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Effect Of Nutritional Education On Essential Micronutrients Deficiencies & Nutritional Status Of Young Pregnant Women: An Interventional Trial

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ABSTRACT

Background: Maternal and foetal health is significantly influenced by nutrition, because it is widely acknowledged that a healthy diet in pregnancy is the basis for long-standing health. The objectives of our study were to determine the frequencies of iron, calcium, magnesium deficiencies, malnutrition among young pregnant women and their effects on feto-maternal outcome. The effects of nutritional counselling / education in improving maternal nutrition and comparison between fetal maternal health outcomes at tertiary care hospital were measured. ***Methodology:*** Total 191 participants were selected study purpose, 91subjects were labelled study group and 100 were labelled comparison group. Study subjects were provided nutritional / diet plan according to the nutritional status and deficiencies and followed for three months. Pregnancy outcomes were measured and compared with comparison group. Sociodemographic information, anthropometric measure, laboratory investigations and dietary plans were collected and analyzed on SPSS (version 26.0), various tests of significance were applied for association and correlation.

Results: All women were primigravida having age from 18 to 26 years, belonging to both urban and rural areas and majority of participants were from middle class families. Mean gestational age of the study group in their 1st visit was **26.02 ± 1.92** and in 2nd visit it was **36.62 ± 1.29** while in comparison group mean gestational age at the time of delivery was **36.15 ± 2.04.** Mean weight was **69.12 ± 4.56** for study group and mean weight was **65.51 ± 4.87** for comparison group at the time of delivery **(p-value 0.535).** Mean gestational weight gain measured was **12.21 ± 1.85** for study group at the time of delivery and mean gestational weight gain was **9.71 ± 1.69** for comparison group at the time of delivery **(p-value 0.012)**. Mean hemoglobin level of study group was 10.74 ± 1.32 mg/dl at their 1st visit and 12.05 ± 1.39 mg/dl at their 2nd visit while in comparison group mean hemoglobin level was 10.07 ± 2.06 mg/dl. Statistical significant values were **(p-value 0.024)** at 95% confidence level. The study group's mean serum calcium level was 8.86 ± 1.04 mg/dl at the first visit and 9.85 ± 0.72 at the second. The mean serum calcium level for the comparison group was 8.75 ± 1.11. At a 95% confidence level, the statistically significant values were **(p-value 0.000).** The study group's mean serum Magnesium level was 1.81 ± 0.30 mg/dl at their first visit and 2.15 ± 0.12 mg/dl at their second visit, whereas the comparison group's mean was 1.95 ± 0.35 mg/dl. At a 95% confidence level, statistically significant values were **(p-value 0.000).**

Proper nutritional counselling and diet plan throughout pregnancy is strongly associated with significantly reduced mortality and morbidity in both mother and neonate. Good and balanced nutrition significantly improved feto-maternal health outcomes. All the parameters under study were improved after intervention. There was a statistically significant correlation between maternal nutrition and health outcomes **(p-value 0.003, OR- 1.2)**, while in comparison group there was increased risk of poor health outcome **(p-value 0.749, OR 2.63)** from our study data. Correlation between maternal nutritional status and health outcome of the newborn and there was highly statistically significant association b/w maternal nutrition and health outcome of the babies (**p-value 0.012, OR- 2.458**), while in comparison group there was increased risk of poor health outcome of babies was (**p-value 0.749, 0R 6.934**). Knowledge of study group was assessed before intervention. It was noted that there was gap between knowledge and nutritional status of the participants. **P-value 0.035** was significant at in comparison group.

Conclusion: This study concluded that improving nutritive values, food rich in micronutrients during pregnancy can be implemented that increasing the intake of foods naturally high in iron, calcium, and magnesium. These interventions are available to policy makers interested in boosting healthy food intake notably during pregnancy to prevent feto-maternal morbidity and mortality. There was a gap between nutritional knowledge and behavior in these women. An important predictor of nutrition practices among pregnant women was age, household registry, education level (including pregnant women and their husbands), monthly income, and nutrition awareness.

Key Words: Maternal Nutrition, Essential Micronutrients, Feto-maternal outcome

INTRODUCTION

Nutrition plays a major role in maternal and child health and it is widely recognized that optimum nutrition in early life is the foundation for long-term health. A healthy maternal dietary pattern, along with adequate maternal body composition, metabolism and placental nutrient supply, reduces the risk of maternal, fetal and long-term effects in the offspring. While undernutrition is mainly an issue of low-income countries, malnutrition, due to poor quality diet, is becoming a global health problem [Cetin, 2015]. The World Health Organization (WHO) offers recommendations for prenatal care, but there are no thorough guidelines outlining the nutritional requirements of women throughout the whole reproductive cycle, from conception to nursing and pregnancy [Tuncalp, 2020]. More than half of the female participants expressed that they were not getting enough servings from the various dietary groups [Bodnar, 2017].

Important factors affecting the health of the fetus before and throughout pregnancy include the mother's body size, food habits, and nutritional state. Suboptimal pregnancy outcomes for the mother and child are caused by complications relating to conception, placental, embryonic, and fetal development, fetal size, and perinatal complications. These complications can arise from both excessive and inadequate nutrition and weight before and during pregnancy. (Stephenson J, 2018). Pregnant women (56%) are the population category in poor countries that is most impacted [Mawani, 2016].

Pregnant women especially young pregnant ladies face many problems in their first pregnancy due to lack of awareness and knowledge. Poor nutrition and improper antenatal care affect the health of these women which lead to malnutrition and many macronutrients and micronutrients ultimately putting them at high risk of maternal mortality and high risk deliveries [Tuncalp, 2020]. In 2018, the Pakistan National Nutrition Survey revealed that 14% of women and girls were undernourished [Brazier, 2020].

Particularly, the growth of a fetus in an obesogenic intrauterine environment can permanently affect a person's biological and metabolic pathways, resulting in adaptive pathophysiological changes in the progeny and elevated risks of non-communicable diseases in adulthood [Parisi, 2019]. When the diet of the pregnant woman does not provide the fetus with the nutrition it needs, the nutrients are taken from the mother's tissues. This makes the mother even more vulnerable, raises the likelihood of major, life-threatening problems, and makes low birth weight babies more likely to have feeding difficulties in their early years of life. A mother who is underweight is 30% more likely than a mother who is well-nourished to give birth to a baby who is underweight [Dharmalingam, 2010]. Recommendations for energy intake should be customized because pregnant women's energy needs differ greatly based on their pre-pregnancy body mass index, metabolic rate, and degree of physical activity [Mousa, 2019].

Essential Micronutrients in Pregnancy

Micronutrients, including vitamins and minerals that can be obtained through food, are crucial for biological function. The status of micronutrients varies greatly between communities and during pregnancy. The rigors of gestation can exacerbate micronutrient deficiencies, which can have a negative impact on the health of the fetus in low-income nations where pregnancies are frequently started by malnourished women. Irons to reduce the risk of low birth weight are a few examples of effective single micronutrient therapies. Birth weight is also increased by vitamin D and folic acid [Gernand, 2016]. Pregnancy-related nutritional condition can significantly affect the health of the mother and the newborn. Maternal homeostasis and fetal growth are supported by increased needs for macronutrients including protein and energy during pregnancy [Mousa, 2019]. Following are some important micronutrients essential during pregnancy:

Iron

A growing body of research suggests that the best course of action may be to treat iron deficiency in pregnancy early on with scientifically advanced supplements rather than treating it later with high-dose iron medications or traditional oral iron supplements. Despite the fact that iron is extremely important for human health, it is the most prevalent nutritional deficit worldwide [Flynn, 2020]. The need of maintaining normal iron levels during pregnancy is widely known to medical practitioners. This vital vitamin is crucial for both mother and fetus in the movement of oxygen throughout the body. Additionally, iron is essential for cell division, blood cell production, cognitive function, energy metabolism, and immune system upkeep [Auerbach, 2019]. Approximately two-thirds of pregnant women in underdeveloped countries are affected by anemia, which is one of the leading causes of maternal death and morbidity worldwide [Ali, 2020].

Following absorption by the body, the majority of iron binds to globin and subsequently exists in red blood cells to help transport oxygen. The human body lacks a controlled mechanism for iron excretion; hence iron absorption primarily controls the iron balance [Wallace, 2016]. Low maternal iron consumption during the first trimester is linked to an increased risk of autism, schizophrenia during the second trimester, and aberrant brain development during the third trimester in the kids. A lack of enough iron for the fetus is linked to long-term neurodevelopmental consequences and an increased risk of postnatal iron insufficiency [Auerbach, 2020]. Pregnant women are now frequently advised to take iron supplements to avoid IDA [Taylor, 2017]. The figures are based on a lady weighing 120 lb (54 kg), who is pregnant. 360 mg of iron are needed for the placenta and fetus' development. To increase the mass of mother red blood cells (RBCs) during pregnancy, an additional 450 mg iron is required. Therefore, acquiring 0.1 g of iron is necessary to support feto-placental growth and maintain the mother's iron balance during pregnancy. [Allison, 2017].

The World Health Organization (WHO) estimates that there are 528.7 million (29.4%) anemic women in the world, 20.2 million of whom are severely anemic. Additionally, nearly two-thirds of pregnant women in developing nations suffer from anemia. More specifically, South-East Asia (41.9%), followed by Africa and the Eastern Mediterranean, has the highest prevalence of anemia among women of reproductive age. In Pakistan, 51% of the population of women in their

childbearing age is anemic [Ali, 2020]. Compared to pregnant women, non-pregnant women have a considerably reduced burden of anemia [Kassa, 2017].
According to research, the concentrations of hemoglobin and hematocrit (Hct) usually fall throughout the first trimester of pregnancy, peak towards the end of the second trimester, and then rise once more during the third trimester. The WHO classifies pregnant women as anemic if their hemoglobin levels are less than 11.0 g/dl in the first and third trimesters and less than 10.5 g/dl in the second trimester [Tabrizi, 2015].
Approximately 75% of cases of non-physiologic anemia in pregnancy are caused by iron deficiency, and the incidence of iron deficiency anemia during pregnancy is around 41.8% worldwide. The most common deficiency ailment, dietary iron insufficiency affects over two billion people worldwide, especially pregnant women. Chronic infections, malaria, parasites, and starvation can all lead to IDA. An iron deficiency accounts for 95% of cases of anemia, which affects more than two thirds of expecting mothers in underdeveloped countries. Approximately 84% of women have an iron shortage during the first postpartum week. Maternal mortality and feto-maternal morbidity are both directly (20%) and indirectly (50%), linked to IDA worldwide [Al-Khaffaf, 2020].

Calcium

Much of the construction of bones and teeth is composed of calcium, which also maintains tissue robust, flexible, and rigid, allowing for regular physical mobility. Blood artery contraction and dilatation, muscle contraction, blood clotting, neuron transmission, and hormone production are all mediated by the little ionized pool of calcium found in the circulatory system, extracellular fluid, and different tissues. The bones contain nearly all of the calcium in the body (98%) and are both a source and a reservoir for calcium, helping the body to maintain calcium homeostasis. In order to maintain serum calcium levels, restore damage, alter bone size throughout growth, and provide as a source of additional minerals, bone remodeling is necessary [Vannucci, 2018].
Calcium deficiency can result from poor nutrition and the normal physiological changes associated with pregnancy in most developing countries Nutritional deficiencies and poor maternal and neonatal health continue to be major causes of disease burden. Asphyxia, severe infections, low birth weight, and preterm birth were the main causes of the 3.1 million infant deaths that occurred in the first 28 days of life in 2010. 15 million preterm babies are born each year, and 1.1 million of them pass away during the neonatal or early childhood stages. [Ajong, 2023] Preterm birth, fetal growth restriction (FGR), and the development of maternal hypertension, a major contributor to morbidity have all been related to inadequate calcium consumption during pregnancy [Korhonen, 2021]. Preterm birth is the leading cause of early neonatal and infant mortality; hypertensive disorders are linked to a significant number of maternal deaths and a considerable risk of preterm birth, which can be prevented in part by taking a calcium supplement during pregnancy [Dwarkanath, 2024]. The main cause of the drop in serum calcium levels throughout the second and third trimesters of pregnancy is hemodilution [Kant, 2019].
Consuming insufficient amounts of calcium puts the mother and fetus at risk. Maternal hazards include preeclampsia and hypertension, whereas fetal risks include low birth weight, poor bone mineralization, restricted intrauterine growth, and preterm delivery [Willemse, 2020]. A newborn baby's skeleton has between 20 and 30 g of calcium in it. The third trimester is when the fetal skeleton grows the fastest, with the majority of the growth occurring from mid-pregnancy onward [Kumar, 2017].
It is commonly known that taking supplements of calcium during pregnancy lowers the chance of having high blood pressure (BP) during pregnancy. Pregnancy-induced hypertension appears to be mitigated by daily calcium intake of 1500–2000 mg. A dietary intake of 1200 mg/day of calcium for pregnant women is recommended by WHO. Each day, 500 mg of calcium is added back to the calcium that has been extracted from bones [Khanam, 2018].
According to a survey, 41% females are deficient to Calcium and Vitamin D [Naveed S, 2016]. Pregnant women had a 70.55% frequency of hypocalcaemia. The fetus actively receives calcium from the mother during the last trimester, as evidenced by the cord blood's noticeably higher total calcium concentration than that of the mother's serum. The study's conclusions demonstrated that 79.09% of preterm newborns and 53.71% of low birth weight infants experienced early hypocalcaemia [Benali, 2014].

Magnesium

Pregnant women frequently experience hypomagnesaemia, especially in developing nations and low-income areas. It is yet unknown if hypomagnesaemia is linked to problems in human pregnancies, even given the widespread therapeutic use of magnesium during pregnancy and the data from animal studies that links hypomagnesaemia to unfavorable pregnancy outcomes [Morton, 2018], One of the necessary elements is magnesium, involved in many different metabolic processes [Orlova, 2021]. Among these, magnesium (Mg^{++}) is a vital mineral that is needed for a developing fetus's cell division and is a vital component of life chemistry for maintaining a healthy neuromuscular system. Research with conflicting data has been spurred by a proposed function for magnesium insufficiency in illnesses such as pre-eclampsia and pre-term delivery [Enaruna, 2013]. Magnesium is the utmost prevalent element ion engaged in the activity of enzymes. It is necessary for bone development, neurological function, cardiac excitability, muscle contraction, modulation of vascular tone, synthesis of proteins, nucleic acids, consumption of glucose, and synthesis of adenosine triphosphate [Caspi, 2014].

Studies show that minerals and trace elements are essential for a fetus's development. Magnesium is important during pregnancy and the main cause of perinatal morbidity and mortality is preterm birth, and its prevalence is rising in certain developed nations. Through calcium antagonistic effects, magnesium may prevent premature uterine contractions; Mg^{++} has been used as a tocolytic drug for more than 50 years. However, taking a magnesium supplement throughout pregnancy is a straightforward, safe preventative step that may lower the chance of an early labor or birth [Dalton, 2016].

A magnesium deficit during pregnancy can result in low birth weight babies, premature labor, leg cramps, hypertension, and IUGR [Baloch, 2012]. The range of serum magnesium concentrations is 1.8–2.2 mg/dl^{-1}. Thus, hypomagnesemia is diagnosed in a patient whose serum magnesium levels are below the range that is regarded as normal [Marin, 2023]. It should be noted that pregnancy and lactation require a roughly 10% greater intake of magnesium; that is, an RDA of 350–400 mg/day is advised during pregnancy and 310–360 mg/day during lactation, as opposed to 300–310 mg/day for women who are neither pregnant nor breastfeeding [Fanni, 2021].

MATERIALS & METHODS

This interventional study was carried out in Gynecology and Obstetrics Department at Peoples Medical College Hospital Nawabshah, from January to December 2023. The Study population was 191 participants, 91 were taken as study subjects and 100 were taken as Comparison group. Young Pregnant women were included fulfilling the inclusion criteria having age ranging from 18 to 26 years with minimum primary education and belonging to lower middle class or higher. Study participants were contacted at the end of the 2nd trimester to the start of 3rd trimester and were given nutritional education, counselling and problems related to their pregnancy. No any associated comorbidity or malabsorption syndrome and not taking any nutrition supplement were included in this study.

Data Collection Methods: After taking written consent data collection encompassed a comprehensive approach to gather information from the selected subjects. Questionnaires were designed for this study and following information were collected. **Sociodemographic Characteristics** about the subject's age, gender, educational background of Participant and their husbands, socioeconomic status, Occupation of the Participants and their Husband and other relevant demographic data. **Patient's history of current Pregnancy** included details such as the age the time of marriage, Weight before pregnancy, approximate weight gain, complications during pregnancy, term of Pregnancy, normal fetal development, family history, environmental and any psychological condition. Data collected regarding **Subject's current nutritional status** and any macro or micro nutrients deficiencies, especially Iron Deficiency, Vitamin D Deficiency or insufficiency, Calcium Deficiency, Magnesium Deficiency and Malnutrition. Complete Nutritional chart and Weekly nutritional Plan was provided to Study participants and were given proper counselling related to Nutrition and early self-detectable signs and symptoms were discussed at their first visit at the start of 3rd trimester. Participants were also provided information leaflet related to Nutrition, requirement during pregnancy and Diet plan daily and weekly.

Clinical assessment and Laboratory Investigations: All relevant anthropometric measures like Height, Weight, BMI, and micronutrients related signs and symptoms were measured at the 1st visit of study subjects. Laboratory investigations (CBC, Serum Vitamin D, Serum Calcium and Magnesium) were also collected from the participants.

1. Sample collection for CBC: After applying all aseptic measures a total of 2cc blood was drawn from the patient for CBC and was transferred immediately in EDTA tube and shake to prevent clotting and were sent to laboratory for test and report. **Biotoo HA 300 Auto Hematology Analyzer** was used for this purpose. Blood Hemoglobin level, MCV, MCH, MCHC and other parameters were analyzed.

2. Sample collection for serum calcium: For serum calcium, after using all aseptic measures 2cc blood was drawn from the patient and was directly moved to laboratory. "**Chem reader Smart –N SE 250-N Semi auto Chemistry Analyzer"** used for serum calcium level.

3. Sample collection for serum magnesium: For serum magnesium, after using all aseptic measures 2cc blood was drawn from the patient and was directly sent to laboratory. "**Chem reader Smart –N SE 250-N Semi auto Chemistry Analyzer"** used for **s**erum magnesium level.

4. Calories and Micronutrients calculation Chart: For calculation of calories and essential micronutrients a chart was used having food items and their values were used. Food items were selected according to the availability in the local market and participant's food preferences.

These study participants were also followed at the time of delivery. All these information were collected from the comparison group at the time of delivery or at the time of termination of pregnancy. Then finally **Maternal and Fetal Outcome was assessed a**fter giving birth to newborn all the relevant information were collected from the mother or attendant related to her health and her baby's health and health related complications.

Data Analysis

The statistical package for social sciences (SPSS Version 27.0), Microsoft office 2016, Calculator and hand sorting techniques were used for analysis. Depending on the type of data and the goals of the study, this analysis was used a variety of statistical tests and methods. Statistics include mean, median, standard deviation, relative risk, odds ratio, test of significance (Pearson correlation, paired sample t-test, p-value, chi square, binary logistic regression), graphs and tables of frequency distribution and comparison was done on SPSS. Inferences about the subject population were made, trends were found, and significant conclusions were drawn from the data. This method ensures a meticulous and thorough approach to data collection, statistical analysis, and sample selection, so offering a strong basis for the results of research study and conclusions. The dependability and credibility of the study findings are increased by the adoption of standardized processes and tools.

RESULTS

Table No. 01: Socio demographic information of the Study Participants (n=91, n=100)

			Study Group		Comparison Group	
Sr. No.	Characteristics	Category	Frequency	Relative Frequency	Frequency	Relative Frequency
1	**Age of the Participants**	18 to 20 years	21	23.08	25	25.0
		21 to 23 year	21	23.08	38	38.0
		24 to 26 years	49	53.84	39	39.0
2	**Residence of Participants**	Urban	41	45.05	49	49.0
		Rural	50	54.95	51	51.0
3	**Educational status of Participant**	Primary	20	21.97	35	35.0
		Secondary	62	68.14	56	56.0
		Graduate	09	9.89	09	9.0
4	**Educational status of Husband**	Primary	17	18.68	18	18.0
		Secondary	51	56.05	56	56.0
		Graduate	23	25.27	25	25.0
5	**Occupation of the Participants**	Employed	16	17.59	12	12.0
		Skilled Person	03	3.29	03	3.0
		House Wife	72	79.12	85	85.0
6	**Occupation of the Husband**	Unemployed	3	3.29	11	11.0
		Skilled Person	53	58.25	57	57.0
		Employed	35	38.46	32	32.0
7	**Socioeconomic Status of Participants**	Lower Middle Class	39	42.85	42	42.0
		Upper Middle Class	52	57.14	58	58.0
8	**Term of Pregnancy**	Preterm (<37week GA)	20	21.97	39	39.0
		Full Term (37week GA)	63	69.23	44	44.0
		Post Term (>37week GA)	08	8.79	17	17.0

The above table shows the socio-demographic information of the participants.

Table No. 02: Mean and Standard deviation of Blood Hemoglobin level, Serum Calcium Level and Serum Magnesium level of the Participants (n=91, n=100)

		Study Group		**Comparison Group**	Group Comparison (Paired Sample test)	
		(1st Visit) Before intervention	(2nd Visit) After intervention			
		Mean Std. Deviation	Mean Std. Deviation	Mean Std. Deviation	Std. Error Mean	Sig. (2-tailed)
1	Blood Hemoglobin Level (mg/dl)	**10.74 ± 1.32**	**12.05 ± 1.39**	**10.07 ± 2.06**	0.252	**0.000**
2	Serum Calcium (mg/dl)	**8.86 ± 1.04**	**9.85 ± 0.72**	**8.75 ± 1.11**	0.134	**0.003**
3	Serum Magnesium (mg/dl)	**1.83 ± 0.30**	**2.15 ± 0.42**	**1.95 ± 0.35**	**0.058**	**0.001**

Blood Hemoglobin Level (mg/dl): Normal >11, Anemia during pregnancy: < 11 in 1st and 3rd trimester and < 10.5 in 2nd trimester. (Tabrizi, 2015)
Serum Calcium level (mg/dl**):** Normal: 8.8 to 10.3, Hypocalcemia during pregnancy: < 8.8 (Kant, 2019).
Serum Magnesium level (mg/dl**):** Normal: 1.9 to 2.5, Hypomagnesemia during pregnancy: < 1.9. (Marin, 2023)

Complete blood count (CBC) was done for each participant in study group in each visit while for comparison group at the time of delivery. Mean hemoglobin level of study group was 10.74 ± 1.32 mg/dl at their 1st visit and 12.05 ± 1.39 mg/dl at their 2nd visit while in comparison group mean hemoglobin level was 10.07 ± 2.06 mg/dl. Statistical significant values were **(p-value 0.024)** at 95% confidence level. The study group's mean serum calcium level was 8.86 ± 1.04 mg/dl at the first visit and 9.85 ± 0.72 at the second. The mean serum calcium level for the comparison group was 8.75 ± 1.11. At a 95% confidence level, the statistically significant values were **(p-value 0.000).** The study group's mean serum Magnesium level was 1.81 ± 0.30 mg/dl at their first visit and 2.15 ± 0.12 mg/dl at their second visit, whereas the comparison group's mean was 1.95 ± 0.35 mg/dl. At a 95% confidence level, statistically significant values were **(p-value 0.000).**

Table No. 03 Comparison of association of anemia, hypocalcemia and hypomagnesemia with health outcome of mother (n=91, n=100)

		Health Outcome of Mother							
		Study Group (After Intervention)				**Comparison Group**			
		Healthy Recovery	**Ill health / Need care**	**Total**	**p-value**	**Healthy Recovery**	**Ill health / Need care**	**Total**	**p-value**
Status Of Anemia	Normal	**63**	**7**	70	0.000	**30**	**10**	40	0.042
	Anemia	**10**	**11**	21		**33**	**27**	60	
Total		73	18	91		63	37	100	
Status of Hypocalcemia	Normal	**66**	**9**	75	0.001	**47**	**12**	59	0.188
	Hypocalcemia	**7**	**9**	16		**16**	**25**	41	
Total		73	18	91		63	37	100	
Status of Hypomagnesemia	Normal	**57**	**15**	72	0.024	**40**	**20**	60	0.236
	Hypomagnesemia	**16**	**3**	19		**23**	**17**	40	
Total		73	18	91		63	37	100	
The values were statistically significant at < 0.05									

Status of anemia was associated with mother outcome in both groups and chi square test was applied to validate the association and there was highly statistically significant **(p-value = 0.000)** association between anemia and mother outcome compared to comparison group where the values were significant at **(p-value = 0.042)** as shown in above table. The association between the mother's serum calcium level during delivery and the result is displayed in the above table. The p-value of 0.001 indicated that the values were highly statistically significant as compared to comparison group where no significant association was **seen (p-value = 0.188).** This demonstrates the strong correlation between a normal serum calcium level and favorable maternal outcomes. The association b/w serum magnesium level and health status of the mother was observed after intervention and compared with comparison group as shown in above table. It was evident that magnesium level and mother's health were significant correlated **(p-value 0.024)** after intervention compared to comparison group with no statistically significant values **(p-value 0.236).**

Table No. 04: Difference in total Caloric intake (daily) between Study and Comparison groups (n=91, n=100)

		Paired Differences					T	Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	**Upper**			
Between Group*	Calories Intake Daily (K Cal) (Study)	**2077.91**	**145.64**	**15.27**	2047.58	2108.24	**136.11**	**90**	**0.001**
	Calories Intake Daily (K Cal) (Comparison)	**1821.91**	**254.96**	**25.50**	1771.32	1872.50	**71.46**	**99**	
There is statistical difference in study group at significant level $\alpha \leq 0.05$ *Sample t-test used for between the group difference									

To test the hypothesis Paired sample t-test was applied to quantity the difference in total caloric intake (daily) between the groups after intervention. The study group's statistically significant difference (p-value 0.001) is displayed in the above table.

Table No. 05: Comparison of weight at the time of admission and gestational weight gain between study and comparison groups (n1=91, n2=100)

Descriptive Statistics

	Study Group (After intervention)	**Comparison Group**	**P-value**
	Mean & Standard Deviation (n= 91)	Mean & Standard Deviation (n= 100)	
Weight at the time of Admission (in Kg)	**69.12 ± 4.56**	**65.51 ± 4.87**	**0.535**
Gestational Weight Gain (GWG) (in Kg)	**12.21 ± 1.85**	**9.71 ± 1.69**	**0.012**
One sample t test for test of significance at <0.05			

Mean weight was **69.12 ± 4.56** for study group and mean weight was **65.51 ± 4.87** for comparison group at the time of delivery **(p-value 0.535).** Mean gestational weight gain measured was **12.21 ± 1.85** for study group at the time of delivery and mean gestational weight gain was **9.71 ± 1.69** for comparison group at the time of delivery **(p-value 0.012)**.

Table No. 06: Comparison of Correlation between Maternal Nutrition and Health Outcome of Mother (n1=91, n2=100)											
		Health outcome of mother									
		Study Group					**Comparison Group**				
		Healthy Recovery	Ill health / Need care	**Death**	**p-value**	**OR**	Healthy Recovery	Ill health / Need care	**Total**	**p-value**	**OR**
Status of Maternal Nutrition	Poor Nutrition	**10**	**3**	**0**	**0.003**	**1.2**	**32**	**30**	**0**	**0.749**	**2.63**
	Good Nutrition	**63**	**15**	**0**			**31**	**7**	**0**		
Total		73	18	0			63	37	0		
*Binary Logistic Regression used for correlation											

The relationship between the mother's nutritional state and health outcomes is displayed in the above table. There was a statistically significant correlation between maternal nutrition and health outcomes **(p-value 0.003, OR- 1.2)**, while in comparison group there was increased risk of poor health outcome **(p-value 0.749, OR 2.63)** from our study data.

Table No. 07: Comparison of correlation between maternal nutrition and health outcome of newborn (n1=91, n2=100)											
		Newborn Weight at the time of Birth									
		Study Group					**Comparison Group**				
		Healthy Recovery	Ill health / Need care	**Death**	**p-value**	**OR**	Healthy Recovery	Ill health / Need care	**Total**	**p-value**	**OR**
Status of Maternal Nutrition	Poor Nutrition	4	3	**0**	**0.012**	**2.46**	29	22	8	**0.00**	**6.93**
	Good Nutrition	71	12	**0**			38	3	0		
Total		73	18	0			63	37	0		
*Multinomial Logistic Regression used for correlation											

The above table illustrates the correlation between maternal nutritional status and health outcome of the newborn and there was highly statistically significant association b/w maternal nutrition and health outcome of the babies (**p-value 0.012, OR-2.458**), while in comparison group there was increased risk of poor health outcome of babies was (**p-value 0.749, 0R 6.934**).

Table No. 08: Comparison of status of calories intake (daily) of the participants (n1=91, n2=100)					
		Study Group		Comparison Group	
		Frequency	Percent (%)	Frequency	Percent (%)
Status of caloric intake of Mothers	**Poor Calories**	8	8.79	59	59.0
	Good Calories	83	91.21	41	41.0
	Total	91	100.0	100.0	100.0

The above table illustrates the frequency of nutritional status of the participants. In study group after intervention and counselling good nutrition was adopted by 83 (91.21%) participants and poor nutrition was seen in 8 (8.79%) participants. In comparison group good nutrition was seen in 41 (41%) participants and poor nutrition was seen in 59 (59%) participants.

Table No. 09: Comparison of Association between Knowledge of mothers related to nutrition and nutritional status during Pregnancy (n1=91, n2=100)									
		Maternal Nutritional Status							
		Study Group				Comparison Group			
		Good	Poor	Total	p-value	Good	Poor	Total	p-value
Level of Knowledge	**Good**	**21**	**3**	24	0.964[a]	**12**	**7**	19	0.035[a]
	Average	**42**	**2**	44		**20**	**32**	52	
	Poor	**20**	**3**	23		**9**	**20**	29	
Total		83	8	91		41	59	100	
a. Based on normal approximation									

Participants' knowledge of nutrition during pregnancy was also assessed. Knowledge of study group was assessed before intervention. It was noted that there was gap between knowledge and nutritional status of the participants. P-value was significant at 0.035 in comparison group.

Table No. 10: Difference in total Caloric intake (daily) between Study and Comparison groups (n1=91, n2=100)

		Paired Differences (K Cal)					T	Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	**Upper**			
Between Group*	Calories Intake Daily (Study)	**2077.91**	**145.64**	**15.27**	2047.58	2108.24	**136.11**	**90**	**0.001**
	Calories Intake Daily (Comparison)	**1821.91**	**254.96**	**25.50**	1771.32	1872.50	**71.46**	**99**	

There is statistical difference in study group at significant level $\alpha \leq 0.05$
*Sample t-test used for between the group difference

To test the hypothesis Paired sample t-test was applied to quantity the difference in total caloric intake (daily) between the groups after intervention. The study group's statistically significant difference (p-value 0.001) is displayed in the above table.

Table No. 10: Knowledge level related to maternal weight, BMI, nutrition, calories intake and essential micronutrients during pregnancy (n1=91, n2=100),
(Sangwan KS., et al,. 2022 & Wang W, et al., 2020)

Sr. No.	**Characteristics**	**Study Group**		**Comparison Group**	
		Correct	Incorrect	Correct	Incorrect
1	During pregnancy, eating a balanced diet is crucial.	**82**	**9**	**77**	**23**
2	Pregnant women eat differently than regular women.	**57**	**34**	**50**	**41**
3	A woman should gain between 11.5 and 16.0 kg during pregnancy if her prenatal weight was normal.	**34**	**57**	**35**	**65**
4	I know the normal BMI and I ask my doctor to calculate BMI in every visit	**29**	**62**	**34**	**66**
5	Foetal growth and well-being may be impacted by an underweight mother.	**77**	**14**	**70**	**30**
6	Numerous pregnancy complications are more likely to affect obese women.	**46**	**45**	**39**	**61**
7	I am aware of common signs and symptoms related to nutritional deficiencies.	**32**	**59**	**39**	**61**
8	I know about the extra amount of food during pregnancy	**36**	**55**	**42**	**58**
9	Pregnancy-related additional energy requirements should be customized based on the woman's BMI.	**43**	**48**	**44**	**56**
10	I know the important micronutrients required during pregnancy	**50**	**41**	**43**	**57**
11	Lack of certain nutrients during pregnancy may have an effect on the mother's and the unborn child's health.	**49**	**42**	**61**	**39**
12	I know about the sources of macronutrients	**50**	**41**	**36**	**64**
13	I know about the sources of micronutrients	**31**	**60**	**33**	**67**
14	I know about the need of iron, Vitamin D3 calcium, Magnesium and folic acid requirement during pregnancy.	**37**	**54**	**42**	**58**
15	I know about avoidable substances during pregnancy	**42**	**49**	**51**	**49**

*Incorrect answers include, don't know, don't remember, no answer
Total Score:
The above table was used to access the knowledge of the participants related to nutrition and care during pregnancy.
Knowledge, Good = 11 - 15 responses, Average = 6 - 10 responses and Poor = ≤ 5

The above table shows the responses related to knowledge of nutrition and calories during pregnancy of the participants.

Table No. 11: Level of knowledge level of participants on nutrition during pregnancy (n1=91, n2=100)

		Study Group		**Comparison Group**	
		Frequency	Percentage	Frequency	Percentage
Level of Knowledge	Good	24	26.37	19	19.0
	Average	44	48.35	52	52.0
	Poor	23	25.25	29	29.0
Total		91	100.0	100	100.0

Level of knowledge of the participants related to Nutrition during pregnancy was accessed. Study group level of knowledge was asked at first visit and it was seen that 26.37% participants had good knowledge, 48.35% had average knowledge and 25.25% participants had poor knowledge. Comparison group was asked the same at the time of delivery and it was seen that 19% participants had good knowledge, 52% had average knowledge and remaining 29% participants had poor knowledge.

Table No. 12: Comparison of Association between Knowledge of mothers related to nutrition and nutritional status during Pregnancy (n1=91, n2=100)

		Maternal Nutritional Status							
		Study Group				Comparison Group			
		Good	Poor	Total	p-value	Good	Poor	Total	p-value
Level of Knowledge	**Good**	**21**	**3**	24	0.964[a]	**12**	**7**	19	0.035[a]
	Average	**42**	**2**	44		**20**	**32**	52	
	Poor	**20**	**3**	23		**9**	**20**	29	
Total		83	8	91		41	59	100	
a. Based on normal approximation									

Participants' knowledge of nutrition during pregnancy was also assessed. Knowledge of study group was assessed before intervention. It was noted that there was gap between knowledge and nutritional status of the participants. **P-value 0.035** was significant at in comparison group.

DISCUSSION

Pregnancy causes speedy and significant physiological alterations from time of conception till delivery. In order to sustain the mother's metabolism and tissue accretion while promoting the fetus's growth and development, pregnancy increases the need for specific nutrients (Baker, 2002) The mother's and the baby's health can be greatly impacted by pregnancy-related dietary conditions. Macronutrients like proteins and energy are most vital during pregnancy in order to promote the growth of foetal and mothers are homeostasis. Energy constraint can help obese women acquire less weight during pregnancy. A few micronutrients are also critical for improving pregnancy outcomes [Mousa, 2019].

Maternal and perinatal outcomes are influenced by the timing of gestational weight increase. Preeclampsia is predicted by pre-gestational BMI, pregnancy-induced hypertension is predicted by maternal weight gain in the 3rd trimester, and the rise in total Small for gestational age, and proper GWG lowers the risk of pregnancy related DM. Gonzalez-Ballano (2021) investigation found that GWG had a decreased chance of having SGA neonates, with OR 0.62 (95% CI, 0.39-0.98) and OR 0.60 (95% CI, 0.37-0.98), respectively [Gonzalez-Ballano, 2021].

Neural signaling, skeletal structure, and smooth muscle contraction all depend on calcium & vitamin D3. In regions where these foods are easily accessible, moderately priced, and socially acceptable, encouraging the use of naturally occurring foods that contain calcium & vitamin D_3 may be a useful strategy to increase intake of these nutrients [Bourassa, 2022]. Because it must satisfy the needs of the developing foetus and the mother's regular nutritional needs, a healthy, balanced diet is crucial for expecting moms. In contrast to the reference group, which had 41% hypocalcaemia, the study group's frequency of hypocalcaemia was 50.55% prior to intervention and considerably dropped to 17.58% following three months of intervention. Prior to the intervention, the study group's prevalence of vitamin D_3 deficiency or insufficiency was 87.91%; following the intervention, it dropped to 58.24%, whereas in the comparison group, it was 84%. 56.70% of women experience complete hypocalcaemia in the latter stages of pregnancy. The number of meals consumed daily, dessert intake, the makeup of the most consumed meal, and monthly income all has a significant impact on the frequency of overall hypocalcaemia during pregnancy [Ajong, 2020].

When comparing the comparison group to the study group after the intervention, where 17.6% of participants were hypocalcemic and only 06 had poor baby outcomes, it was evident that maternal serum calcium had a through bearing on health of the newborn. 76% of neonates were hypocalcemic, and 52% of those babies had late hypocalcaemia. According to a research by Elsary (2018), hypovitaminosis D prevalence was 38%. Hypocalcaemia was more common in newborns who had no history of maternal calcium supplementation (57.9%) or vitamin D supplementation (98.7%) [Elsary, 2018].

For the regulation of blood pressure, magnesium is necessary. High in potassium and magnesium, fruits and vegetables are associated with lowered blood pressure during pregnancy. Because magnesium is necessary for the development of preeclampsia during pregnancy, preeclampsia will develop in 33% of patients with insufficient magnesium levels. Preeclampsia and hypertension during pregnancy are associated with magnesium deficiency and found pregnant women with hypomagnesaemia who took magnesium supplements were 6.51 times less likely to develop preeclampsia. Their research demonstrated that pregnant women with hypomagnesaemia benefit greatly from magnesium supplementation in preventing preeclampsia [Darma, 2021].

Frequency of hypomagnesmia was measured in our study participants who were primigravida and were admitted for delivery or LSCS and it was noted that 59 (30.89%) participants had low serum magnesium level. Enaruna (2013) conducted a test study to find the mean serum Mg^{++} level in female patient population at the teaching hospital. According to the findings of research, prevalence of magnesium shortage during pregnancy has been estimated to range from 4.6% to 48%. A magnesium deficit during pregnancy can affect the mother, foetus, baby, and even the unborn kid for a long time. There were no maternal mortality were present in our study. This is also in accordance with our study as well [Enaruna, 2013].

Hypomagnesemia is linked with poor baby outcome and prolonged hospital stay. Babies delivered to mothers with low serum magnesium have low birth weight babies, preterm babies and majority of the babies need special care and admission to NICU after birth for further management. In a research by Atiba (2020) revealed that it seems that hypomagnesaemia is a

side effect of pre-eclampsia. This biomarker's serum level has a major impact on the outcome for the mother and fetus. Their study's conclusions demonstrated a statistically significant link between LBW and preterm deliveries, the necessity for a baby of moms with low serum magnesium levels to be admitted to a special care baby unit [Atiba, 2020]. This is in accordance with our study as well.

Adolescents go through physiological changes during pregnancy that are distinct from those experienced by adults because they haven't finished growing physically. Thus, there may be differences in the results for mothers and newborns. Inadequate GWG was shown to be the factor that enhanced the chance of low birth weight (RP: 1.61, p = 0.008), according to study data. Comparable outcomes for the SGA outcome were noted. The risks of SGA was somewhat elevated in M2 due to inadequate GWG (RP: 1.36, p = 0.084) [Samano, 2022]. According to the results of our investigation, there is a highly statistically significant correlation between the baby's birth weight and the gestational weight gain during pregnancy. Of the participants, 47 out of 58 (81.03%) had babies with normal weight who had satisfactory GWG, and 21 out of 23 (91.3%) had babies with good GWG. When it comes to newborn weight, satisfactory and good GWG performs better 81 out of 91 (p-value 0.000) had normal weight than the comparison group (p-value 0.010).

During pregnancy, proper food consumption is necessary for supporting the nutritional health of both mother and the unborn child. The current study determined that proper counselling and promoting nutrition according to the need during pregnancy have good effects on feto-maternal outcome and reduced morbidity and mortality of both. A research conducted by Asim (2020) mentioned that pregnant women in Punjab region face a variety of complex barriers that limit their ability to consume an adequate diet. Two other structural obstacles were found: the dearth of reasonably priced, nutrient-dense food and insufficient prenatal care. To support healthy eating habits during this crucial time, effective antenatal health education programs and fundamental interventions are dire needs [Asim, 2020].

Knowledge linked to nutrition during pregnancy of participants was also assessed in our study. Knowledge of study group was assessed prior intervention and it was noted that there was gap between knowledge and nutritional status of the participants. P-value was significant at 0.035 in comparison group. This data of pregnant women's practices to receive balanced nutrition was fully explained by the knowledge, attitude, and practice hypothesis. Sangwan (2022) conducted a KAP survey with the goal of determining the extent to which pregnant women's attitudes, awareness, and understanding regarding nutrition. The study shows that 8 (8.5%) mothers concerned about following a regular diet, and 86 (91.5%) mothers knew that they needed extra food during pregnancy. The study demonstrates that the studied population has adequate knowledge and attitudes on diet and nutrition during pregnancy, but there is still a deficiency in nutrition practices. Thus, there is a considerable gap in the practical application of knowledge and attitude. It is necessary to raise awareness of the value of nutrition during pregnancy. [Sangwan, 2022]. Wang W et al.'s further investigation revealed a discrepancy between knowledge and practice (16.8% or above were good). This study provides a predictive model to identify the vulnerable group and emphasizes how nutritional education programs tailored to specific communities may increase the conversion rate of dietary practices. [Wang, 2023]

Certain micronutrients are essential for enhancing the outcomes of pregnancy. Recent research recommends the use of calcium supplements to avoid pregnancy-related hypertension problems, especially in high-risk or low-dietary calcium-consuming women. Although there are still knowledge gaps, research on the connection between maternal and foetal outcomes and nutrition during pregnancy has advanced significantly in recent years.

CONCLUSION

Optimal foetal growth, favourable obstetrical outcomes, increased perinatal survival, and the possibility of enhanced long-term health for both the mother and the child are all facilitated by comprehensive changes in women's nutrition and health status both before and throughout pregnancy. This study concluded that improving nutritive values, food rich in iron, vitamin D_3, calcium and magnesium intake during pregnancy can be carried out, such as encouraging the intake of nutrients that are certainly high in iron, vitamin D_3 calcium and magnesium. Policymakers interested in promoting healthy eating habits, particularly during pregnancy, to lower feto-maternal morbidity and death can use these strategies.

RECOMMENDATIONS

The recommendations made discuss three areas, (1) The importance of encouraging better nutrition among pregnant women, (2) The health advantages of eating a healthy diet before, during, and after pregnancy and (3) The critical knowledge gaps about nutrition during the reproductive years. Despite the meeting's primary focus on American women, there were significant insights from international partners as well.

CONFLICT OF INTEREST

There was no any conflict of interest in our study

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