit of 113.9 µg.

The findings are supported by a study titled "Dietary Intake and Health Status of Pregnant Women and Their Association with Course and Outcome of Pregnancy" conducted by Jena (2006), who reported similar food intake pattern in the pregnant women. In case of macronutrients, energy was found to be excess. Percentage excess of energy from standard of sedentary work category was 29.37. In case of micronutrients, iron, calcium, and carotene were found to be deficit in pregnant women. Percentage deficit of iron, calcium, and carotene from standard of sedentary work category was 14.105, 15.72, and 17.75 respectively.

3. GAP IN FOOD INTAKE AMONG NON-PREGNANT WOMEN

The food gap in the intake of cereals & millets, pulses, green leafy vegetables, other vegetables, roots & tubers, fruits, milk, nuts & oil seeds, and spices of non-pregnant women are presented in Table VI and Figure 13.

TABLE VI
GAP IN FOOD INTAKE AMONG NON-PREGNANT WOMEN

(N=30)

Food Groups	RDA*	Average Intake	Excess/Deficit
Cereals & Millets	200	173.91	-26.09
Pulses	60	48.82	-11.18
Green Leafy Vegetables	100	52.63	-47.37
Other Vegetables	200	187.33	-12.67
Roots & Tubers	100	111.74	+ 11.74
Fruits	150	123.67	-26.33
Milk	300	292.39	-7.61
Fats & Oils	15	27.12	+ 12.12
Oil Seeds & Nuts	30	30.58	+ 0.58
Spices	10	13.42	+ 3.42

***ICMR (2020)**

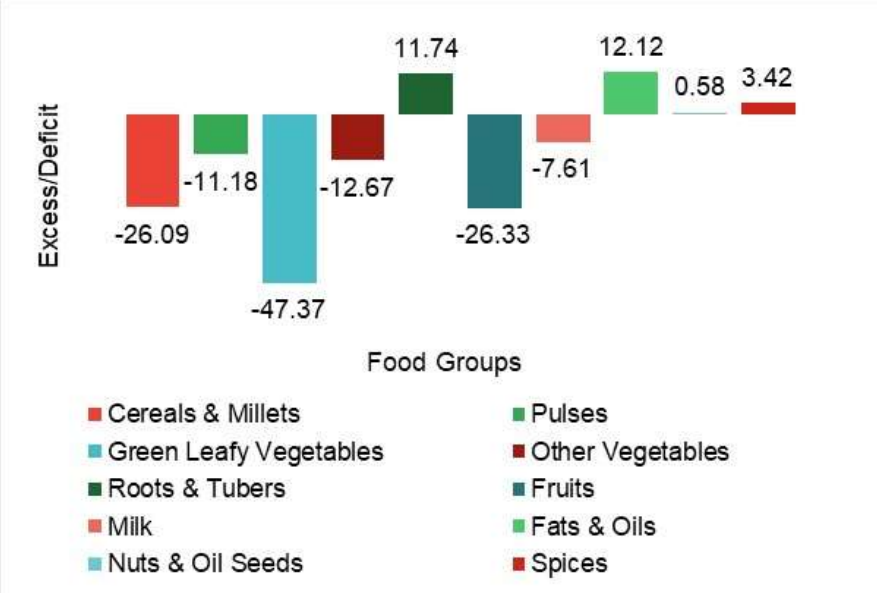


FIGURE 13

GAP IN FOOD INTAKE AMONG NON-PREGNANT WOMEN

The average intake of cereals, pulses, green leafy vegetables, other vegetables, fruits, and milk was less than the RDA given by ICMR whereas the average intake of roots and tubers, fats and oils, nuts and oil seeds and spices were excess. The average intake of cereals and millets was 173.91 g/day as against RDA of 200 g/day with a deficit of 26.09 g. The average intake of pulses was 48.82 g/day as against RDA of 60 g/day with a deficit of 11.18 g. The average intake of green leafy vegetables was 52.63 g/day as against RDA of 100 g/day with a deficit of 47.37 g. The average intake of other vegetables was 187.33 g/day as against RDA of 200 g/day with a deficit of 12.67 g. The average intake of roots & tubers was 111.74 g/day as against RDA of 100 g/day with an excess of 11.74 g. The average intake of fruits was 123.67 g/day as against RDA of 150 g/day with a deficit of 26.33 g. The average intake of milk was 292.39 ml/day as against RDA of 300 ml/day with a deficit of 7.61 ml. The average intake of fats & oils was 27.12 g/day as against RDA of 15 g/day with an excess of 12.12 g. The average intake of nuts and oil seeds was 30.58 g/day as against RDA of 30 g/day with an excess of 0.58 g. The average intake of spices was 13.42 g/day as against RDA of 10 g/day with an excess of 3.42 g.

4. GAP IN NUTRIENT INTAKE AMONG NON-PREGNANT WOMEN

The nutrient gap in the intake of Energy, Carbohydrate, Protein, Fat, Calcium, Iron, Folate, Vitamin B_{12}, Vitamin C and β-Carotene of non-pregnant women are presented in Table VII and Figure 14.

TABLE VII
GAP IN NUTRIENT INTAKE AMONG NON-PREGNANT WOMEN

(N=30)

Macro-Nutrients	RDA*	Average Intake	Excess / Deficit
Energy (Kcal)	1660	1702.73	+ 42.73
Carbohydrate (g)	130	136.4	+ 6.4
Protein (g)	45.7	34.33	- 22.61
Fat (g)	20	24.5	+ 4.5
Calcium (mg)	1000	781	- 219
Iron (mg)	29	24.3	- 4.7
Folate (µg)	220	124.56	- 95.44
Vitamin B12 (µg)	2.5	4.5	+ 2
Vitamin C (mg)	65	64.4	- 0.6
β-Carotene (µg)	840	733.3	- 106.7

***ICMR (2020)**

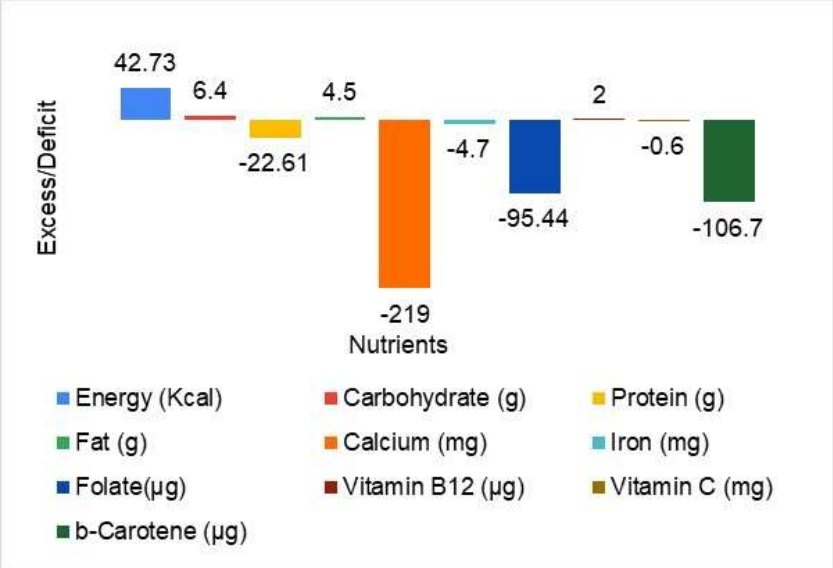


FIGURE 14

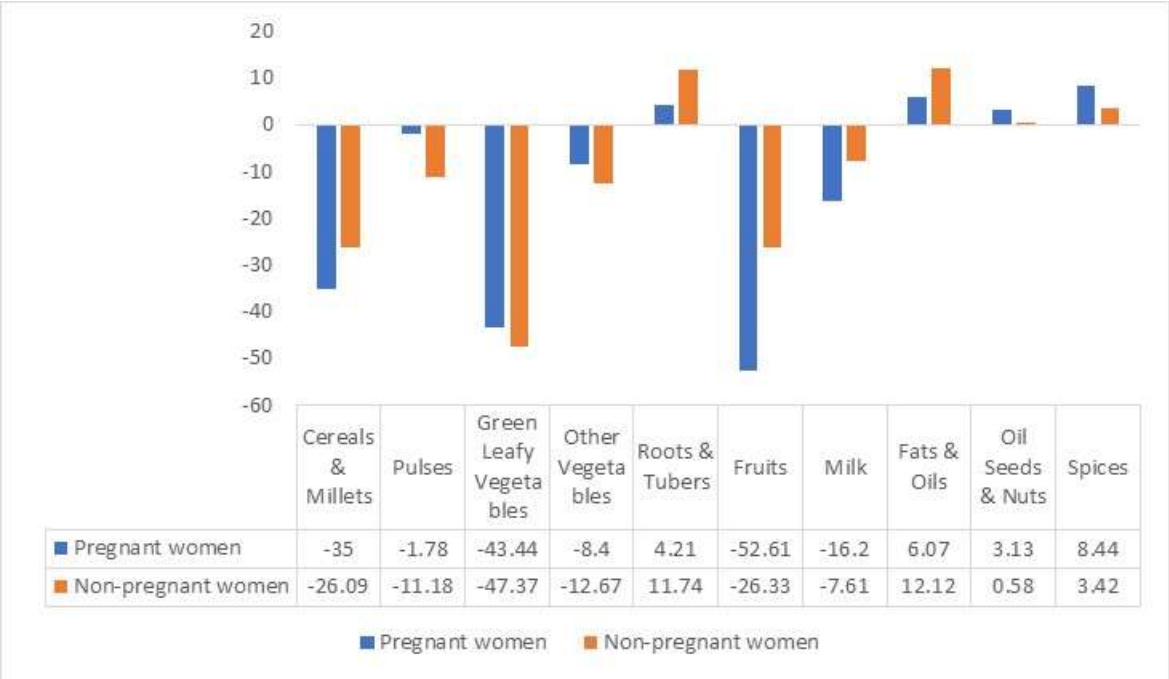
GAP IN NUTRIENT INTAKE AMONG NON-PREGNANT WOMEN

The average intake of protein, calcium, iron, folate, vitamin C, and β-carotene was less than the RDA given by ICMR for non-pregnant women whereas the intake of energy, carbohydrate, fat, and vitamin B12 were in excess. The average intake of energy was 1702.73 Kcal/day as against RDA of 1660 Kcal/day with an excess of 42.73 kcal. The average intake of carbohydrate was 136.4 g/day as against RDA of 130 g/day with an excess of 6.4 g. The average intake of protein was 34.33 g/day as against RDA of 45.7 g/day with a deficit of 22.61 g. The average intake of fat was 24.5 g/day as against RDA of 20 g/day with an excess of 4.5 g. The average intake of calcium was 781 mg/day as against RDA of 1000 mg/day with a deficit of 219 mg. The average intake of iron was 24.3 mg/day as against RDA of 29 mg/day with a deficit of 4.7 mg. The average intake of folate was 124.56 µg/day as against RDA of 220 µg/day with a deficit of 95.44 µg. The average intake of vitamin B12 was 4.5 µg/day as against RDA of 2.5 µg/day with an excess of 2 µg. The average intake of vitamin C was 64.4 mg/day as against RDA of 65 mg/day with a deficit of 0.6 mg. The average intake of β-carotene was 733.3 µg/day as against RDA of 840 µg/day with a deficit of 106.7 µg.

The findings are supported by a study titled "Dietary Intake across Reproductive Life Stages of Women in India: A Cross-Sectional Survey from 4 Districts of India" conducted by Singh. et.al., (2020), who report that adolescents and newly married women on an average consumed less than three-fourths of the recommended intakes of iron, calcium, folic acid, and protein in one day. On the contrary, the consumption of fat was 140 percent of the recommended intake among newly married women.

5. COMPARISON BETWEEN THE DIETARY INTAKE PATTERNS

The comparison between the food and nutrient intake patterns of pregnant and non-pregnant women are given in figure 15 and 16.

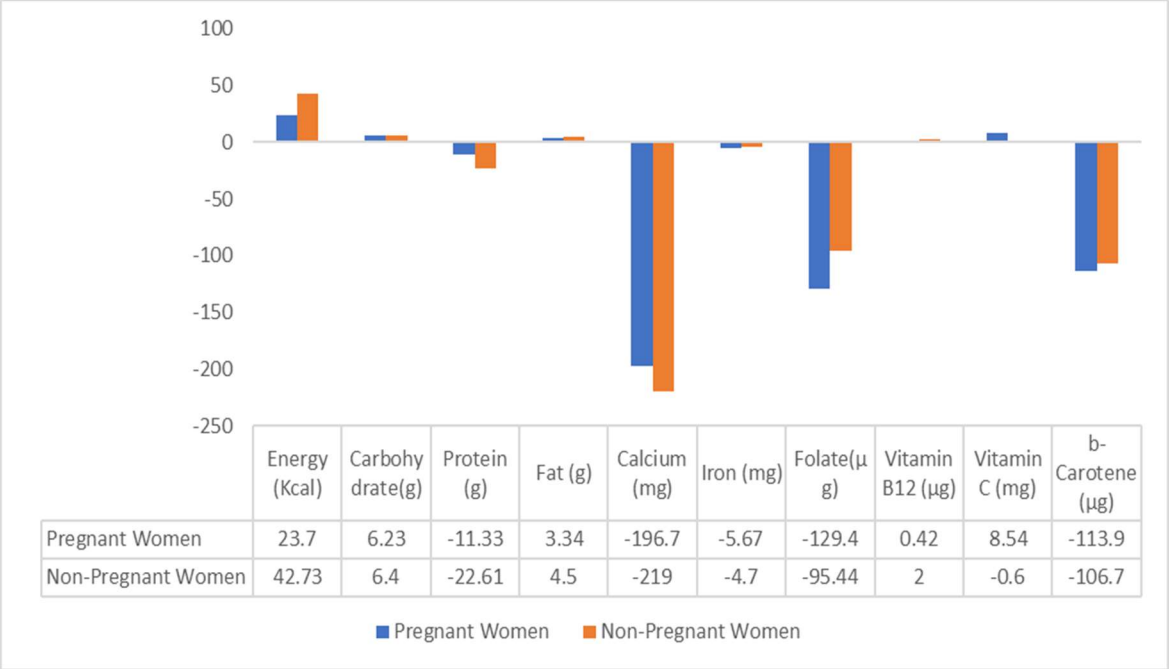


	Cereals & Millets	Pulses	Green Leafy Vegetables	Other Vegetables	Roots & Tubers	Fruits	Milk	Fats & Oils	Oil Seeds & Nuts	Spices
Pregnant women	-35	-1.78	-43.44	-8.4	4.21	-52.61	-16.2	6.07	3.13	8.44
Non-pregnant women	-26.09	-11.18	-47.37	-12.67	11.74	-26.33	-7.61	12.12	0.58	3.42

FIGURE 15

COMPARISON OF FOOD GAP AMONG PREGNANT AND NON-PREGNANT WOMEN

Figure 15 shows that the gap in food intake of cereals & millets, fruits and milk was higher among pregnant women. Deficiency of cereals and millets was 35 g in pregnant women and 26.09 g in non-pregnant women. Deficiency of fruits was 52.61 g in pregnant women and 26.33 g in non-pregnant women. Deficiency of milk was 16.2 ml in pregnant women and 7.61 ml in non-pregnant women. The gap in food intake of pulses, green leafy vegetables, and other vegetables was higher in non-pregnant women. Deficiency of pulses was 11.18 g in non-pregnant women and 1.78 g in pregnant women. Deficiency of green leafy vegetables was 47.37 g in non-pregnant women and 43.44 g in pregnant women. Deficiency of other vegetables was 12.67 g in non-pregnant women and 8.4 g in pregnant women. Non-pregnant women consumed 11.74 g in excess and pregnant women consumed 4.21 g excess roots & tubers. Non-pregnant women consumed 12.12 g in excess and pregnant women consumed 6.07 g excess fats & oils. Pregnant women consumed 3.13 g in excess and non-pregnant women consumed 0.58 g excess nuts & oil seeds. Pregnant women consumed 8.44 g in excess and non-pregnant women consumed 3.42 g excess spices.



	Energy (Kcal)	Carbohydrate(g)	Protein (g)	Fat (g)	Calcium (mg)	Iron (mg)	Folate(µg)	Vitamin B12 (µg)	Vitamin C (mg)	b-Carotene (µg)
Pregnant Women	23.7	6.23	-11.33	3.34	-196.7	-5.67	-129.4	0.42	8.54	-113.9
Non-Pregnant Women	42.73	6.4	-22.61	4.5	-219	-4.7	-95.44	2	-0.6	-106.7

FIGURE 16

CAMPARISON OF NUTRIENT GAP AMONG PREGNANT AND NON-PREGNANT WOMEN

Figure 16 shows that the gap in nutrient intake of iron, folate, and β-carotene was higher among pregnant women. Deficiency of iron was 5.67 mg in pregnant women and 4.7 mg in non-pregnant women. Deficiency of folate was 129.4 µg in pregnant women and 95.44 µg in non-pregnant women. Deficiency of β-carotene was 113.9 µg in pregnant women and 106.7 µg in non-pregnant women. The gap in nutrient intake of protein and calcium was higher in non-pregnant women. Deficiency of protein was 22.61 g in non-pregnant women and 11.33 g in pregnant women. Deficiency of calcium was 219 mg is non-pregnant women and 196.7 mg in pregnant women. Non-pregnant women consumed 42.73 Kcal in excess and pregnant women consumed 23.7 Kcal in excess. Non-pregnant women consumed 6.4 g in excess and pregnant women consumed 6.23 g excess of carbohydrate. Non-pregnant women consumed 4.5 g in excess and pregnant women consumed 3.34 g excess of fat. Non-pregnant women consumed 2 µg in excess and pregnant women consumed 0.42 µg excess of vitamin B_{12}. Pregnant women consumed 8.54 mg excess of vitamin C while non-pregnant women had a deficit of 0.6 mg.

No statistically significant difference was found between the average dietary intake, suggested allowance and dietary intake, and dietary gap of pregnant and non-pregnant women.

6. DIETARY INTAKE & SOCIO – ECONOMIC STATUS

The comparisons between average dietary intake as per the socio-economic status of reproductive age women is presented in Tables VIII – X.

TABLE VIII

FOOD INTAKE AND SOCIO – ECONOMIC STATUS

Criteria	Cereals (g)	Pulses (g)	Green Leafy Vegetables (g)	Other Vegetables (g)	Roots & Tubers (g)	Fruits (g)	Milk (ml)	Fats & Oils (g)	Oil seeds Nuts (g)
Age									
18 – 25	293.7	82.55	55.71	193.02	104.17	118.97	353.4	35.71	39.14
26 – 35	288.3	91.71	56.05	189.29	101.89	94.08	396.8	36.31	47.62
Religion									
Hindu	296.21	90.06	60.76	198.56	106.61	98.36	397.63	33.81	41.86
Muslim	298.63	94.82	57.83	190.24	100.07	103.07	362.2	35.6	44.98
Christian	289.87	80.39	53.65	188.73	97.39	116.2	340.7	27.79	38.54
Area of Residence									
Urban	296.35	90.17	73.92	194.69	94.31	134.67	371.2	31.08	40.38
Rural	266.43	83.62	58.03	187.23	103.26	101.12	384.44	27.31	33.63
Type of Family									
Joint	276.39	73.15	56.91	124.68	101.16	81.06	317.03	23.56	40.63
Nuclear	297.65	89.53	58.26	199.56	108.13	85.54	365.17	27.24	41.28
Education									
High Secondary	282.08	82.85	62.33	197.33	102.85	134.53	363.0	25.33	32.09
Graduate	255	84.9	56.09	175.54	84.9	117.54	359.35	26.25	42.25
Postgraduate	292.44	87.0	55.74	167.27	97.0	143.0	384.29	24.2	40.6
Occupation									
Government	277.5	64.27	55.0	182.5	92.86	92.0	325.0	23.0	31.38
Private	266.67	76.89	53.89	180.33	95.44	117.78	343.89	25.0	40.33
Homemaker	287.67	84.27	56.32	187.41	102.86	125.05	371.38	27.93	41.38
Annual Income									
3 Lakh	297.71	87.11	47.11	133.53	111.27	103.78	381.17	26.75	24.37
3 – 6 lakhs	288.13	83.31	57.68	185.14	94.51	112.85	386.25	27.45	31.69
6–12 lakhs	285.71	99.33	57.73	200.56	106.17	140.43	395.71	33.75	43.15

Women who were 18 – 25 years old consumed more cereals, other vegetables, roots & tubers and fruits. Women belonging to the age group of 26 – 35 years consumed more pulses, green leafy vegetables, milk, fats & oils, and nuts & oil seeds. The findings reveal that the intake of food was relatively higher in the age group of 26 – 35 years than women belonging to the age group of 18 – 25 years probably because the women were more weight conscious in the lower age group.

Hindus consumed more amount of green leafy vegetables, other vegetables, roots & tubers, and milk. Muslims consumed more amount of cereals, pulses, fats & oil, and nuts & oil seeds. The consumption of fruits was more in Christians. The findings reveal that Hindus consume more plant-based diet and Muslims and Christians consume more of cereals, pulses and fruits which was probably because of their cultural norms.

The women residing in urban areas consumed more cereals, pulses, green leafy vegetables, other vegetables, fruits, fats & oils, and nuts & oil seeds. The women residing in rural areas consumed more roots & tubers and milk. The findings reveal that urban people have more food intake than the rural people probably because urban women had better chances of getting variety of foods.

The dietary intake cereals, pulses, green leafy vegetables, other vegetables, roots & tubers, fruit, milk, fats & oils, and nuts & oil seeds was higher in women living in nuclear families. The findings reveal that the dietary intake of joint family was comparatively lower than the nuclear family which was probably because there is an increased chance of getting nutritious food equally divided among the members in case of nuclear families.

The women who were postgraduates consumed more cereals, pulses, fruits, and milk. The women who were only graduates consumed more fats & oils, and nuts & oil seeds. The samples who had studied only till higher secondary consumed more green leafy vegetables, other vegetables, and roots & tubers. The findings reveal that the higher the education level the higher was the food intake which was probably because of their increase in knowledge regarding nutrition.

The homemakers consumed more cereals, pulses, green leafy vegetables, other vegetables, roots & tubers, fruits, milk, fats & oils, and nuts & oil seeds. The findings reveal that home makers had greater dietary intake than working women which was probably because home makers have more time to plan and consume a nutritious menu for each day while the working women hardly have time for menu plan or for food consumption per se each day.

The economically weaker sections (EWS) consumed more amount of cereals, and roots & tubers. The women belonging to the middle-income group (MIG) consumed more pulses, green leafy vegetables, other vegetables, fruits, milk, fats & oils, and nuts & oil seeds than the women belonging to low-income group (LIG). The findings reveal that the food intake was higher in middle-income group which was probably because of their higher purchasing power to buy more nutritious foods.

The findings are supported by a study titled "Dietary Intake and Health Status of Pregnant Women and Their Association with Course and Outcome of Pregnancy" conducted by Jena (2006), who reported that 15 – 25 age group have higher food intake than the age group of 26 – 35. The intake of pulses, green leafy vegetables, other vegetables, fruits, and oil & fat are higher in urban areas than the rural areas. The women living in nuclear families have higher dietary intake then those living in joint families. Homemakers consume higher quantities of food stuff than that of the women who are full time and daily wage. The women belonging to lower annual income, consume less diet than that of the other income group. Only intake of cereals, roots and tubers is higher.

TABLE IX

MACRONUTRIENT INTAKE AND SOCIO – ECONOMIC STATUS

Criteria	Energy (Kcal)	Carbohydrate (g)	Protein (g)	Fat (g)
Age				
18 – 25	1883.54	172.64	58.26	33.46
26 – 35	1762.99	179.23	54.58	36.71
Religion				
Hindu	2065.21	186.72	51.65	35.43
Muslim	1751.67	181.53	53.47	33.29
Christian	1654.94	178.29	50.03	30.6
Area of Residence				
Urban	1979.28	180.62	54.97	36.84
Rural	1767.7	188.53	50.31	30.68
Type of Family				
Joint	1796.62	161.41	52.06	30.77
Nuclear	1821.62	178.34	58.56	33.59
Education				
High Secondary	1781.67	176.6	52.86	30.16
Graduate	1993.62	173.73	56.45	34.91
Postgraduate	2038.84	182.83	59.81	33.22
Occupation				
Government	1706.52	170.67	53.06	37.32
Private	1913.17	176.62	51.97	35.38
Homemaker	2012.95	179.56	50.16	33.22
Annual Income				
3 Lakh	1704.69	179.43	46.31	32.09
3 – 6 lakhs	2016.18	180.93	50.28	32.38
6–12 lakhs	2032.39	184.38	51.95	33.14

The intake of energy and protein was higher in the women belonging to the age group of 18 – 25 years. The intake of carbohydrate and fats was higher in the women belonging to the age group of 26 – 35 years. The findings reveal that with increase in age the intake of carbohydrate and fat also increased which was probably because of increased intake of junk food or the habit of eating out.

The consumption of energy, carbohydrate and fat was more among Hindu women. The consumption of protein was higher Muslim women. The findings reveal that the consumption of macronutrients was less among Christian compared to Hindu and Muslim women. Protein intake was more in Muslims probably because of the consumption of meats.

The findings suggest that women residing in urban areas consumed more energy, protein and fat as compared to the rural women who consumed more carbohydrate which was probably because in rural areas women mostly consumed rice.

The findings reveal that intake of energy, carbohydrate, protein, and fat was more among women living in nuclear families than those living in joint families which was probably because the family unit was smaller in nuclear families and the intake of nutrients were higher than the joint families.

Postgraduate women in the study consumed more energy, carbohydrate, and protein. Graduates consumed more fats. The findings reveal that the intake of macronutrients was less among women who had higher secondary education than intake of these macronutrients by graduates and postgraduates which was probably because these girls were unemployed with less purchasing power.

The homemakers consumed more energy and carbohydrates, while government employees consumed more proteins and fats. The findings reveal that the diet of women working in private sector contained less macronutrients the diets of than other women which was probably because of their very busy working hours where they don't get enough time to eat.

The women belonging to the middle-income group (MIG) consumed more energy, carbohydrate, protein, and fats than the women belonging to economically weaker sections (EWS) and low-income group (LIG). The findings reveal that the macronutrient intake was higher in middle-income group which was probably because of their higher purchasing power to buy more nutritious foods.

The findings of the present are supported by the findings of a study titled "Dietary Intake and Health Status of Pregnant Women and their Association with Course and Outcome of Pregnancy", who reported that the intake of protein, calories is higher in 15 – 25 age group than that of 26 – 35 age group. The women of nuclear families take more nutrient than the women from joint families. The entire nutrient intake is higher in the middle-income group (Rs. 6 – 12 lakhs per annum) because of their more purchasing power to buy more nutritious foods (Jena, 2006).

TABLE X

MICRONUTRIENT INTAKE AND SOCIO – ECONOMIC STATUS

Criteria	Calcium (mg)	Iron (mg)	Folate (µg)	Vitamin B12 (µg)	Vitamin C (mg)	β-Carotene (µg)
Age						
18 – 25	833.98	34.49	438.61	3.10	86.54	733.12
26 – 35	842.73	31.31	336.86	2.93	78.42	784.91
Religion						
Hindu	870.41	37.59	436.04	3.21	84.58	778.98
Muslim	822.94	33.02	407.19	3.67	81.37	754.31
Christian	809.82	28.37	375.83	3.99	76.29	735.16
Area of Residence						
Urban	720.36	31.7	434.58	2.82	75.54	779.81
Rural	802.11	36.6	386.26	2.74	68.35	772.65
Type of Family						
Joint	790.61	32.06	361.55	2.73	68.34	740.13
Nuclear	821.55	32.92	416.15	2.80	79.43	793.20
Education						
High Secondary	786.06	29.94	341.85	2.89	76.62	743.41
Graduate	814.15	31.04	402.05	3.21	78.01	777.69
Postgraduate	817.09	37.63	437.39	3.63	89.56	782.49
Occupation						
Government	814.23	23.16	434.17	2.48	78.01	733.31
Private	800.06	31.25	425.21	2.89	68.93	743.87
Homemaker	736.76	33.06	312.95	3.66	61.95	775.52
Annual Income						
3 Lakh	799.64	30.50	404.69	2.88	68.56	779.41
3 – 6 lakhs	800.95	32.38	362.69	3.31	76.09	766.63
6–12 lakhs	827.01	33.14	432.39	3.56	87.73	711.33

The intake of iron, folate, vitamin B12, and vitamin C was higher in the samples belonging to the age group of 18 – 25 years. The intake of calcium and β-carotene was higher in the women belonging to the age group of 26 – 35 years. The findings reveals that the micronutrients intake was more in the women who were 18 – 25 years old than the women who were 26 – 35 years old probably because they consume more of micronutrient rich foods.

The consumption of calcium, iron, folate, vitamin C and β-carotene was more in the women belonging to Hindu religion. The consumption of vitamin B12 was more in the women belonging to Christian religion. The findings reveals that the consumption of micronutrients was less among Muslim women than the women belonging to Hindu and Christian religion probably because they consume less of micronutrient rich foods.

The women residing in urban areas consumed more folate, vitamin B12, vitamin C and β-carotene. The women residing in rural areas consumed more calcium and iron. The micronutrient intake was found to be more in urban samples than the rural samples probably because urban women have better chances of getting variety of foods.

The intake of calcium, iron, folate, vitamin B12, vitamin C and β-carotene was more in case of sample living in nuclear families than the samples living in joint families. The findings suggest that in case of nuclear families there is an increased chance of getting nutritious food equally divided among the members.

The intake of calcium, iron, folate, vitamin B12, vitamin C and β-carotene was more in case of women who were postgraduates than the samples who have studied till higher secondary and graduation. The findings reveal that samples who had studied only till higher secondary have less micronutrient intake than the samples who were graduates and postgraduates which was probably because these girls were unemployed with less purchasing power.

The homemakers consumed more iron, vitamin B12, and β-carotene. The samples who were government employees consume more calcium, folate, and vitamin C. The findings reveal that women working in private sector have less micronutrient intake than others which was probably because of their very busy working schedule where they don't get enough time to eat.

The economically weaker sections (EWS) consumed more β-carotene The women belonging to the middle-income group (MIG) consumed more calcium, iron, folate, vitamin B12 and vitamin C than the samples belonging to low-income group (LIG). The findings reveal that the

micronutrient intake was higher in middle-income group which was probably because of their higher purchasing power to buy more nutritious foods.

The findings are supported by a study titled "Dietary Intake and Health Status of Pregnant Women and Their Association with Course and Outcome of Pregnancy" conducted by Jena (2006), who reported that the intake of iron is higher in 15 – 25 age group than that of 26 – 35 age group. Homemakers consume more iron and β-carotene compared to working women. The women of nuclear families take more nutrient than the women from joint families. The entire nutrient intake is higher in the middle-income group (Rs. 6 – 12 lakhs per annum) because of their higher purchasing power to buy more nutritious foods.

C. DETAILS ON THE NUTRITIONAL SUPPLEMENT

The nutritive value, sensory analysis, bridging the nutrient gap and cost of the health mix developed in the present study (Utkal Health Mix- UHM) and comparison between standard and UHM is presented in Tables XI to XVII.

1. NUTRITIVE VALUE OF UTKAL HEALTH MIX

The macro and micronutrients present in the Utkal health mix is presented in Tables XI and XII.

TABLE XI

MACRONUTRIENTS IN UTKAL HEALTH MIX

Ingredients	Amount (g)	Energy (Kcal)	Carbohydrates (g)	Fat (g)	Protein (g)
Ragi	30	92.6	20.1	0.6	2.15
Corn	30	96.5	19.43	1.13	2.64
Green gram	30	84.8	13.8	0.3	6.8
Bengal gram	30	95.01	14.02	1.6	6.5
Almond	10	58.62	0.3	5.8	1.84
Fenugreek Seeds	10	22.61	1.1	0.6	2.54
Wheat flour	20	61.64	12.83	0.3	2.1
Jaggery	40	136.16	33.95	0.06	0.74
Total =	**200**	**647.94**	**115.53**	**10.39**	**25.31**

The Utkal health mix contained 647.94 Kcal of Energy, 115.53 g of Carbohydrate, 10.39 g of Fat and 25.31 g of Protein per 200 g.

TABLE XII

MICRONUTRIENTS IN UTKAL HEALTH MIX

Ingredients	Amount (g)	Calcium (mg)	Iron (mg)	Folate (µg)	Vitamin C (mg)	β-Carotene (µg)
Ragi	30	109.2	1.38	10.4	---	0.46
Corn	30	1.9	0.22	18.88	1.28	10.88
Green gram	30	12.94	1.16	27.62	---	36.6
Bengal gram	30	13.896	1.824	54.6	---	49.5
Almond	10	22.8	0.46	3.7	0.07	---
Fenugreek Seeds	10	13.5	0.84	5.1	---	14.2
Wheat flour	20	6.188	0.82	5.844	---	0.534
Jaggery	40	42.8	1.852	5.76	---	---
Total	**200**	**223.224**	**8.556**	**131.904**	**1.35**	**112.17**

The Utkal health mix contains 223.224 mg of Calcium, 8.556 mg of Iron, 131.904 µg of Folate, 1.35 mg of Vitamin C and 112.17 µg of β-Carotene.

2. ACCEPTABILITY OF UTKAL HEALTH MIX

The results of the sensory evaluation of the Utkal health mix are presented in Table XIII and Figure 17.

TABLE XIII

ACCEPTABILITY SCORE OF UTKAL HEALTH MIX

Variations	Appearance	Colour	Flavour	Texture	Taste	Overall Acceptability
Standard	8.17 ± 0.67	7.8 ± 0.6	7.76 ± 0.57	8 ± 0.74	8.03 ± 0.67	7.83 ± 0.46
Variation 1	8.9 ± 0.3	8.7 ± 0.45	8.87 ± 0.35	8.67 ± 0.48	8.9 ± 0.31	8.83 ± 0.38
Variation 2	7.5 ± 0.57	7.43 ± 0.57	7.5 ± 0.51	7.47 ± 0.51	7.37 ± 0.5	7.3 ±0.47

Variation 1 (containing roasted and powdered 30g of ragi, 30g of corn, 30g of green gram, 30g of bengal gram, 10g of almonds, 10g of fenugreek seeds, 20g of wheat flour and 40g of jaggery) obtained the highest scores for all the sensory parameters namely appearance (8.9 ± 0.3), colour (8.7 ± 0.45), flavour (8.87 ± 0.35), texture (8.67 ± 0.48), and taste (8.9 ± 0.31) compared with a commercial standard and variation 2. The mean overall acceptability of the three variations is depicted in Figure 17.

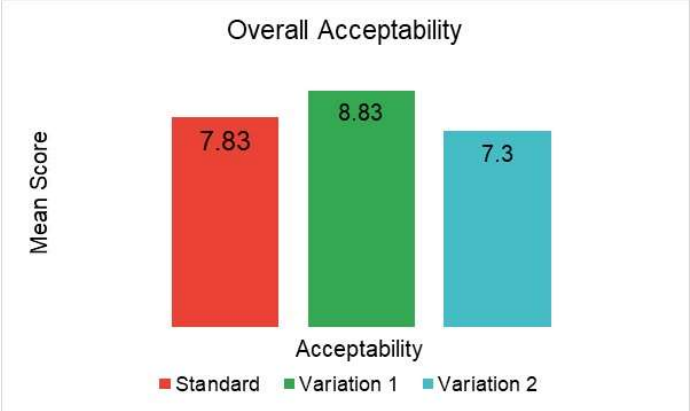


FIGURE 17

MEAN OVERALL ACCEPTABILITY OF THE VARIATIONS

3. BRIDGING THE NUTRIENT GAP

The results of bridging the nutrient gap in pregnant and non-pregnant women using the health mix is presented in Table XIV and XV.

TABLE XIV

BRIDGING THE NUTRIENT GAP IN PREGNANT WOMEN

Nutrients	RDA*	Before consumption of Health Mix	After Consumption of Health Mix	Excess/ Deficit over RDA* (%)
Protein (g)	60	50.12	75.43	26.05
Calcium (mg)	1000	803.3	1026.524	2.65
Iron (mg)	40	34.33	42.886	7.22
Folate (µg)	570	440.6	572.504	0.44
β-Carotene (µg)	900	786.1	898.27	-0.13

*** ICMR 2020**

After consumption of the Utkal Health Mix by pregnant women their protein intake increased by 26.05 percent from 50.12 g to 75.43 g per day as against RDA of 60 g per day, calcium intake increased by 2.65 percent from 803.3 mg to 1026.524 mg per day as against RDA of 1000 mg per day, iron intake increased by 7.22 percent from 34.33 mg to 42.886 mg per day as against RDA of 40 mg per day and folate intake increased by 0.44 percent from 440.6 µg to 572.504 µg per day as against RDA of 570 µg per day. β-carotene intake increased from 786.1 µg to 898.27 µg per day, but it was 0.13 percent deficit as against RDA of 900 µg per day. No statistically significant difference was found between RDA and nutrient intake of pregnant women after consumption of Utkal health mix.

TABLE XV
BRIDGING THE NUTRIENT GAP IN NON-PREGNANT WOMEN

Nutrients	RDA*	Before consumption of Health Mix	After Consumption of Health Mix	Excess/ Deficit over RDA* (%)
Protein (g)	45.7	34.33	59.64	30.5
Calcium (mg)	1000	781	1004.224	0.42
Iron (mg)	29	24.3	32.856	13.29
Folate (µg)	220	124.56	256.464	16.57
Vitamin C (mg)	65	64.4	65.75	1.15
β-Carotene (µg)	840	733.3	845.47	0.65

***ICMR 2020**

After consumption of the Utkal Health Mix by non-pregnant women their protein intake increased by 30.5 percent from 34.33 g to 59.64 g per day as against RDA of 45.7 g per day, calcium intake increased by 0.42 percent from 781 mg to 1004.224 mg per day as against RDA of 1000 mg per day, iron intake increased by 13.29 percent from 24.3 mg to 32.856 mg per day as against RDA of 29 mg per day, folate intake increased by 16.57 percent from 124.56 µg to 256.464 µg per day as against RDA of 220 µg per day, vitamin C intake increased by 1.15 percent from 64.4 mg to 65.75 mg per day as against RDA of 65 mg per day, and β-carotene intake increased by 0.65 percent from 733.3 µg to 845.47 µg per day as against RDA of 840 µg per day. No statistically significant difference was found between RDA and nutrient intake of non-pregnant women after consumption of Utkal health mix.

4. COST OF UTKAL HEALTH MIX

The estimated cost of the Utkal health mix per 200g is presented in Table XVI.

TABLE XVI
COST OF INGREDIENTS USED IN UTKAL HEALTH MIX

Ingredients	*MRP per 500 g (in Rs.)	Quantity in Health mix	Price (in Rs.)
Ragi	49	30	2.94
Corn	30	30	1.8
Green Gram	55	30	3.3
Bengal Gram	40	30	2.4
Almond	310	10	6.2
Fenugreek Seeds	90	10	1.8
Wheat Flour	21	20	0.84
Jaggery	90	40	7.2
Total		**200 g**	**Rs. 26.48**

***As prevailing in the market of Bhubaneswar, Odisha in April 2022.**

The cost of 30 g of Ragi was Rs. 2.94, 30 g of Corn was Rs. 1.8, 30 g of Green Gram was Rs. 3.3, 30 g of Bengal Gram was Rs. 2.4, 10 g of Almonds was Rs. 6.2, 10 g of Fenugreek seeds was Rs. 1.8, 20 g of Wheat Flour was Rs. 0.84 and 40 g of Jaggery was Rs. 7.2. Hence, the total cost of the ingredients was Rs. 26.48.

In addition, the approximate cost of gas/fuel was Rs. 1.8 and that of electricity was Rs. 7. So, the cost of other expenses used in making the health mix equalled to Rs. 8.8.

Overall cost of production = Ingredient's cost + Other expenses

= Rs. 26.48 + Rs. 8.8

= **Rs. 35.28**

Thus, the total cost of production of 200g of the Utkal health mix was **Rs. 35.28** and **Rs. 176.4** per kg.

5. COMPARISON BETWEEN COMMERCIAL HEALTH MIX AND UTKAL HEALTH MIX

The comparison of nutritive value, price, and acceptability between commercial health mix and Utkal health mix is presented in Table XVII and Figure 18.

TABLE XVII

COMPARISON BETWEEN COMMERCIAL HEALTH MIX AND UTKAL HEALTH MIX (per 200 g)

Criteria	Commercial Health Mix	Utkal Health Mix
Energy (Kcal)	380	647.94
Carbohydrate (g)	76	115.53
Protein (g)	10	10.39
Fat (g)	4	25.31
Iron (mg)	3.5	8.556
Cost (Rs.)	149	35.28
Acceptability (mean)	7.83	8.83

The Utkal health mix was more nutritive, less costly and had higher acceptability as compared to the commercial health mix. It ensured total food safety as it was prepared at home from food ingredients popular in local dietaries and no chemical preservative or additive or colourant was added. The comparison of acceptability between commercial health mix and Utkal Health Mix is depicted in Figure 18.

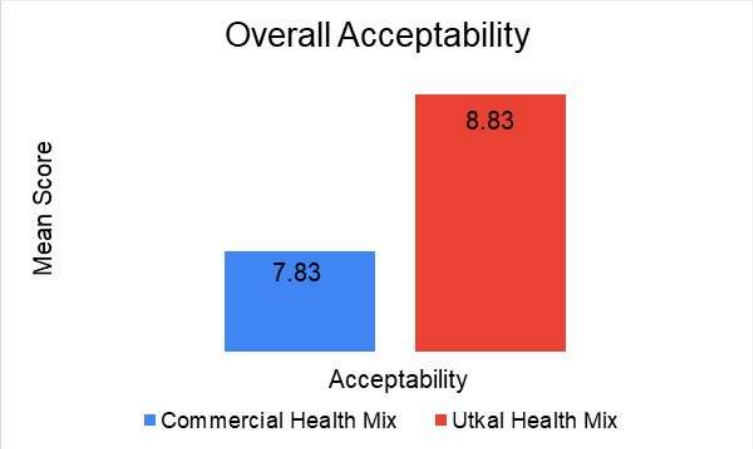


FIGURE 18

COMPARISON OF ACCEPTABILITY BETWEEN STANDARD AND HEALTH MIX

D. EFFECT OF NUTRITION EDUCATION

1. EFFECT OF NUTRITION EDUCATION ON KNOWLEDGE, ATTITUDE AND PRACTICE

The effect of nutrition education on knowledge, attitude and practice of pregnant and non-women is presented in Table XVIII.

TABLE XVIII

EFFECT OF NUTRITION EDUCATION ON KNOWLEDGE, ATTITUDE AND PRACTICE

Group	Pregnant Women (N = 30)			Non-Pregnant Women (N = 30)		
	Before	After	T-Test	Before	After	T-Test
Knowledge	10.7 ± 2.64	20.37 ± 1.12	20.13**	9 ± 3.91	19.47 ± 1.72	12.11**
Attitude	13.4 ± 3.41	19.6 ± 1.07	9.76**	15.3 ± 3.99	19.33 ± 1.12	5.12**
Practice	5.73 ± 1.42	7.63 ± 0.96	6.32**	5.57 ± 2.03	7.27 ± 1.44	3.94**

**** Significant at 5% level**

The mean knowledge score of pregnant women before nutrition education was 10.7 ± 2.64 and after education it increased to 20.37 ± 1.12, which means after nutrition education the score increased significantly ($p < 0.05$). Similarly, among non-pregnant women, the mean knowledge score before nutrition education was 9 ± 3.91 and after nutrition education it increased to 19.47 ± 1.72, which means that after education the knowledge score increased significantly ($p < 0.05$).

The mean attitude score of pregnant women before nutrition education was 13.4 ± 3.41 and after education it increased to 19.6 ± 1.07, which means after nutrition education the score increased significantly ($p < 0.05$). Similarly, among non-pregnant women, the mean attitude score before nutrition education was 15.3 ± 3.99 and after education it increased to 19.33 ± 1.12, which means that after nutrition education the attitude score increased significantly ($p < 0.05$).

The mean practice score of pregnant women before nutrition education was 5.73 ± 1.42 and after education it increased to 7.63 ± 0.96, which means that after nutrition education the score increased significantly ($p < 0.05$). Similarly, among non-pregnant women, the mean practice score before nutrition education was 5.57 ± 2.03 and after nutrition education it increased to 7.27 ± 1.44, which means that after education the practice score increased significantly ($p < 0.05$).

The effect of nutrition and reproductive health education of pregnant women in Indonesia using quasi experimental study report that after receiving nutrition education, pregnant women in the intervention group reported a significant increase in knowledge, attitudes, and behaviors related to nutrition and reproductive health. The intervention group's pre- and post-test mean scores for overall knowledge, attitudes, and practices were respectively 55.1 and 83.1 for overall knowledge, 40.2 and 49.0 for attitudes, and 36.2 and 40.2 for practices (Rizqiya. *et.al.,* 2021).

During the year 2011, a quasi-experimental intervention was conducted on a random sample of pregnant women (n = 100) who visited urban health clinics in Ilam (western Iran) for prenatal treatment. Pregnant women's knowledge of healthy nutrition increased dramatically from 3% before intervention to 31% after the nutritional education intervention. This considerable difference was independent of maternal age and literacy levels and was especially noticeable among obese moms (Fallah. *et.al.,* 2013).

2. OVERALL EFFECT OF NUTRITION EDUCATION

The overall effect of nutrition education on both pregnant and non-pregnant women is presented in Figures 19 to 21.

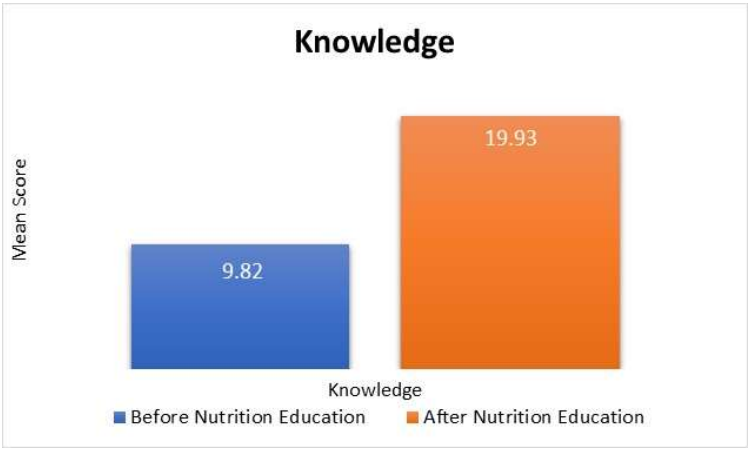


FIGURE 19

MEAN OVERALL KNOWLEDGE SCORES OF THE WOMEN

FIGURE 20

MEAN OVERALL ATTITUDE SCORES OF THE WOMEN

FIGURE 21

MEAN OVERALL PRACTICE SCORES OF THE WOMEN

After nutrition education, the mean score of knowledge questions out of 21 increased from 9.82 to 19.93, the mean score of attitude questions out of 20 increased from 14.35 to 19.47, and the mean score of practice questions out of 08 increased from 5.65 to 7.45. This shows that nutrition education was successful in improving the knowledge, attitude, and practice of the sixty reproductive age women regarding nutritional and lifestyle changes in pregnancy.

The present study was successful in determining the socio-economic status of reproductive age women where most of them belonged to the age group of 18 – 25 years, who were Hindus mostly living in urban areas in nuclear family setting. Most of them were predominantly graduates and home makers with the annual income majorly being up to 3 Lakhs rupees (EWS). 39 of them were married out of whom 30 were pregnant. The socio-economic factors correlated with each other positively. The intake of cereals, pulses, green leafy vegetables, other vegetables, fruits, milk, protein, calcium, iron, folate, and β-carotene were deficient in pregnant women. The intake of cereals, pulses, green leafy vegetables, other vegetables, fruits, milk, protein, calcium, iron, folate, vitamin C, and β-carotene were deficient in non-pregnant women. The socio-economic parameters affected the dietary intake of the reproductive age women. The formulated nutritional supplement, Utkal Health Mix contained adequate amount of nutrients to bridge the nutrient gap in the diets of pregnant and non-pregnant women. The Utkal health mix formulated was highly acceptable and cost effective for the reproductive age women as compared to the commercial health mix. After imparting nutrition education digitally, the knowledge, attitude and practice scores of reproductive age women significantly increased ($p < 0.05$).

Summary and Conclusion

SUMMARY & CONCLUSION

The summary and conclusion pertaining to the topic '**Formulation and Impact Evaluation of Selected Nutrition Intervention Methods on Reproductive Age Women'** is discussed below.

Women represent almost half of the total population of our country. India is the only country where the ratio of women to men has been declining and where the life expectancy of women is lower than men. Reproductive age is one of the most critical periods in a women's life cycle and the critical place it occupies in the chain of life cycle has health and social importance for individuals, families, and societies. It is a period of great physiological as well as psychological stress for the women. Reproductive age women have been widely recognized as a vulnerable group from the health and nutritional point of view. Considerable attention has been paid to their dietary intake and nutritional status. In developing countries, the nutritional status of women in the reproductive age group is far from satisfactory. The fertility rates are high, and their diet are deficient in calories and many other essential nutrients. Keeping these factors in mind the present study was undertaken with the objectives to assess the socio-economic status, determine the food and nutrient gap, develop a nutritional supplement to bridge the nutrient gap, impart nutrition education digitally and assess its impact on the KAP of reproductive age women.

In phase I of the study, sixty reproductive age women (thirty pregnant and thirty non-pregnant) were selected from Odisha and their socio-economic and demographic information was collected and assessed. In phase II, the dietary intake of reproductive age women was calculated using 24-hour Food Recall method and compared with RDA 2020 to determine the food and nutrient gap. In phase III, a nutritious health mix named 'Utkal Health Mix' was developed. It's nutritive value, acceptability and cost were estimated to help bridge the nutrient gap in the diets of the women. In phase IV, nutrition education was imparted digitally on google meet, a website and a YouTube channel using power point presentations, digital posters, and videos and its impact was assessed on KAP. For investigation, appropriate research tools were selected which included three day 24-hour Food Recall and pre & post intervention KAP questionnaires. The data obtained was analysed using IBM SPSS Statistics Version 26.0 and Microsoft Excel 2019. The results obtained from the study are summarized below.

Salient Findings of the Study

- Among the respondents, 65 percent (39 women) were in the age group of 18 – 25 years and the remaining 35 percent (21 women) were in the age group of 26 – 35 years.
- Among the respondents, 81.67 percent (49 women) were Hindus, 11.67 percent (07 women) were Muslims, and the remaining 6.66 percent (04 women) were Christians.
- Among the respondents, 78.3 percent (47 women) reside in urban area and the remaining 21.7 percent (13 women) reside in rural area.
- Among the respondents, 61.7 percent (37 women) were living in nuclear type of family and the remaining 38.3 percent (23 women) were living in joint family setting.
- Among the respondents, 56.7 percent (34 women) were graduates, 33.3 percent (20 women) were postgraduates and the remaining 10 percent (6 women) had completed higher secondary.
- Among the respondents, 51.7 percent (31 women) were homemakers, 30 percent (18 women) work in private sector and the remaining 18.3 percent (11 women) were government employees.
- Among the respondents, 55 percent (33 women) belonged to economically weaker sections (EWS) with annual income up to Rs. 3 Lakhs, 28.3 percent (17 women) belonged to low-income groups (LIG) with annual income between Rs. 3 – 6 Lakhs and the remaining 16.7 percent (10 women) belonged to middle income groups with annual income between Rs. 6 – 12 Lakhs.
- Among the respondents, 65 percent (39 women) were married, and the remaining 35 percent (21 women) were un-married.
- Among the respondents, 50 percent (30 women) were pregnant, and the remaining 50 percent (30 women) were non-pregnant.
- Area of residence correlated positively with type of family (r=0.415), education (r=0.655)occupation (r=0.457), and annual income (r=0.803). Type of family correlated positively with education (r=0.633), occupation (r=0.834), and annual income (r=0.644). Education correlated positively with occupation (r=0.753), and annual income (r=0.766). Occupation correlated positively with annual income (r=0.710).
- The average intake of cereals, pulses, green leafy vegetables, other vegetables, fruits, and milk was less than the RDA given by ICMR for pregnant women whereas the average intake of roots and tubers, fats and oils, nuts and oil seeds and spices were in excess. The average intake of cereals and millets was 35 g deficit. The average intake of pulses was 1.78 g deficit.

The average intake of green leafy vegetables was 43.44 g deficit. The average intake of other vegetables was 8.4 g deficit. The average intake of roots & tubers was 4.21 g excess. The average intake of fruits was 52.61 g deficit. The average intake of milk was 16.2 ml deficit. The average intake of fats & oils was 6.07 g excess. The average intake of nuts and oil seeds was 3.13 g. excess The average intake of spices was 8.44 g excess.

- The average intake of protein, calcium, iron, folate, and β-carotene was less than the RDA given by ICMR for pregnant women whereas the intake of energy, carbohydrate, fat, vitamin B_{12}, and vitamin C were in excess. The average intake of energy was 23.7 kcal excess. The average intake of carbohydrate was 6.23 g excess. The average intake of protein was 11.33g deficit. The average intake of fat was 3.34 g excess. The average intake of calcium was 196.7 mg deficit. The average intake of iron was 5.67 mg deficit. The average intake of folate was 129.4 µg deficit. The average intake of vitamin B_{12} was 0.42 µg excess. The average intake of vitamin C was 8.54 mg excess. The average intake of β-carotene was 113.9µg deficit.
- The average intake of cereals, pulses, green leafy vegetables, other vegetables, fruits, and milk was less than the RDA given by ICMR for non-pregnant women whereas the average intake of roots and tubers, fats and oils, nuts and oil seeds and spices were excess. The average intake of cereals and millets was 26.09 g deficit. The average intake of pulses was 11.18 g deficit. The average intake of green leafy vegetables was 47.37 g deficit. The average intake of other vegetables was 12.67 g deficit. The average intake of roots & tubers was 11.74 g excess. The average intake of fruits was 26.33 g deficit. The average intake of milk was 7.61 ml deficit. The average intake of fats & oils was 12.12 g excess. The average intake of nuts and oil seeds was 0.58 g excess. The average intake of spices was 3.42 g excess.
- The average intake of protein, calcium, iron, folate, vitamin C, and β-carotene was less than the RDA given by ICMR for non-pregnant women whereas the intake of energy, carbohydrate, fat, and vitamin B_{12} were in excess. The average intake of energy was 42.73 kcal excess. The average intake of carbohydrate was 6.4 g excess. The average intake of protein was 22.61 g deficit. The average intake of fat was 4.5 g excess. The average intake of calcium was 219 mg deficit. The average intake of iron was 4.7 mg deficit. The average intake of folate was 95.44 µg deficit. The average intake of vitamin B_{12} was 2 µg excess. The average intake of vitamin C was 0.6 mg deficit. The average intake of β-carotene was 106.7 µg deficit.

- The gap in food intake of cereals & millets, fruits and milk was higher in pregnant women. The gap in food intake of pulses, green leafy vegetables, and other vegetables was higher in non-pregnant women. Non-pregnant women consumed excess of roots & tubers and fats & oils. Pregnant women consumed excess of nuts & oil seeds and spices.
- The gap in nutrient intake of iron, folate, and β-carotene was higher in pregnant women. The gap in nutrient intake of protein and calcium was higher in non-pregnant women. Non-pregnant women consumed excess of energy, carbohydrate, fat, and vitamin B12. Pregnant women consumed excess of vitamin C while non-pregnant women had a deficit.
- No statistically significant difference was found between the average dietary intake, suggested allowance and dietary intake, and dietary gap of pregnant and non-pregnant women.
- Women who were 18 – 25 years old consumed more cereals, other vegetables, roots and tubers, fruits, energy, protein, iron, folate, vitamin B12, and vitamin C. Women belonging to the age group of 26 – 35 years consumed more pulses, green leafy vegetables, milk, fats & oils, nuts & oil seeds, carbohydrate, fat, calcium, and β-carotene.
- Hindus consumed more amount of green leafy vegetables, other vegetables, roots & tubers, milk, energy, carbohydrate, fat, calcium, iron, folate, vitamin C, and β-carotene. Muslims consumed more amount of cereals, pulses, fats & oil, nuts & oil seeds, and protein. The consumption of fruits, and vitamin B12 was more in Christians.
- The women residing in urban areas consumed more cereals, pulses, green leafy vegetables, other vegetables, fruits, fats & oils, nuts & oil seeds, energy, protein, fat, folate, vitamin B12, vitamin C, and β-carotene. The women residing in rural areas consumed more roots & tubers, milk, carbohydrate, calcium, and iron.
- The dietary intake of cereals, pulses, green leafy vegetables, other vegetables, roots & tubers, fruit, milk, fats & oils, nuts & oil seeds, energy, carbohydrate, protein, fat, calcium, iron, folate, vitamin B12, vitamin C and β-carotene was higher in women living in urban families than the rural families.
- The women who were postgraduates consumed more cereals, pulses, fruits, milk, energy, carbohydrate, protein, calcium, iron, folate, vitamin B12, vitamin C, and β-carotene. The women who were only graduates consumed more fats & oils, nuts & oil seeds, and fat. The samples who had studied only till higher secondary consumed more green leafy vegetables, other vegetables, and roots & tubers.

- The homemakers consumed more cereals, pulses, green leafy vegetables, other vegetables, roots and tubers, fruits, milk, fats & oils, nuts & oil seeds, energy, carbohydrate, iron, vitamin B_{12}, and β-carotene. The women who were government employees consumed more protein, fat, calcium, folate, and vitamin C. The working in private sectors had less micronutrient intake.
- The economically weaker sections (EWS) consumed more amount of cereals, roots & tubers, β-carotene. The women belonging to the middle-income group (MIG) consumed more pulses, green leafy vegetables, other vegetables, fruits, milk, fats & oils, nuts & oil seeds, energy, carbohydrate, protein, fat, calcium, iron, folate, vitamin B_{12}, and vitamin C than the low-income group (LIG).
- The Utkal health mix contained 647.94 Kcal of energy, 115.53 g of carbohydrate, 10.39 g of fat and 25.31 g of protein, 223.224 mg of calcium, 8.556 mg of iron, 131.904 µg of folate, 1.35 mg of vitamin C and 112.17 µg of β-carotene per 200 g.
- Variation 1 (containing roasted and powdered 30g of ragi, 30g of corn, 30g of green gram, 30g of bengal gram, 10g of almonds, 10g of fenugreek seeds, 20g of wheat flour and 40g of jaggery) obtained the highest scores for all the sensory parameters namely appearance (8.9 ± 0.3), colour (8.7 ± 0.45), flavour (8.87 ± 0.35), texture (8.67 ± 0.48), taste (8.9 ± 0.31), and overall acceptability (8.83 ± 0.38)
- The Utkal health mix was successful in bridging the gap in the intake of protein, calcium, iron, and folate in pregnant women. Whereas the health mix was 1.73 µg deficit in β-carotene.
- The health mix was successful in bridging the gap in the intake of protein, calcium, iron, folate, vitamin C and β-carotene in non-pregnant women.
- No statistically significant difference was found between RDA and nutrient intake of pregnant women and non-pregnant women after consumption of Utkal health mix.
- The total cost of production of 200g of the Utkal health mix was Rs. 35.28 and Rs. 176.4 per kg.
- The Utkal health mix was more nutritive, less costly and had higher acceptability as compared to the commercial health mix.
- The mean knowledge score of pregnant women before nutrition education was 10.7 ± 2.64 and after education it increased to 20.37 ± 1.12. Among non-pregnant women, the mean knowledge score before nutrition education was 9 ± 3.91 and after education it increased to 19.47 ± 1.72.

- The mean attitude score of pregnant women before nutrition education was 13.4 ± 3.41 and after education it increased to 19.6 ± 1.07. Among non-pregnant women, the mean attitude score before nutrition education was 15.3 ± 3.99 and after education it increased to 19.33 ± 1.12.
- The mean practice score of pregnant women before nutrition education was 5.73 ± 1.42 and after education it increased to 7.63 ± 0.96. Among non-pregnant women, the mean practice score before nutrition education was 5.57 ± 2.03 and after education it increased to 7.27 ± 1.44.
- There was no significant correlation between socio-economic factors and KAP, which means that the difference in scores were independent of socio-economic parameters.

Conclusion:

From the results it was concluded most of the reproductive age women belonged to the age group of 18 – 25 years (65 percent), maximum of them were Hindus (81.67 percent), mostly living in urban areas (78.3 percent) in nuclear family setting (61.7 percent). An equal number were graduates (56.7 percent) and home makers (51.7 percent) with the annual income majorly being up to 3 Lakhs rupees (EWS – 55 percent). Of the 60 women included in the study, 39 were married and 30 of them were pregnant. The intake of cereals, pulses, green leafy vegetables, other vegetables, fruits, milk, protein, calcium, iron, folate, and β-carotene were deficient in pregnant women. The intake of cereals, pulses, green leafy vegetables, other vegetables, fruits, milk, protein, calcium, iron, folate, vitamin C, and β-carotene were deficient in non-pregnant women. Variation 1 of the formulated health mix, Utkal health mix was successful in bridging the nutrient gap, was cost effective and acceptable among the reproductive age women. It was superior to the commercial health mix in terms of ease of preparation, nutrient content, cost effectiveness, acceptability, and food safety. After nutrition education, the mean score of knowledge questions out of 21 increased from 9.82 to 19.93, the mean score of attitude questions out of 20 increased from 14.35 to 19.47, and the mean score of practice questions out of 08 increased from 5.65 to 7.45.

Based on the findings, the following recommendations can be made for further studies:

1) Assess nutritional status of reproductive age women below poverty line.
2) Assess the effect of the Utkal Health Mix on other vulnerable groups.
3) Develop nutritional supplements from indigenous ingredients for other age groups.
4) Provide follow up nutrition education to the reproductive age women.

Bibliography

BIBLIOGRAPHY

Arikpo, D., Edet, E. S., Chibuzor, M. T., Odey, F., & Caldwell, D. M. (2018). Educational interventions for improving primary caregiver complementary feeding practices for children aged 24 months and under. The Cochrane database of systematic reviews, 5(5), CD011768. https://doi.org/10.1002/14651858.CD011768.pub2

Bacchus, L., Reiss, K., Church, K., Colombini, M., Pearson, E., & Naved, R. et al. (2019). Using Digital Technology for Sexual and Reproductive Health: Are Programs Adequately Considering Risk? Global Health: Science And Practice, 7(4), 507-514. https://doi.org/10.9745/ghsp-d-19-00239

Blondin, J., & LoGiudice, J. (2018). Pregnant women's knowledge and awareness of nutrition. Applied Nursing Research, 39, 167-174. https://doi.org/10.1016/j.apnr.2017.11.020

Caut, C., Leach, M., & Steel, A. (2020). Dietary guideline adherence during preconception and pregnancy: A systematic review. Maternal & child nutrition, 16(2), e12916. https://doi.org/10.1111/mcn.12916

Chattu, V., Lopes, C., Javed, S., & Yaya, S. (2021). Fulfilling the promise of digital health interventions (DHI) to promote women's sexual, reproductive and mental health in the aftermath of COVID-19. Reproductive Health, 18(1). https://doi.org/10.1186/s12978-021-01168-x

Chowdhury, R., Taneja, S., Dhabhai, N., Mazumder, S., Upadhyay, R. P., Sharma, S., Tupaki-Sreepurna, A., Dewan, R., Mittal, P., Chellani, H., Bahl, R., Bhan, M. K., & Bhandari, N. (2020). Burden of preconception morbidity in women of reproductive age from an urban setting in North India. PloS one, 15(6), e0234768. https://doi.org/10.1371/journal.pone.0234768

Custodio, E., Kayikatire, F., Fortin, S., Thomas, A. C., Kameli, Y., Nkunzimana, T., Ndiaye, B., & Martin-Prevel, Y. (2020). Minimum dietary diversity among women of reproductive age in urban Burkina Faso. Maternal & child nutrition, 16(2), e12897. https://doi.org/10.1111/mcn.12897

Dunneram, Y., & Jeewon, R. (2015). Healthy Diet and Nutrition Education Program among Women of Reproductive Age: A Necessity of Multilevel Strategies or Community Responsibility. Health promotion perspectives, 5(2), 116–127. https://doi.org/10.15171/hpp.2015.014

Fallah, F., Pourabbas, A., Delpisheh, A., Veisani, Y., & Shadnoush, M. (2013). Effects of Nutrition Education on Levels of Nutritional Awareness of Pregnant Women in Western Iran. International Journal Of Endocrinology And Metabolism, 11(3). https://doi.org/10.5812/ijem.9122

Felder, J., Epel, E., Neuhaus, J., Krystal, A., & Prather, A. (2020). Efficacy of Digital Cognitive Behavioral Therapy for the Treatment of Insomnia Symptoms Among Pregnant Women. JAMA Psychiatry, 77(5), 484. https://doi.org/10.1001/jamapsychiatry.2019.4491

Finkelstein, J. L., Fothergill, A., Johnson, C. B., Guetterman, H. M., Bose, B., Jabbar, S., Zhang, M., Pfeiffer, C. M., Qi, Y. P., Rose, C. E., Williams, J. L., Bonam, W., & Crider, K. S. (2021). Anemia and Vitamin B-12 and Folate Status in Women of Reproductive Age in Southern India: Estimating Population-Based Risk of Neural Tube Defects. Current developments in nutrition, 5(5), nzab069. https://doi.org/10.1093/cdn/nzab069

Finkelstein, J. L., Fothergill, A., Johnson, C. B., Guetterman, H. M., Bose, B., Jabbar, S., Zhang, M., Pfeiffer, C. M., Qi, Y. P., Rose, C. E., Krisher, J. T., Ruth, C. J., Mehta, R., Williams, J. L., Bonam, W., & Crider, K. S. (2020). Periconceptional surveillance for prevention of anaemia and birth defects in Southern India: protocol for a biomarker survey in women of reproductive age. BMJ open, 10(10), e038305. https://doi.org/10.1136/bmjopen-2020-038305

Harika, R., Faber, M., Samuel, F., Kimiywe, J., Mulugeta, A., & Eilander, A. (2017). Micronutrient Status and Dietary Intake of Iron, Vitamin A, Iodine, Folate and Zinc in Women of Reproductive Age and Pregnant Women in Ethiopia, Kenya, Nigeria and South Africa: A Systematic Review of Data from 2005 to 2015. Nutrients, 9(10), 1096. https://doi.org/10.3390/nu9101096

ICMR RDA Short Report - 2020

Kaliwile, C., Michelo, C., Titcomb, T., Moursi, M., Donahue Angel, M., & Reinberg, C. et al. (2019). Dietary Intake Patterns among Lactating and Non-Lactating Women of Reproductive Age in Rural Zambia. Nutrients, 11(2), 288. https://doi.org/10.3390/nu11020288

Kalpana J. (2006). Dietary intake and health status of pregnant women and their association with course and outcome of pregnancy. URI: http://hdl.handle.net/10603/187085

Kim, K., Yisahak, S. F., Nobles, C. J., Andriessen, V. C., DeVilbiss, E. A., Sjaarda, L. A., Alohali, A., Perkins, N. J., & Mumford, S. L. (2021). Low Intake of Vegetable Protein is Associated With Altered Ovulatory Function Among Healthy Women of Reproductive Age. The Journal of clinical endocrinology and metabolism, 106(7), e2600–e2612. https://doi.org/10.1210/clinem/dgab179

Kominiarek, M. A., & Rajan, P. (2016). Nutrition Recommendations in Pregnancy and Lactation. The Medical clinics of North America, 100(6), 1199–1215. https://doi.org/10.1016/j.mcna.2016.06.004

Lim, S., Tan, A., Madden, S., & Hill, B. (2019). Health Professionals' and Postpartum Women's Perspectives on Digital Health Interventions for Lifestyle Management in the Postpartum Period: A Systematic Review of Qualitative Studies. Frontiers In Endocrinology, 10. https://doi.org/10.3389/fendo.2019.00767

Matsuzaki, M., Birk, N., Bromage, S., Bowen, L., Batis, C., Fung, T. T., Li, Y., Stampfer, M. J., Deitchler, M., Willett, W. C., Fawzi, W. W., Kinra, S., & Bhupathiraju, S. N. (2021). Validation of Global Diet Quality Score Among Nonpregnant Women of Reproductive Age in India: Findings from the Andhra Pradesh Children and Parents Study (APCAPS) and the Indian Migration Study (IMS). The Journal of nutrition, 151(12 Suppl 2), 101S–109S. https://doi.org/10.1093/jn/nxab217

Mazloomy-Mahmoodabad, S., Goodarzi-Khoigani, M., Baghiani Moghadam, M., Nadjarzadeh, A., Mardanian, F., & Fallahzadeh, H. (2018). Impact of nutrition education in improving dietary pattern during pregnancy based on pender's health promotion model: A randomized clinical trial. Iranian Journal Of Nursing And Midwifery Research, 23(1), 18. https://doi.org/10.4103/ijnmr.ijnmr_198_16

Muhunzi, S., Samwel Ngocho, J., Mwanamsangu, A., Sanga, L., Hiza, H., E Msuya, S., & J Mahande, M. (2020). Prevalence, predictors and reasons for home delivery amongst women of childbearing age in Dodoma Municipality in central Tanzania. African Health Sciences, 20(4), 1933-42. https://doi.org/10.4314/ahs.v20i4.52

Nepak, A., Soren, S., & Karjee, A. (2021). Maternal and neonatal outcomes in teenage pregnancy: an observational study from Odisha. International Journal Of Reproduction, Contraception, Obstetrics And Gynecology, 10(3), 889. https://doi.org/10.18203/2320-1770.ijrcog20210470

Onukwugha, F., Smith, L., Kaseje, D., Wafula, C., Kaseje, M., & Orton, B. et al. (2022). The effectiveness and characteristics of mHealth interventions to increase adolescent's use of Sexual and Reproductive Health services in Sub-Saharan Africa: A systematic review. PLOS ONE, 17(1), e0261973. https://doi.org/10.1371/journal.pone.0261973

P. F. Guiné, R., C. D. Ramalhosa, E., & Paula Valente, L. (2016). New Foods, New Consumers: Innovation in Food Product Development. Current Nutrition &Amp; Food Science, 12(3), 175-189. https://doi.org/10.2174/1573401312666160608120727

Permatasari, T., Rizqiya, F., Kusumaningati, W., Suryaalamsah, I., & Hermiwahyoeni, Z. (2021). The effect of nutrition and reproductive health education of pregnant women in Indonesia using quasi experimental study. BMC Pregnancy And Childbirth, 21(1). https://doi.org/10.1186/s12884-021-03676-x

Puri, P., Kothavale, A., Singh, S. K., & Pati, S. (2021). Burden and determinants of multimorbidity among women in reproductive age group: a cross-sectional study based in India. Welcome open research, 5, 275. https://doi.org/10.12688/wellcomeopenres.16398.2

Sahoo, S., & Panda, B. (2006). A Study of Nutritional Status of Pregnant Women of Some Villages in Balasore District, Orissa. Journal Of Human Ecology, 20(3), 227-232. https://doi.org/10.1080/09709274.2006.11905932

Sharma, S., Akhtar, F., Singh, R., & Mehra, S. (2020). Dietary Intake across Reproductive Life Stages of Women in India: A Cross-Sectional Survey from 4 Districts of India. Journal Of Nutrition And Metabolism, 2020, 1-13. https://doi.org/10.1155/2020/9549214

Stephenson, J., Heslehurst, N., Hall, J., Schoenaker, D., Hutchinson, J., Cade, J. E., Poston, L., Barrett, G., Crozier, S. R., Barker, M., Kumaran, K., Yajnik, C. S., Baird, J., & Mishra, G. D. (2018). Before the beginning: nutrition and lifestyle in the preconception period and its importance for future health. Lancet (London, England), 391(10132), 1830–1841. https://doi.org/10.1016/S0140-6736(18)30311-8

Teweldemedhin, L., Amanuel, H., Berhe, S., Gebreyohans, G., Tsige, Z., & Habte, E. (2021). Effect of nutrition education by health professionals on pregnancy-specific nutrition knowledge and healthy dietary practice among pregnant women in Asmara, Eritrea: a quasi-experimental study. BMJ Nutrition, Prevention &Amp; Health, 4(1), 181-194. https://doi.org/10.1136/bmjnph-2020-000159

Ülger, Taha & Akçali, Çağlar & Yardimci, Hülya. (2018). Evaluation of Nutrition Education During Pregnancy and Nutritional Knowledge of Pregnant Women.

Weerasekara, P., Withanachchi, C., Ginigaddara, G., & Ploeger, A. (2020). Food and Nutrition-Related Knowledge, Attitudes, and Practices among Reproductive-age Women in Marginalized Areas in Sri Lanka. International Journal Of Environmental Research And Public Health, 17(11), 3985. https://doi.org/10.3390/ijerph17113985

Yang, Z., & Huffman, S. (2011). Review of fortified food and beverage products for pregnant and lactating women and their impact on nutritional status. Maternal &Amp; Child Nutrition, 7, 19-43. https://doi.org/10.1111/j.1740-8709.2011.00350.x

Yaya, S., & Bishwajit, G. (2020). Predictors of institutional delivery service utilization among women of reproductive age in Gambia: a cross-sectional analysis. BMC Pregnancy And Childbirth, 20(1). https://doi.org/10.1186/s12884-020-02881-4

Yousef, H., Al-Sheyab, N., Al Nsour, M., Khader, Y., Al Kattan, M., Bardus, M., Alyahya, M., Taha, H., & Amiri, M. (2021). Perceptions Toward the Use of Digital Technology for Enhancing Family Planning Services: Focus Group Discussion With Beneficiaries and Key Informative Interview With Midwives. Journal of medical Internet research, 23(7), e25947. https://doi.org/10.2196/25947

Websites:

https://www.unicef.org/india/what-we-do/womens-nutrition

https://discoverfoodtech.com/food-product-development-process/

https://www.who.int/news-room/fact-sheets/detail/maternal-mortality

https://www.unfpa.org/sites/default/files/pub-pdf/Religion_Womens_Health_and_Rights.pdf

Appendix

APPENDIX I

INSTITUTIONAL HUMAN ETHICS COMMITTEE

Avinashilingam
Institute for Home Science and Higher Education for Women
(Deemed to be University under Category 'A' by MHRD, Estd. u/s 3 of UGC Act 1956) Re-accredited with 'A++' Grade by NAAC.Recognised by UGC Under Section 12 B
Coimbatore-641 043, Tamil Nadu, India

Chairman
Dr. SudhaRamalingam
Director-Research & Innovation,
Professor-Community Medicine,
PSG Institute of Medical Sciences & Research, Coimbatore

Member Secretary
Dr.S.Uma Mageshwari
Professor and Head,
Department of Food Service Management & Dietetics

Members
Mr.K.Arunmoli (Legal Expert)
Dr.Subhashini K. Sripathi
Dr.A.Saraswathy (Medical Officer)
Ms.D.Kavitha
Dr.A.R.SudamaniRamasamy
Dr.G.Victoria Naomi
Dr. Judith Justin
Dr.AnithaSubash

26th February 2022

To
Ms.Baisali Bharadwaj Dash
Department of Food Science and Nutrition
Avinashilingam Institute for Home Science and Higher Education for Women
Coimbatore – 641 043

Dear Baisali Bharadwaj Dash ,

Ref: Your proposal No. IHEC/21-22/FSN-04 entitled "Formulation and Impact Evaluation of Selected Nutrition Intervention Methods on Reproductive Age Women" submitted for approval of IHEC on 23.11.2021.

The Institutional Human Ethics Committee of our University hereby grants approval to your research proposal No. IHEC/21-22/ FSN-04 entitled "Formulation and Impact Evaluation of Selected Nutrition Intervention Methods on Reproductive Age Women" submitted by you. The Approval number for the same is AUW/IHEC/ FSN-21-22/XPD-04.

We wish you all the best in your research endeavours.

Regards,

S. Uma Mageshwari
Dr.S.Uma Mageshwari
Member Secretary

Institutional Human Ethics Committee

APPENDIX II

SOCIO-ECONOMIC STATUS QUESTIONAIRRE – Online Mode

1. Name:

2. E-mail ID:

3. Age:

4. Religion:

☐Hindu ☐Muslim ☐Christian ☐Other

5. Area of residence: ☐Urban ☐Rural

6. Type of family: ☐Joint ☐Nuclear

7. Education:

☐Illiterate ☐Dropout ☐High School

☐Higher Secondary ☐Graduate ☐Postgraduate

8. Occupation:

☐ Government Employee ☐ Private Sector ☐ Home Maker

9. Annual Income:

☐Up to 3 Lakhs ☐3 – 6 Lakhs ☐6 – 12 Lakhs

10. Marital Status: ☐Married ☐Unmarried

11. Pregnancy Status: ☐Pregnant ☐Not Pregnant

APPENDIX III

NUTRITION EDUCATION QUESTIONAIRE (KAP) METHOD

I. KNOWLEDGE RELATED QUESTIONS

1. Which food is a good source of folate?

☐Sesame seeds ☐Legumes ☐Skimmed milk ☐Sunflower oil ☐Red meat

2. Obesity can adversely affect woman's fertility.

☐True ☐False

3.How much folic acid in the form of a supplement (in addition to consuming folate through foods in a varied diet) is recommended for healthy, pregnant women?

☐≥60 µg/d ☐≥200 µg/d ☐≥400 µg/d ☐≥5000 µg/d

4. Folate belongs to the group of B-vitamins and is also referred to as ____

☐Vitamin B6 ☐Vitamin B3 ☐Vitamin B12 ☐Vitamin B9

5. A normal BMI during pregnancy is important for maternal and child health, but a high pre-pregnancy BMI is not a risk factor for unhealthy pregnancy outcomes.

☐True ☐False

6. The folic acid supplementation recommendations are _____for obese women compared to women with a healthy BMI.

☐Lower ☐The same ☐Higher

7. A "nutrient dense" food contains ____

☐A high amount of essential nutrients in proportion to the amount of fibre

☐A high amount of energy in proportion to the amount of fibre.

☐A high amount of energy in proportion to the amount of essential nutrients.

☐A high amount of essential nutrients in proportion to the amount of carbohydrates.

☐A high amount of essential nutrients in proportion to the amount of energy.

8. Simultaneous consumption of which nutrient (or foods rich in this nutrient) can improve iron absorption?

☐Vitamin B12 ☐Folic Acid ☐Vitamin C ☐Iodine ☐Calcium

9. Which statement about the transmission and adverse foetal outcomes of toxoplasmosis infection is correct?

☐Rate of maternal-foetal transmission is constant throughout pregnancy, but severity increases.

☐Rate of maternal-foetal transmission increases throughout pregnancy, but severity remains the same.

☐Rate of maternal-foetal transmission decreases throughout pregnancy, but severity increases.

☐Rate of maternal-foetal transmission increases throughout pregnancy but severity decreases.

10. The half-life of caffeine in the body during pregnancy is ___

☐Longer ☐The same ☐Shorter

11. Which of the following nutrients is the preferred foetal energy source in the second half of pregnancy and is transported in the greatest amounts from mother to foetus across the placenta?

☐Fatty acids ☐Amino acids ☐Cholesterol ☐Fructose ☐Glucose

12.Changes in lipid metabolism during pregnancy promote the ___

☐Decrease of maternal fat stores in early and mid-pregnancy and enhance fat mobilization in late pregnancy.

☐Accumulation of maternal protein and glycogen stores in early and mid-pregnancy and enhance fat mobilization in late pregnancy.

☐Accumulation of maternal fat stores in early and mid-pregnancy and inhibit fat mobilization in late pregnancy.

☐Decrease of maternal fat stores in early and mid-pregnancy and inhibit fat mobilization in late pregnancy.

☐Accumulation of maternal fat stores in early and mid-pregnancy and enhance fat mobilization in late pregnancy

13. How are increasing energy requirements distributed throughout pregnancy?

☐They gradually increase throughout the first, second and third trimester.

☐They are evenly distributed throughout the pregnancy.

☐The distribution of energy requirements is dependent on the individual woman.

☐They gradually increase throughout the first and second trimester before dropping off again in the third trimester.

14. Protein requirements ___

☐are not higher during pregnancy than before.

☐only increase at the end of pregnancy to 50g per day.

☐increase from 0.8g/kg bodyweight to 1.1 g/kg bodyweight per day.

15. What is the relationship between BMI and serum vitamin D concentrations in pregnant women?

☐BMI and serum vitamin D concentrations are not correlated at all.

☐BMI and serum vitamin D concentrations are positively correlated.

☐BMI and serum vitamin D concentrations are inversely correlated.

16. What is the most recommended method for initial control of hyperglycaemia in pregnancy?

☐One fasting day per week ☐Treatment with metformin

☐Lifestyle modifications (dietary plan, physical activity) ☐Insulin treatment

17. Which of the following factors has the strongest influence on the maternal metabolome?

☐Gestational weight gain ☐Age ☐Pre-pregnancy BMI

☐Total energy intake ☐Ethnicity

18. Fish is a valuable food source for essential nutrients in pregnancy. These are ___

☐Folate and vitamin B12 ☐Vitamin D and iodine

☐Zinc and vitamin C ☐Magnesium and vitamin A

19. Women who are physically active during pregnancy are at an increased risk of premature birth compared to non-exercisers.

☐True ☐False

20. During pregnancy, foods with a high glycaemic index are preferable over foods with a low glycaemic index.

☐True ☐False

21. What is the health benefit for taking folic acid supplements/tablets?

☐For normal development of the nervous system of the unborn baby (brain, spine and skull)

☐To prevent birth defects/abnormalities the nervous system of the unborn baby (brain, spine and skull)

II. ATTITUDE RELATED QUESTION

Statement	Response		
	Agree	**Undecided**	**Disagree**
A balanced diet is important during pregnancy and lactation.			
Women nutrition during pregnancy and lactation period is different from others.			
The daily recommended intake of iron for a woman during pregnancy is 32 mg.			
Pregnant and lactating must consume protein on daily basis.			
During pregnancy, a woman needs more folic acid and iron than a woman who is not pregnant.			
A Pregnant woman must take folic acid in daily diet.			
Women should take a diet which is rich in calcium, daily during pregnancy and lactation period.			
Fatty acids are essential for brain and retina development of foetus.			
Nutrient deficiency during pregnancy and lactation could affect health status of mothers and baby.			
If a woman had a normal weight before pregnancy, she should gain weight between 11.5 kg to 16.0kg during pregnancy.			
Body Mass Index (BMI) between 18.5 – 24.9 kg/m2 is a suitable weight during pregnancy.			
Additional energy needs should be tailored based on the woman's BMI before pregnancy.			
Underweight mother can affect baby well-being and growth.			
Obese women are at an increased risk of several pregnancy problems.			

Micronutrients and trace elements play a vital role in pregnancy.			
Alcohol and smoking should be restricted in pregnancy.			
Those who develop gestational diabetes are at higher risk of developing type 2 diabetes later in life.			
Foodborne illness during pregnancy can cause serious health problems, miscarriage, premature delivery, stillbirth or even death of the mother.			
Preconception care can improve pregnancy outcomes and women's health.			
Pregnant women should get at least 150 minutes of moderate-intensity aerobic activity every week.			

III. PRACTICE RELATED QUESTION

Statement	Responses		
	Always	**Sometimes**	**Never**
Consuming healthy and nutrient dense foods.			
Maintaining ideal BMI.			
Consuming a balanced diet.			
Consuming foods rich in folic acid, iron, vitamin D, calcium, vitamin B12 and iodine.			
Consuming alcohol.			
Practising Smoking.			
Consuming raw or uncooked foods.			
Moderate physical activity for at least 30 mins per day.			