



Comparison of the Effect of Maternal Vegetarian diets and Non-Vegetarian diets on Fat Free Mass in Neonates

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KEYWORDS

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ABSTRACT:

Background: Maternal nutrition during pregnancy plays a critical role in determining fetal growth and neonatal body composition. Differences in dietary patterns, particularly vegetarian versus non-vegetarian diets, may influence the development of fat-free mass in neonates.

Objective: To compare the effect of vegetarian and non-vegetarian maternal diets during pregnancy on the fat-free mass appropriate for gestational age (FFM-for-GA) in neonates.

Methods: This was a single-center, hospital-based, observational comparative study conducted in the Department of Pediatrics at Saveetha Institute of Medical and Technical Sciences (SIMATS), Chennai, between January and May 2025.

Results: The study findings revealed no significant differences in baseline maternal characteristics such as age, socioeconomic status, height, or BMI between the vegetarian and non-vegetarian groups. However, maternal weight was significantly higher among non-vegetarian mothers. Both groups had similar gestational ages at delivery and parity distribution. Dietary analysis showed that non-vegetarian mothers had significantly higher caloric, carbohydrate, and protein intake compared to vegetarian mothers, although fat intake showed only a non-significant trend toward higher values. Prenatal multivitamin use and neonatal gender distribution were comparable across groups. Importantly, neonates born to non-vegetarian mothers exhibited significantly greater fat-free mass (2.78 ± 0.29 kg vs. 2.64 ± 0.32 kg; $p = 0.001$), higher birth weight (3.12 ± 0.39 kg vs. 3.01 ± 0.41 kg; $p = 0.014$), and increased birth length (49.9 ± 2.2 cm vs. 49.2 ± 2.1 cm; $p = 0.007$) compared to those born to vegetarian mothers.

Conclusion: The study concludes that a non-vegetarian maternal diet during pregnancy is associated with significantly higher neonatal fat-free mass, birth weight, and length. Ensuring adequate nutritional intake in vegetarian mothers is essential to support optimal fetal growth outcomes.

Introduction

Maternal nutrition during pregnancy plays a critical role in shaping fetal growth, neonatal body composition, and long-term health outcomes. The intrauterine environment, particularly the availability of macro- and micronutrients, is a key determinant of fetal development

and the accretion of lean body mass,⁽¹⁾ which has implications for infant metabolic health and growth trajectories.⁽²⁾ In this context, maternal dietary patterns—vegetarian versus non-vegetarian—may exert differential effects on fetal growth parameters due to variations in nutrient quality, bioavailability, and overall caloric intake.



Vegetarian diets, while rich in fiber, phytochemicals, and certain micronutrients, may be relatively lower in high-quality proteins, vitamin B12, iron, zinc, and long-chain polyunsaturated fatty acids, all of which are essential for fetal growth and brain development.(3) In contrast, non-vegetarian diets provide animal-source foods that are dense in complete proteins and bioavailable nutrients, which may promote greater accrual of fetal lean mass and fat-free tissue. Some studies have shown that maternal protein and energy intake are directly correlated with increased neonatal birth weight and lean mass,(4) while deficiencies in critical nutrients—common in restrictive vegetarian or vegan diets—may be associated with suboptimal fetal growth.(5)

Emerging research suggests that vitamin B12, a nutrient predominantly found in animal-source foods, may function as an epigenetic modifier influencing gene expression related to muscle mass and growth.(6) Vitamin B12 plays a crucial role in one-carbon metabolism, DNA methylation, and cellular differentiation—all of which are vital processes during fetal development. Deficiencies in maternal vitamin B12 have been linked to adverse outcomes such as intrauterine growth restriction and reduced lean mass in neonates.(7) Given that vegetarian diets are often low in bioavailable vitamin B12, this study may provide indirect evidence supporting the role of B12 as a potential epigenetic regulator of fetal muscle mass development.

Fat-free mass (FFM), representing the metabolically active tissue of the neonate including muscles, bones, and organs, is considered a more accurate indicator of intrauterine nutritional status than birth weight alone.(8) Recent advancements in neonatal body composition assessment, particularly the use of air displacement plethysmography (ADP), have enabled precise quantification of neonatal FFM and fat mass shortly after birth, thereby allowing researchers to examine the effects of maternal factors on neonatal tissue distribution.(9) Despite a growing body of research examining the impact of maternal diet on fetal outcomes, limited studies have specifically compared neonatal fat-free mass between vegetarian and non-vegetarian mothers. Most available literature focuses primarily on birth weight, with inconsistent findings regarding the influence of vegetarian diets on neonatal anthropometry and body

composition.(10) Given the increasing adoption of vegetarian diets globally, including in India for cultural and religious reasons, it is imperative to assess whether such dietary patterns are adequate to support optimal neonatal growth, especially in terms of fat-free mass.(11) Against this background, the objective of the present study was to compare the effect of vegetarian and non-vegetarian maternal diets during pregnancy on the fat-free mass appropriate for gestational age (FFM-for-GA) in neonates.

Materials and Methods

This was a single-center, hospital-based, observational comparative study conducted in the Department of Pediatrics at Saveetha Institute of Medical and Technical Sciences (SIMATS), Chennai, over a period of five months from January to May 2025. Prior to initiation, the study protocol was reviewed and approved by the Institutional Human Ethics Committee of SIMATS. Written informed consent was obtained from all participating mothers after providing a detailed explanation of the study procedures and confidentiality assurance using a standardized Patient Information Sheet and consent form. The study included neonates aged between 1 and 10 days, born at term (≥ 37 weeks of gestation), and classified as appropriate for gestational age (AGA) according to INTERGROWTH-21st standards. Only neonates whose mothers adhered consistently to either a vegetarian or non-vegetarian diet throughout pregnancy were included. A gender-matched comparison was ensured across both dietary groups to eliminate sex-based confounding. Exclusion criteria comprised neonates born preterm or post-term, those with congenital anomalies, dysmorphic features, or perinatal asphyxia, as well as those requiring neonatal intensive care. Mothers with gestational diabetes, chronic hypertension, thyroid disorders, or mixed dietary patterns during pregnancy were also excluded from the study.

The sample size was calculated based on an expected effect size of 0.4, with a power of 80% and a confidence level of 95%, resulting in a requirement of 150 neonates in each group, totaling 300 participants. An additional 10% was considered to account for possible attrition. A consecutive sampling technique was employed, wherein eligible neonates born during the study period were recruited prospectively and allocated to the vegetarian or



non-vegetarian group following gender matching. Maternal dietary history was documented using a validated food frequency questionnaire, and neonates underwent detailed anthropometric and body composition assessments. Birth weight was measured using a calibrated electronic scale and used to compute weight-for-age Z-scores (WAZ) using WHO Anthro software. Skinfold thickness was measured at the triceps and subscapular regions using a Harpenden caliper, with three readings taken at each site and the average used for analysis. Body composition analysis was performed using air displacement plethysmography (Pea Pod® Infant Body Composition System), which provided accurate estimates of fat-free mass adjusted for gestational age based on normative data.

The primary outcome of interest was fat-free mass appropriate for gestational age (FFM-for-GA), compared between neonates of vegetarian and non-vegetarian mothers. Secondary outcomes included differences in WAZ scores and skinfold thickness measurements. Data were entered and analyzed using IBM SPSS Statistics version 28.0. Normality of distribution for continuous variables was assessed using the Shapiro–Wilk test. Means and standard deviations or medians and interquartile ranges were calculated as appropriate. Between-group comparisons were performed using the independent t-test or Mann–Whitney U test for continuous variables and the Chi-square or Fisher’s exact test for categorical variables. A p-value of less than 0.05 was considered statistically significant.

Results

The mean maternal age in the vegetarian group was 27.45 ± 3.21 years, while in the non-vegetarian group it was 27.18 ± 3.56 years ($p = 0.416$). Socioeconomic status

distribution was similar in both groups, with the majority of mothers belonging to the middle class (63.3% in the vegetarian group and 60.0% in the non-vegetarian group), followed by the upper and lower classes; the difference was not statistically significant ($p = 0.791$). Maternal height and BMI showed no significant differences between the groups, with mean heights of 156.3 ± 5.4 cm and 157.1 ± 5.9 cm ($p = 0.258$), and BMIs of 25.1 ± 2.4 and 25.4 ± 2.7 kg/m² ($p = 0.147$) in the vegetarian and non-vegetarian groups respectively. However, maternal weight was significantly higher in the non-vegetarian group (62.5 ± 6.8 kg) compared to the vegetarian group (61.2 ± 6.3 kg), with a p-value of 0.032.

The mean gestational age at delivery was comparable between the groups (38.6 ± 1.1 weeks in vegetarians vs. 38.7 ± 1.0 weeks in non-vegetarians; $p = 0.482$). Parity distribution was balanced, with primiparous mothers constituting 53.3% in the vegetarian group and 50.0% in the non-vegetarian group ($p = 0.563$). Dietary analysis revealed that total caloric intake was significantly higher in the non-vegetarian group (2140 ± 162 kcal/day) compared to the vegetarian group (2080 ± 154 kcal/day; $p = 0.015$). Similarly, intake of carbohydrates (328 ± 30 g/day vs. 320 ± 32 g/day; $p = 0.027$) and protein (61 ± 5 g/day vs. 58 ± 6 g/day; $p = 0.003$) were significantly greater in the non-vegetarian group. Fat intake showed a non-significant trend toward higher consumption in non-vegetarians (64 ± 7 g/day) compared to vegetarians (62 ± 8 g/day; $p = 0.092$). The use of prenatal multivitamins was comparable between groups, with 80.0% of vegetarian and 82.7% of non-vegetarian mothers reporting use ($p = 0.553$). Neonatal gender distribution was also similar, with males comprising 53.3% in the vegetarian and non-vegetarian groups ($p = 1.000$).

Table 1: Baseline characteristics of the study groups

Characteristic		Vegetarian Group (n=150)	Non-Vegetarian Group (n=150)	p-value
Maternal age (years), Mean (SD)		27.45 ± 3.21	27.18 ± 3.56	0.416
Socioeconomic status, n (%)	Upper	35 (23.3)	40 (26.7)	0.791
	Middle	95 (63.3)	90 (60.0)	
	Lower	20 (13.3)	20 (13.3)	



Maternal height (cm), Mean (SD)		156.3 ± 5.4	157.1 ± 5.9	0.258
Maternal weight (kg), Mean (SD)		61.2 ± 6.3	62.5 ± 6.8	0.032
Maternal BMI (kg/m ²), Mean (SD)		25.1 ± 2.4	25.4 ± 2.7	0.147
Gestational age (weeks), Mean (SD)		38.6 ± 1.1	38.7 ± 1.0	0.482
Parity, n (%)	Primipara	80 (53.3)	75 (50.0)	0.563
	Multipara	70 (46.7)	75 (50.0)	
Total calories (kcal/day), Mean (SD)		2080 ± 154	2140 ± 162	0.015
Carbohydrates (g/day), Mean (SD)		320 ± 32	328 ± 30	0.027
Protein (g/day), Mean (SD), Mean (SD)		58 ± 6	61 ± 5	0.003
Fat (g/day), Mean (SD), Mean (SD)		62 ± 8	64 ± 7	0.092
Use of prenatal multivitamins, n (%)	Yes	120 (80.0)	124 (82.7)	0.553
	No	30 (20.0)	26 (17.3)	
Neonatal gender, n (%)	Male	80 (53.3)	80 (53.3)	1.000
	Female	70 (46.7)	70 (46.7)	

The comparison of key neonatal outcomes revealed statistically significant differences between the vegetarian and non-vegetarian groups. Neonates born to non-vegetarian mothers had a higher mean fat-free mass (2.78 ± 0.29 kg) compared to those born to vegetarian mothers (2.64 ± 0.32 kg), with a mean difference of -0.14 kg (95% CI: $-0.21, -0.07$; $p = 0.001$). Similarly, the mean birth weight was greater in the non-vegetarian group (3.12 ± 0.39 kg) than in the vegetarian group (3.01

± 0.41 kg), yielding a statistically significant mean difference of -0.11 kg (95% CI: $-0.20, -0.02$; $p = 0.014$). Birth length was also higher among neonates in the non-vegetarian group (49.9 ± 2.2 cm) compared to the vegetarian group (49.2 ± 2.1 cm), with a mean difference of -0.70 cm (95% CI: $-1.21, -0.19$; $p = 0.007$). These findings indicate that maternal non-vegetarian diet during pregnancy is associated with significantly higher fat-free mass, birth weight, and birth length in neonates.

Table 2: Comparison of study groups by Fat-Free Mass (kg), Birth Weight (kg), and Birth Length (cm)

Parameter	Vegetarian Group	Non-Vegetarian Group	Mean Difference [95% CI]	p-value
Fat-Free Mass (kg)	2.64 ± 0.32	2.78 ± 0.29	$-0.14 [-0.21, -0.07]$	0.001
Birth Weight (kg)	3.01 ± 0.41	3.12 ± 0.39	$-0.11 [-0.20, -0.02]$	0.014
Birth Length (cm)	49.2 ± 2.1	49.9 ± 2.2	$-0.70 [-1.21, -0.19]$	0.007

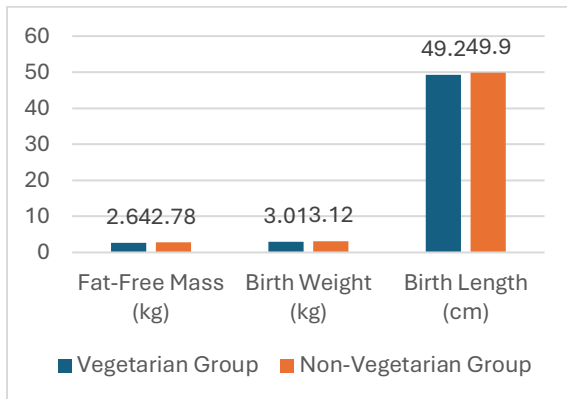


Figure 1: Comparison of study groups by Fat-Free Mass (kg), Birth Weight (kg), and Birth Length (cm)

Discussion

This observational comparative study examined the influence of maternal dietary patterns—vegetarian versus non-vegetarian—during pregnancy on neonatal body composition, specifically focusing on fat-free mass appropriate for gestational age (FFM-for-GA). The findings demonstrated that neonates born to non-vegetarian mothers had significantly higher fat-free mass, birth weight, and birth length compared to those born to vegetarian mothers. These results underscore the importance of maternal nutrition quality, especially protein and micronutrient intake, in determining neonatal growth outcomes.

Despite comparable maternal characteristics such as age, socioeconomic status, height, and body mass index, a statistically significant difference in maternal weight and dietary intake was observed between the two groups. Non-vegetarian mothers consumed higher total calories, protein, and carbohydrates, which likely contributed to improved neonatal growth markers. The association between increased maternal protein intake and greater neonatal fat-free mass is consistent with findings from previous studies. For example, Blumfield et al.(12) (2012) reported that maternal protein intake during pregnancy positively correlates with birth weight and lean mass in neonates, especially when protein is derived from animal sources rich in essential amino acids. Fat-free mass in neonates primarily reflects skeletal muscle and organ development, both of which are highly dependent on adequate maternal protein, iron, zinc, and vitamin B12 intake—nutrients more abundantly available in non-vegetarian diets.(13) Vegetarian diets,

while often rich in fiber and phytochemicals, may lack bioavailable sources of these critical nutrients unless carefully supplemented or fortified. In this study, although multivitamin use was similar across groups, the observed differences in neonatal anthropometric outcomes suggest that standard supplementation might not fully bridge the nutritional gap introduced by an exclusively vegetarian diet during pregnancy.(14)

Birth weight and length also showed significant differences favoring the non-vegetarian group. These metrics are strong predictors of neonatal health and long-term growth and development. The WHO recognizes low birth weight and suboptimal linear growth at birth as major public health concerns due to their association with increased morbidity, impaired immune function, and long-term cognitive deficits.(15) The present findings are in line with those of Derbyshire (2016), who highlighted that vegetarian mothers tend to deliver neonates with slightly lower birth weights, attributed to lower energy and protein density of plant-based diets unless appropriately planned.(16) Importantly, the observed differences in FFM-for-GA highlight not only the quantity but also the quality of fetal growth. While fat mass reflects energy reserves, fat-free mass more directly corresponds to functional tissue development. A higher FFM at birth is linked to better metabolic health and growth trajectories in infancy.(17-19) Therefore, the dietary choices of pregnant women can have substantial implications for neonatal body composition and later-life health outcomes.(20, 21)

Nevertheless, the implications of these findings should be contextualized. Well-planned vegetarian diets supplemented with essential nutrients can support healthy pregnancies and favorable birth outcomes. The American Dietetic Association (now the Academy of Nutrition and Dietetics) states that appropriately planned vegetarian diets, including vegan diets, are nutritionally adequate for pregnancy and can offer health benefits.(22) However, this requires deliberate dietary planning and possibly supervised supplementation, particularly for nutrients like vitamin B12, iron, and high-quality protein.

The present study has certain limitations that must be acknowledged. As an observational study conducted in a single tertiary care center, the findings may not be generalizable to broader populations with differing socioeconomic, cultural, or dietary backgrounds.



Although efforts were made to control for confounding variables such as maternal age, BMI, and parity, residual confounding from unmeasured factors like genetic influences, environmental exposures, or micronutrient status may still exist. The reliance on self-reported dietary history using a food frequency questionnaire is subject to recall bias and may not accurately capture actual nutrient intake or dietary adherence throughout pregnancy. Additionally, although the study excluded mothers with known comorbidities, undiagnosed conditions such as subclinical hypothyroidism or nutritional deficiencies may have influenced neonatal outcomes. The study also did not assess long-term neonatal growth or developmental outcomes, limiting the ability to evaluate the sustained impact of maternal diet beyond the immediate postnatal period. Finally, the cross-sectional nature of the assessment at birth precludes establishing a causal relationship between maternal diet and neonatal fat-free mass, underscoring the need for prospective, longitudinal studies with more detailed nutritional and metabolic assessments.

Conclusion

In conclusion, the present study demonstrates that maternal dietary patterns during pregnancy have a significant influence on neonatal body composition, particularly fat-free mass, birth weight, and birth length. Neonates born to non-vegetarian mothers exhibited higher fat-free mass appropriate for gestational age, as well as greater birth anthropometric measures, compared to those born to vegetarian mothers. These differences are likely attributable to the higher intake of protein, calories, and key micronutrients associated with non-vegetarian diets. While both dietary patterns can support healthy pregnancies when well-planned, the findings underscore the importance of ensuring adequate nutritional intake—especially of high-quality protein and micronutrients—among vegetarian mothers. The study highlights the need for individualized nutritional counseling during pregnancy and provides a foundation for future research exploring dietary interventions aimed at optimizing fetal growth and neonatal body composition.

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