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Pregnancy and Perinatal Outcomes of Vegetarian Pregnancies: A Case Control Study

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Abstract

Background: A rapid increase in vegetarian and vegan diets has been recently observed among childbearing potential women. Although evidences demonstrated the safety of plant-based diets during pregnancy, the risk of nutritional deficiencies must still be considered. This study aims to evaluate the maternal and neonatal outcomes of vegetarian and vegan diets during pregnancy in order to guide healthcare professionals in the management of such women.

Methods: This is a retrospective observational (1:2) case-control study comparing the main pregnancy and perinatal outcomes of vegetarian/vegan and omnivorous (control) women.

Results: A total of 309 women were identified during the study period. Of these, 103 women followed a vegetarian/vegan diet and 206 women belonged to the control group. Vegetarian women resulted to have a greater intake of acetylsalicylic acid (due to anamnestic risk factors) (veg=15.53%; controls=6.80%; p=0.023) and a higher prevalence of preterm birth, namely late preterm (veg=12.62%; controls=4.37%; p=0.017). No differences in intrapartum outcomes were found between the two groups beside a greater prevalence of post-partum hemorrhage following vaginal birth (veg=13.92%; controls=26.35%; p=0.03) in the control group.

The multivariate logistic regression showed that the risk of preterm birth was increased in vegetarian women, smoking during pregnancy (OR=10.79, p=0.030), and was reduced by an appropriate weight gain (OR=0.873, p=0.009).

Conclusion: The greater rate of preterm birth found among vegetarians, reflects nutritional deficiencies not adequately treated during pregnancy and appears associated to smoking habits. An early identification and correction of dietary imbalances through the integration of critical nutrients, in accordance with national and international guidelines may prevent adverse perinatal outcomes in such population.

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Introduction

Healthy nutrition during pregnancy play a pivotal role, not only for the right development of the organs and the fetus but, above all, for determining the future health of the newborn throughout his entire life.

In recent years, a rapid increase in vegetarian and vegan diets has been observed, especially among women aged between 25 and 34, or health, ethical, religious, and environmental reasons [1].

Indeed, around the world, the percentage of people who adhere to an exclusively or predominantly plant-based diet is around 10%, but it varies greatly from state to state. In India, for instance, the vegetarian percentage reaches 30% of the population and has always been much higher than in other countries in the world, mainly for religious reasons [2].

A vegetarian diet excludes the consumption of all types of meat (pork, beef, mutton, lamb, poultry), meat products (sausages, pates, etc.), fish, clams, and crustaceans.

Based on the inclusion of dairy products, eggs, and honey, we can distinguish the lacto-ovo-vegetarian (LOV) diet which excludes meat and fish, but includes dairy products, eggs, and honey, together with a wide range of plant-based foods [3]. The subcategories are lacto-vegetarianism (LV), which excludes eggs, and ovo-vegetarianism (OV), excluding also milk and dairy products. Veganism (VEG), on the other hand, excludes meat, fish, dairy products, eggs, and honey and is based on a wide range of foods of plant origin. In most cases, it does not only concern nutrition but excludes the use of animal resources from any area including clothes, cosmetics, and household cleaning products.

The American Dietetic Association declared in 2009 that a properly planned vegetarian or vegan diet can be considered safe for pregnant women and can bring health benefits in the prevention and treatment of certain pathologies [4].

[The elimination of meat and fish-based foods from the diet leads to a greater consumption of plant foods which provide a great variety of protective nutrients and reduce the harmful effects of some nutrients of animal origin: animal proteins, iron, saturated fats, cholesterol; in addition to the environmental toxic agents that the animal eats, which represent risk factors for the main chronic diseases: cardiovascular diseases, hypertension, diabetes, some types of cancer, and obesity [5].

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Although several studies have now demonstrated the safety of plant-based diets during pregnancy, the risk of nutritional deficiencies must still be considered and therefore requires particular attention to ensure that there is an adequate intake of essential nutrients [4].

Healthcare providers are ethically obliged to respect vegetarian dietary patterns and to provide women with information so that they are aware of their nutritional needs and sources of nutrients. Adequate counseling for vegetarian/vegan women by health professionals is therefore necessary, who must underline the importance of introducing foods rich in iron and vitamin B12 and the need for possible supplementation.

From this perspective, the management of pregnancies of vegetarian women should be followed to guarantee a balanced diet and recognize inadequate dietary patterns in order to implement the changes and interventions necessary to assure better maternal and fetal outcomes.

This study aims to evaluate the maternal and neonatal outcomes of vegetarian and vegan diets during pregnancy and define the role of the midwife in the management of such women.

Material and Methods

A retrospective observational case-control study was conducted with a 1:2 ratio between the two groups vegetarian/vegan and omnivorous (control) women, with the aim of evaluating any associations between the vegetarian/vegan dietary pattern and maternal/fetal outcomes and to define the role of the professionals in the management of such women.

Given the observational and retrospective nature of the study, it fell in the low risk category, thus the Ethic Committee opinion could be waived.

The patients were enrolled from January 2022 to August 2023 at the Gynecology and Obstetrics Unit of the Santa Maria Nuova hospital in Reggio Emilia, and at the Department of Maternal, Child and Adult Medical and Surgical Sciences of the Modena Polyclinic Hospital. The medical records were checked to identify vegetarian/vegan women. Controls, were randomly selected from the next two omnivorous women which delivered after one case of vegetarian.

The main sociodemographic, pregnancy and perinatal variables (maternal age, pre-pregnancy BMI, maternal diseases, labor and delivery outcomes) were retrospectively collected anonymously in both study groups.

Statistical analysis

Data analysis was performed using the GraphPad-Prism program.

The comparisons between the study groups (vegetarian/vegan and controls) were made using the t test for continuous data and the Fisher test for categorical data. The P value ≤ 0.05 was considered as the threshold for defining statistical significance. Continuous variables are presented as mean ± SD, and the categorical variables as N (%).

Results

A total of 309 women matching the "nutritional" inclusion criterion, were identified during the study period. Of these, 103 women followed a vegetarian/vegan diet and 206 women belonged to the control group. Of the 103 women in the vegetarian/vegan group, 98 were lacto-ovo-vegetarian (95.2%) and the remnants 5 were vegan (4.8%).

The two groups were homogeneous in terms of age and origin (percentage of Italians and foreigners), but in the control group a wider range of foreign countries of origin was observed compared to the vegetarian group, indeed in vegetarian group the 86.79% of the foreigners came from South Asia (p < 0.001).

As far as the parity is concerned, we found a higher percentage of nulliparous women in the vegetarian (62.14%) compared to the control group (49.51%), p = 0.04.

The main demographic and anthropometrics characteristics are summarized in table 1.

Table 1: Demographic and anthropometrics characteristics in the study groups.

	Vegetarian (n=103)	Controls (n=206)	P value
Mean Maternal age (years)	32.99 ± 5.47	31.87 ± 5.24	0.082
Maternal age >35 years	33 (32.04%)	50 (24.27%)	0.173
Italian place of origin	50 (48.54%)	116 (56.31%)	0.227
Foreigners			
South Asia	46 (86.79 %)	35 (38.89%)	<0.001
North Africa	2 (3.77%)	21 (23.33%)	0.002
Sub-Saharan Africa	0	9 (10.00%)	0.026
East Asia	0	8 (8.89%)	0.026
Non-Italian Caucasians	4 (7.55%)	15 (16.67%)	0.13
South America	1 (1.89%)	2 (2.22%)	>0.999
Pre-pregnancy weight (kg)	64.00 ± 11.97	66.40 ± 15.25	0.165
Pre-pregnancy BMI (kg/m²)	24.19 ± 4.39	24.46 ± 6.09	0.351
Underweight (BMI < 18,5 kg/m²)	5 (4.85%)	16 (7.77%)	0.473
Normal weight (BMI 18,5 - 24,9 kg/m²)	58 (56.31%)	109 (52.91%)	0.629
Overweight (BMI 25 - 29,9kg/m²)	26 (25.24%)	52 (25.24%)	>0.999
Obesity (BMI 30 ≥ kg/m²)	14 (13.59%)	29 (14.08%)	>0.999
Type I (BMI 30 - 34,9 kg/m²)	13 (92.86%)	15 (51.72%)	**0.015**
Type II /III (BMI 35 kg/m²)	1 (7.14%)	14 (48.28%)	**0.015**

Regarding the use of food supplements during pregnancy, a greater intake of acetylsalicylic acid 150mg emerged among vegetarians (veg = 15.53%; controls = 6.80%; p = 0.023), justified by a greater presence of anamnestic risk within the group under examination.

An overview of the mainly used food supplements is reported in table 2.

Table 2: Drugs and food supplement in pregnancy.

	Vegetarian (n=103)	Controls (n=206)	P value
Low-dose aspirin (150mg)	16 (15.53%)	14 (6.80%)	**0.023**
Vitamin B12	3 (2.91%)	5 (2.43%)	>0.999
Iron	20 (19.41%)	33 (16.02%)	0.522
Vitamin D	6 (5.83%)	10 (4.86%)	0.787
DHA	0	2 (0.98%)	0.554

The two study arms resulted homogeneous with regards to maternal outcomes during pregnancy (table 3). However, stratifying group of vegetarians according to the country of origin, a significant difference was found in the prevalence of gestational diabetes mellitus (GDM), which was greater among foreign vegetarians (foreign vegetarians N=17, 30.91%; Italian vegetarians N=5, 10%; p=0.008).

Table 3. High risk pregnancies.

	Vegetarian (n=103)	Controls (n=206)	P value
Type I diabetes	1 (0.97%)	3 (1.46%)	>0.999
Type II diabetes	0	3 (1.46%)	0.556
Chronic Hypertension	1 (0.97%)	0	0.333
Gestational Diabetes Mellitus	22 (21.36%)	35 (16.99%)	0.355
Pregnancy Hypertensive Disorders	12 (11.65%)	14 (6.80%)	0.191
Cholestasis	3 (2.91%)	6 (2.91%)	>0.999
Anemia in pregnancy (Hb<9,5g/dl)	7 (6.78%)	13 (6.31%)	0.807

As regards intrapartum outcomes (induction of labor, delivery mode, augmentation with oxytocin, epidural analgesia, episiotomy and spontaneous vagino-perineal lacerations) no significant differences were found between the two groups. While in the omnivore group there was a greater prevalence of post-partum hemorrhage following vaginal birth (veg=13.92%; controls=26.35%; p=0.03); even if no differences were found in terms of mean hemoglobin and anemia at delivery and post-partum.

A statistically significant difference was also found in the gestational age at birth (days) which was approximately 6 days less in the vegetarian/vegan group (vegetarians=270.74±14.34; controls= 276.14±15; p=0.003), difference justified by the higher prevalence of preterm birth, namely late preterm, among cases (cases=12.62%; controls=4.37%; p=0.017).

In line with these results, neonatal weight was lower, on average, by approximately 300g in the vegetarian group (3032.12g±595.41g; controls=3305.25g±513.01g; p=0.0003) even if no differences were observed in terms of prevalence of SGA. On the other hand, the newborns showing a weight lower than 2500g were significantly higher in vegetarian group (veg = 16.50%; controls = 4.85%; p=0.002). Moreover, the rate of intrauterine growth restriction (IUGR) was 12.62% in the vegetarian group and was 6.79% in the controls, p=0.087. These data are reported in Table 4. Furthermore, a prevalence of large for gestational age (LGA) infants was observed in the control group (veg=3.88%; controls=10.68%; p= 0.05).

The multivariate logistic regression demonstrated that the risk of preterm birth was increased in vegetarian women, smoking during pregnancy and was reduced by an appropriate weight gain. Moreover, the risk of low birthweight was associated with a vegetarian diet, preterm birth and IUGR; while the risk of LGA was reduced by a vegetarian diet, and increased by the parity, with obesity, and with a weight gain above the Institute of Medicine (IOM) recommendations [6] (Table 5).

Table 4: Gestational age at birth, preterm birth and neonatal birthweight

	Vegetarian (n=103)	Controls (n=206)	P value
Gestational Age (days)	270.74 ± 14.34	276.14 ± 15.15	0.003
Preterm Birth	13 **(12.62%)**	9 **(4.37%)**	**0.017**
Late preterm	8 (61.54%)	0	0.648
Moderate preterm	3 (23.08%)	0.648	0.240
Very preterm	2 (15.38%)	0.240	>0.999
Early preterm	0	>0.999	
IUGR	13 (12.62%)	14 (6.79%)	0.087
SGA (10°cle)	26 (25.24%)	43 (20.87%)	0.388
Neonatal birthweight < 2500g	16 (16.50%)	10 (4.85%)	0.002
LGA (90°cle)	4 (3.88%)	22 (10.68%)	0.050
Neonatal birthweight >4000g	1 (0.97%)	11 (5.34%)	0.068

Table 5: Multivariate logistic regression for the risk of Preterm Birth, of Low birthweight and LGA.

	Odds Ratio (OR)	95% CI	P value
Preterm Birth			
Vegetarian diet	3.166	1.218 - 8.540	0.019
Smoking during pregnancy	10.79	1.042 - 88.13	0.030
Pathologies of pregnancy	2.164	0.759 - 6.102	0.143
Maternal age	0.970	0.877 - 1.073	0.554
Foreign ethnicity	0.699	0.217 - 2.237	0.542
Parity	0.899	0.447 - 1.657	0.749
Prepregnancy BMI	0.931	0.829 - 1.035	0.203
Weight gain within IOM recommendations	0.873	0.785 - 0.963	0.009
Low Birthweight			
Vegetarian diet	4.420	1.234 – 18.180	0.0275
Preterm Birth	51.12	11.54 - 288.90	<0.001
IUGR	93.66	20.14 - 584.70	<0.001
Preeclampsia	2.006	0.430 - 9.063	0.367
Smoking during pregnancy	0.878	0.011 – 27.03	0.950
Prepregnancy BMI <18,5 Kg/m2	0.163	0.001 – 3.839	0.389
Weight Gain < IOM	1.509	0.401 - 5.801	0.539
LGA			
Vegetarian diet	0.278	0.072 - 0.829	0.036
Parity	1.714	1.057 - 2.750	0.025
Prepregnancy BMI 30≥Kg/m²	2.948	1.055 - 7.916	0.034
Weight Gain > IOM	5.289	2.131 - 13.49	0.0004
Etnicity	0.059	0.219 - 1.527	0.289
Diabetes/GDM	1.826	0.614 - 5.069	0.257
Gestational age (days)	0.991	0.962 - 1.020	0.527

Discussion

This retrospective case-control study compares the maternal-fetal outcomes of women who followed a vegetarian or vegan diet during

The demographic characteristics of the two study groups showed a statistically significant difference in the percentage of foreign women within the vegetarian group; in particular, within the group of foreign vegetarians, the South Asian ethnic group (India, Bangladesh,

Pakistan, Sri Lanka) clearly prevails, in accordance with a 2014 survey [2] which places India at the top of the list of the most vegetarian countries in the world, with an average that reaches (and in certain areas exceeds) 30% of the population.

Analyzing the anthropometric characteristics of the two groups, no particular differences are found, neither in terms of pre-pregnancy BMI nor in terms of weight gain. However, if we analyze the obese group in detail, a difference is highlighted in the prevalence of different degrees of obesity: among vegetarians, almost all of the obese fall within the mild type I obesity category, while among the controls there is a significant percentage of medium-severe obese (type II and type III). This result agrees with several observational studies which state that vegetarian women tend to have a lower BMI [7].

A significant difference was found in the use of acetylsalicylic acid 150mg during pregnancy, with greater use among vegetarians. This could be attributable to the presence of a greater number of maternal anamnestic risk factors, such as chronic hypertension, multiple abortions and nulliparous maternal age over 40 years of age, in accordance with the ACOG 2013 [8] and NICE 2019 guidelines [9], which could, in turn, be attributable to the different ethnic compositions among vegetarians. However, analyzing the consumption of supplements during pregnancy, we observe, in the vegetarian group, the consumption of vitamin B12 does not differ in respect to the omnivorous differently from what is recommended by the guidelines [10]. Indeed, the guidelines states that women at risk of vitamin B12 deficiency (vegetarian and vegan) should take a dosage at the beginning of pregnancy (if a recent dosage is not available) and should be monitored periodically during pregnancy, in order to avoid deficiency states that would be harmful to the mother and for the fetus [11-12].

This could reflect both a superficial anamnesis and an actual lack of indications from the professionals following pregnant women.

The study highlighted a statistically significant difference in the gestational age at birth which was approximately 6 days shorter in pregnant women who followed a vegetarian diet during pregnancy. This difference can be explained by the higher incidence of preterm births within the vegetarian group. However, this percentage falls within the WHO estimated percentage of preterm births in the vegetarian group (between 5% and 18% in 184 countries) [13]. On the contrary, the Italian scientific societies SIGO, AOGOI, AGUI (2018), in agreement with the American Dietetic Association, stated that the percentage of Preterm Birth among vegetarians should not be different from omnivorous women [14]. Therefore, considering the results of this study, which are in contrast with this statement, through a multivariable logistic regression we analyzed the various risk factors that may have had an influence on the onset of preterm birth, including diet. The analysis shows that, even more influential than vegetarian nutrition in the onset of preterm birth, is the habit of smoking during pregnancy, which increases the risk by approximately 10 times. Instead, the weight gain within the IOM recommendation appears to be a protective factor.

Although several studies have recently shown that a balanced vegetarian diet favors the development of a healthy vaginal microbiota and that this is associated with a lower risk of genitourinary infections and therefore preterm birth [15], other studies have established that nutritional deficiencies of macronutrients and micronutrients, such as vitamin B12, vitamin D, vitamin E, calcium, zinc and DHA, are, on the contrary, closely associated with an increased risk of preterm birth [16-18]. Given the results of our study on the use of supplements during pregnancy, significantly below recommendations, the high prevalence of preterm birth in the vegetarian group probably reflects nutritional deficiencies in women that have not been adequately investigated, prevented and treated by the healthcare professionals who took care of them.

An interesting finding concerns the significant difference between the study groups of the infant birthweight. Indeed, infants born to vegetarian mothers weight on average approximately 273g less than those born to omnivorous mothers. In particular, no significant differences were observed in the prevalence of small for gestational age (SGA) newborns between groups; while a higher rate of newborns weighting less than 2500 g is found in the vegetarian groups, similarly to the preterm birth rate. Meaning that the difference between the birthweight in the two study arms is to be attributed more to prematurity than to the maternal diet. To confirm this hypothesis, a multivariable logistic regression was conducted, which identified preterm birth as the factor that had the greatest influence on the birth of low-weight newborns, together with the IUGR. However, this condition is present in a similar percentage within the two groups and therefore cannot be responsible for the difference in prevalence of newborns weighing less than 2500g in the two study arms. In this logistic regression, having adopted a vegetarian diet during pregnancy increases the risk of low-weight newborn by approximately 4 times compared to having followed an omnivorous diet, probably because nutritional deficiencies not adequately identified and treated have caused a greater occurrence of preterm births. Observing the percentages of LGA newborns, it is clear that among controls the prevalence is higher than among vegetarians, with a significant difference. If we observe the multivariable logistic regression for the risk of LGA newborn, the vegetarian diet appears to be protective in this sense, reducing the risk by 72.2%. On the contrary, among the factors which increase the probability of having a newborn weighing above the 90th centile, multiparity (for each child previously had the probability increases by approximately 1.7 times), obesity (the probability is 3 times higher than in normal weight women) and the weight gain above the IOM recommendations (with a risk up to 5 times higher), data in agreement with the systematic review and meta-analysis by Goldstein et al. 2017 [19].

Studies regarding the weight of newborns of vegetarian mothers bring conflicting results. Our data are in line with a study by the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) Fetal Growth Studies–Singletons, which claims that newborns born to vegetarian mothers tend to be lighter, probably due to the reduced weight gain of the pregnant woman, but they do not have a greater risk of being SGA [20].

As regards intrapartum outcomes (induction of labor, delivery mode, augmentation with oxytocin, epidural analgesia, episiotomy and spontaneous vagino-perineal lacerations) no significant differences were found between the two groups. Regarding the blood loss at delivery, it resulted on average, approximately 100ml more abundant in the control group, similarly to the post-partum hemorrhage cases, however these differences were not statistically significant. Moreover, evaluating the post-partum hemoglobin, very similar results were obtained in the two groups and no difference was also found in the incidence of anemia.

Overall, the neonatal outcomes in terms of Ph and BE (base excess) from umbilical cord sampling are similar, reflecting a similar neonatal adaptation between the two groups. There is a statistically significant difference regarding the Apgar score of 6 at the fifth minute of the newborn's life, which was higher in the vegetarian group. Probably, this difference is a direct consequence of the greater prevalence of preterm and low birthweight infants within the vegetarian group, in agreement with the study by Mannan et al. 2012 which maintains that the perinatal prognosis of SGA newborns depends on the degree of maturity reached and, therefore, on the gestational age reached, as well as on the place of birth and the adequacy of perinatal care [21].

Strengths and Limitations of the Study

Among the strengths of the study is the choice of a number of cases-controls in a ratio of 1:2, which allowed a more representative sample, a better estimate of the outcomes and increased the statistical relevance of the analyzes conducted, making the results more generalizable.

A further point of strength is the random criterion adopted for choosing the control group, which made it possible to avoid any selection bias on the part of the study author, maintaining a certain variety in terms of demographic and anthropometric characteristics within the group, such as in fact it is in the general population.

However, this variety of confounding factors also proved to be a point of weakness, as there is no homogeneity between the two groups in terms of ethnicity and equality and it was not possible to fully understand what role these differences may have had in determining certain outcomes.

An important limitation of this study lies in the missing information on the detailed eating habits and on the supplements taken during pregnancy.

Another limitation of the study is associated to the retrospective nature of the study, i.e. the lack of some data on smoking habits, postpartum hemoglobin, the postpartum method and the quality and quantity of amniotic fluid.

Conclusion

The most important data from the study is the greater risk of preterm birth among vegetarians, which has caused a higher prevalence of low-weight newborns within the group in question. Considering the results obtained from the analysis of supplements taken during pregnancy, it is possible that this outcome reflects nutritional deficiencies not adequately treated and appears associated with smoking habits. In this sense, the responsibilities of health professionals who accompany pregnant women are outlined, first of all the midwife: correct nutritional education, associated with an active lifestyle, is fundamental for the prevention of any adverse outcomes, together with early identification and correction of dietary imbalances through the integration of critical nutrients, in accordance with national and international guidelines. For this to be possible, rapid and continuous updating of health professionals on nutrition is essential, especially with regard to unconventional (but increasingly widespread) dietary models such as vegetarian and vegan diets.

Competing Interests

The authors declare no competing interests.

among those who experienced psychological stress. Therefore, besides improving dietary habits, it is necessary to promote self-esteem to address distorted body images and enhance overall well-being.

Authors' Contributions

Conceptualization, I.N. and E.P.; methodology, E.P., F.F. and I.N.; formal analysis, P.D.V.; investigation, G.F. and E.P.; data curation, G.F., P.D.V and D.M.; writing original draft preparation, D.M. and G.F.; writing review and editing, I.N., E.P., F.F.; supervision, I.N.; project administration, I.N. All authors have read and agreed to the published version of the manuscript.

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